UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,596,517 B2
APPLICATION NO. : 15/997091
DATED : March 24, 2020
INVENTOR(S) : Olson et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

On page 3, in Column 2, item (56) under "Other Publications", Line 3, delete "ated" and insert --dated-- therefor

On page 6, in Column 2, item (56) under "Other Publications", Line 28, delete "Actioin" and insert --Action-- therefor

On page 6, in Column 2, item (56) under "Other Publications", Line 39, delete "Serrial" and insert --Serial-- therefor

On page 7, in Column 1, item (56) under "Other Publications", Line 7, delete "dateed" and insert --dated-- therefor

On page 7, in Column 2, item (56) under "Other Publications", Line 16, delete "Seril" and insert --Serial-- therefor

On page 8, in Column 2, item (56) under "Other Publications", Line 16, delete "Combinded" and insert --Combined-- therefor

On page 8, in Column 2, item (56) under "Other Publications", Line 46, delete "Reducton" and insert --Reduction-- therefor

In the Drawings

On sheet 6 of 11, Fig. 6, Line 1, delete "O2" and insert --O_2-- therefor

On sheet 6 of 11, Fig. 6, Line 1, delete "μg/dNm3," and insert --μg/dNm^3,-- therefor

Signed and Sealed this
Fifteenth Day of December, 2020

Andrei Iancu
Director of the United States Patent and Trademark Office

In the Specification

In Column 4, Line 25, delete "grain" and insert --gram-- therefor

In Column 11, Line 25, delete "reagents)" and insert --reagent(s)-- therefor

In Column 15, Line 59, after "(2.5 inch (6.35 cm))", insert --.--

In Column 16, Line 58, after "water", insert --.--

In Column 17, Line 59, delete "(635" and insert --(6.35-- therefor

In Column 19, Line 3, delete "it" and insert --11-- therefor

In Column 20, Line 44, after "ranges", insert --(in--

In Column 20, Line 63, delete "fg/m^3." and insert --μg/m^3.-- therefor

In Column 21, Line 22, after "have", insert --a--

In Column 22, Line 46, delete "fit" and insert --frit-- therefor

In Column 23, Line 47, delete "According y," and insert --Accordingly,-- therefor

In Column 25, Line 54, delete "1.00 g" and insert --100 g-- therefor

In Column 26, Line 26, delete "O_2S_5." and insert --P_2S_5.-- therefor

In Column 28, Line 60, after "effective", insert --.--

In Column 31, Line 66, delete "here" and insert --There-- therefor

In Column 32, Line 1, delete "his" and insert --This-- therefor

In Column 33, Line 9, delete "galium," and insert --gallium,-- therefor

In Column 35, Line 8, after "sorbent", insert --.--

In the Claims

In Column 38, Lines 10-11, in Claim 29, delete "or a combination thereof, or a combination thereof;" and insert --or a combination thereof;-- therefor

In Column 38, Lines 25-26, in Claim 30, delete "or a combination thereof, or a combination thereof;" and insert --or a combination thereof;-- therefor

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 11/19/2020
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
11/19/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Patent No.: 10596517
Issue Date: 03/24/2020
Appl. No.: 15/997,091
Filed: 06/04/2018

PART (A) RESPONSE FOR CERTIFICATES OF CORRECTION

This is a decision on the Certificate of Correction request filed 26 October 2020.

The request for issuance of Certificate of Correction for the above-identified correction(s) under the provisions of 37 CFR 1.322 and/or 1.323 is hereby:

(Check one)
☑ Approved ☐ Approved in Part ☐ Denied

Comments: ____

PART (B) PETITION UNDER 37 CFR 1.324 OR 37 CFR 1.48

☐ This is a decision on the petition filed ____ to correct inventorship under 37 CFR 1.324.

☐ This is a decision on the request under 37 CFR 1.48, petition filed ____. In view of the fact that the patent has already issued, the request under 37 CFR 1.48 has been treated as a petition to correct inventorship under 37 CFR 1.324.

The petition is hereby: ☐ Granted ☐ Dismissed

Comment: ____

The patented filed is being forwarded to Certificate of Corrections Branch for issuance of a certificate naming only the actual inventor or inventors.

/AMBER R ORLANDO/
Supervisory Patent Examiner, Art Unit 1791
Technology Center 1700
Phone: (571)270-3149

Certificates of Correction Branch email: CustomerServiceCoC@uspto.gov CoC Central Phone Number: (703) 756-1814

IN UNITED STATES PATENT AND TRADEMARK OFFICE

Patent No.:	10,596,517 B2	Docket No: 4820.001U10	
Issue Date:	Mar. 24, 2020	Patentee: Midwest Energy Emissions Corp.	
Customer No.:	21186	Confirmation No.: 5161	
Title	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

REQUEST FOR CERTIFICATE OF CORRECTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
ATTN: CERTIFICATE OF CORRECTION BRANCH

It is requested that a Certificate of Correction be issued correcting printing errors appearing in the above-identified United States patent. A copy of the text of the Certificate in the suggested form is enclosed.

Authorization is given to charge Deposit Account No. 19-0743 in the amount of $160.00 to cover the Certificate of Correction Fee.

Issuance of the Certificate of Correction would neither expand nor contract the scope of the claims as properly allowed, and re-examination is not required.

The Examiner is authorized to charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully Submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date : October 26, 2020

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No: 63,803

CERTIFICATE UNDER 37 CFR § 1.8: The undersigned hereby certifies that this correspondence is filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450, on this 26th day of October 2020

Janine Heitland
Name

/Janine Heitland/
Signature

PTO/SB/44 (02-01)
Approved for use through 01/31/2004. OMB 0651-0033
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO : 10,596,517 B2 Page (1) of 3

DATED : Mar. 24, 2020

INVENTOR(S) : Olson et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

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In column 4, line 25, delete "grain" and insert --gram-- therefor

In column 11, line 25, delete "reagents)" and insert --reagent(s)-- therefor

MAILING ADDRESS OF SENDER:

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
Minneapolis, MN 55402

Atty Docket No: 4820.001U10

PATENT NO. 10,596,517

No. of additional copies

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U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
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UNITED STATES PATENT AND TRADEMARK OFFICE
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In column 31, line 66, delete "here" and insert --There-- therefor

MAILING ADDRESS OF SENDER:

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
Minneapolis, MN 55402

Atty Docket No: 4820.001U10

PATENT NO. 10,596,517

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO : 10,596,517 B2

DATED : Mar. 24, 2020

INVENTOR(S) : Olson et al.

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In column 33, line 9, delete "galium," and insert --gallium,-- therefor

In column 35, line 8, after "sorbent", insert --.--

In column 38, lines 10-11, in Claim 29, delete "or a combination thereof, or a combination thereof;" and insert --or a combination thereof;-- therefor

In column 38, lines 25-26, in Claim 30, delete "or a combination thereof, or a combination thereof;" and insert --or a combination thereof;-- therefor

MAILING ADDRESS OF SENDER:

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
Minneapolis, MN 55402

Atty Docket No: 4820.001U10

PATENT NO. 10,596,517

No. of additional copies

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Midwest Energy Emissions Corp.
Examiner: Amber R. Orlando

Patent No.: 10,596,517 B2
Group Art Unit: 1776

Issue Date: Mar. 24, 2020
Docket No: 4820.001U10

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
ATTN: CERTIFICATE OF CORRECTION BRANCH

We are transmitting herewith the attached:

X Authorization to charge Deposit Account No. 19-0743 in the amount of $160.00 to cover the Certificate of Correction Fee.
X Request for Certificate of Correction. (1 pg.)
X Certificate of Correction Form - PTO-1050 (3 pgs.)

Please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
Customer No: 21186

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No: 63,803

CERTIFICATE UNDER 37 CFR § 1.8: The undersigned hereby certifies that this correspondence is filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450, on this 26th day of October 2020.

Janine Heitland
Name

/Janine Heitland/
Signature

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Susan Yee/Janine Heitland
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
CERTIFICATE OF CORRECTION	1811	1	160	160

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Electronic Acknowledgement Receipt

EFS ID:	40940642
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Susan Yee/Janine Heitland
Filer Authorized By:	Susan Yee
Attorney Docket Number:	4820.001US10
Receipt Date:	26-OCT-2020
Filing Date:	04-JUN-2018
Time Stamp:	10:45:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$160
RAM confirmation Number	E20200PA46196596
Deposit Account	190743
Authorized User	Janine Heitland

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		4820001U10COC.pdf	250259 51149170f36ea7c833c4946c1c6eaf86efc4dd6c	yes	5
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Request for Certificate of Correction		2	5	
	Transmittal Letter		1	1	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30285 4c570dd13f88ae1699827df715a4788a46b95e57	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	280544		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	03/24/2020	10596517	4820.001US10	5161

21186 7590 03/04/2020

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Edwin S. Olson, Grand Forks, ND;
Midwest Energy Emissions Corp., Corsicana, TX;
Michael J. Holmes, Thompson, ND;
John H. Pavlish, East Grand Forks, MN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/997,091	06/04/2018	1776	2720	4820.001US10	20	1

CONFIRMATION NO. 5161

CORRECTED FILING RECEIPT

21186
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

OC000000114302051

Date Mailed: 01/30/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Edwin S. Olson, Grand Forks, ND;
Michael J. Holmes, Thompson, ND;
John H. Pavlish, East Grand Forks, MN;

Applicant(s)

Midwest Energy Emissions Corp., Corsicana, TX;

Power of Attorney: The patent practitioners associated with Customer Number 21186

Domestic Priority data as claimed by applicant

This application is a CON of 15/974,343 05/08/2018
which is a CON of 15/951,970 04/12/2018
which is a CON of 14/712,558 05/14/2015
which is a CON of 14/318,270 06/27/2014 PAT 9757689
which is a CON of 13/966,768 08/14/2013 PAT 8821819
which is a CON of 13/427,665 03/22/2012 PAT 8512655
which is a CON of 12/419,219 04/06/2009 PAT 8168147
which is a CON of 12/201,595 08/29/2008 ABN
which is a CON of 11/209,163 08/22/2005 PAT 7435286
which claims benefit of 60/605,640 08/30/2004

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/21/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/997,091**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Preliminary Class

095

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign

patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION RE: UPDATE TO APPLICATION DATA SHEET

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicants hereby request that the information provided on the Application Data Sheet filed in the above-referenced application on June 4, 2018, be updated with the information as provided on the enclosed marked up Application Data Sheet.

We therefore submit a marked up copy of the Application Data Sheet which shows an update to the application information.

Once this request is entered, it is respectfully requested that the USPTO update their records and provide confirmation of the above request by way of an Updated Filing Receipt.

It is believed that no fee is required to fulfill this request, however, if necessary, please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

Schwegman Lundberg & Woessner, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 01/28/2020 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor:

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix

Residence Information (Select One) ☐ US Residency ☐ Non US Residency ☐ Active US Military Service

City		State/Province		Country of Residence	

Mailing Address of Inventor:

Address 1			
Address 2			
City		State/Province	
Postal Code		Country	

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence Information of this application.

Customer Number	
Email Address	

Application Information:

Title of the Invention			
Attorney Docket Number		Small Entity Status Claimed ☐	
Application Type			
Subject Matter			
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country Publication

Publication Information:

☐ **Request Early Publication (Fee required at time of Request 37 CFR 1.219)**

☐ **Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.**

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	☐ Customer	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number			

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Foreign Priority Information:

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

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This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)i the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the POX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Parent Filing Date (YYYY-MM-DD)	Access Code (if applicable)

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant must opt-out of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is ONLY reviewed and processed with the INITIAL filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ **A. Applicant DOES NOT authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.**

☐ **B. Applicant DOES NOT authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.**

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant: Midwest Energy Emissions Corp.

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor
☐ Person to whom the inventor is obligated to assign	☐ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

☐ Deceased	☐ Legally incapacitated

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here: ☒

Organization Name: Midwest Energy Emissions Corp.

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information:

Address 1	~~670 D Enterprise Dr.~~ 1810 Jester Dr		
Address 2			
City	~~Lewis Center~~ Corsicana	State/Province	~~OH~~ TX
Country	United States of America	Postal Code	~~43035~~ 75109
Phone Number			
Email Address			

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is **a juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Nicholas M. Lanzatella/			Date (YYYY-MM-DD)	2020-01-28
First Name	Nicholas	Last Name	Lanzatella	Registration Number	63,803

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-14**

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Midwest Energy Emissions Corp.

Application No./Patent No.: 15/997,091 Filed/Issue Date: June 4, 2018

Titled: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Midwest Energy Emissions Corp. a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3 ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel , Frame , or for which a copy thereof is attached.

B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: PAVLISH, JOHN H. To: ENERGY AND ENVIRONMENTAL RESEARCH CENTER FOUNDATION

   The document was recorded in the United States Patent and Trademark Office at
   Reel 050462, Frame 0111, or for which a copy thereof is attached.

2. From: OLSON, EDWIN S. To: ENERGY AND ENVIRONMENTAL RESEARCH CENTER FOUNDATION

   The document was recorded in the United States Patent and Trademark Office at
   Reel 050461, Frame 0076, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: HOLMES, MICHAEL J. To: ENERGY AND ENVIRONMENTAL RESEARCH CENTER FOUNDATION

The document was recorded in the United States Patent and Trademark Office at
Reel 050461, Frame 0741, or for which a copy thereof is attached.

4. From: ENERGY AND ENVIRONMENTAL RESEARCH CENTER FOUNDATION To: MIDWEST ENERGY EMISSIONS CORP.

The document was recorded in the United States Patent and Trademark Office at
Reel 050462, Frame 0607, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Nicholas P. Lanzatella/
Signature

01/28/2020
Date

Nicholas P. Lanzatella
Printed or Typed Name

USPTO Reg. No. 63,803
Title or Registration Number

Electronic Acknowledgement Receipt

EFS ID:	38422251
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Garrett M. Hall/Diana Johnson
Filer Authorized By:	Garrett M. Hall
Attorney Docket Number:	4820.001US10
Receipt Date:	28-JAN-2020
Filing Date:	04-JUN-2018
Time Stamp:	15:53:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		4820001U10UpdatedADSsigned.pdf	373891 d728d99c68e05826e34258c1d1b698bb02d750b8	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Request for Corrected Filing Receipt	2	2
	Application Data Sheet	3	8
	Assignee showing of ownership per 37 CFR 3.73	9	10
Warnings:			
Information:			
	Total Files Size (in bytes):	373891	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10		
Filed:	June 4, 2018	Serial No.:	15/997,091
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the attached:

X Communication Re: Update to Application Data Sheet (1 Pg.).
X Marked Up Application Data Sheet (6 Pgs.).
X Statement Under 37 CFR 3.73 (c) (2 pgs.)

It is believed that no additional fee is required. However, if necessary, please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743.

Schwegman Lundberg & Woessner, P.A.
Customer No.: 21186

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 28th day of January, 2020.

Diana Johnson
Name

/Diana Johnson/
Signature

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 11/25/2019

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
11/25/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 15/997,091	**Applicant(s)** Olson et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 11 November 2019 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☐ for an original nonprovisional application (Track I).
B. ☑ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/ Paralegal Specialist, OPET	

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 11/22/2019
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
11/22/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Corrected ***Notice of Allowability***	**Application No.** 15/997,091	**Applicant(s)** Olson et al.	
	Examiner AMBER R ORLANDO	**Art Unit** 1776	**AIA (FITF) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the IDS filed 11/11/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Continuation of 3. The allowed claim(s) is/are: 1,9-10,12,16 and 18-42

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 2	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-10,471,412	11/12/2019	Olson, Edwin S, et al.
	US-20050274307A1	12/15/2005	Lissianski, Vitali Victor, et al.
	US-20190329179A1	10/31/2019	Olson, Edwin S., et al.
	US-20190329215A1	10/31/2019	Olson, Edwin S, et al.
	US-20190336913A1	11/7/2019	Olson, Edwin S, et al.

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Foreign Document Number	Publication Date	Name of Patentee or Applicant of cited Document	T1

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T1
	"Application Serial No. 15/382,114, Response filed 10-3-19 to Final Office Action mailed 06-21-19", 23 pgs	
	"Application Serial No. 15/589,359, Corrected Notice of Allowability mailed 10-11-19", 2 pgs	
	"Application Serial No. 15/974,343, Corrected Notice of Allowability mailed 10-23-19", 2 pgs	
	"Application Serial No. 16/509,071, Response filed 10-3-2019 to Non Final Office Action mailed 09-11-19", 26 pgs.	
	"Application Serial No. 16/509,102, Non Final Office Action mailed 10-23-19", 26 pgs	
	"Application Serial No. 16/509,146, Non Final Office Action mailed 10-17-19", 24 pgs	
	"Ch. 35: Mercury, Hazardous Air Pollutants and other Multi-Pollutant Control", Tomei, G. L. (Ed.). Steam: its generation and use, Babcock and Wilcox Co., (2015), 24 pgs.	
	"Defendant's Answer and Counterclaim", Midwest Energy Emissions Corp., et al., v. Vistra Energy Corp., et al. - Case 1:19-cv-01334-RGA, 71 pgs.	
	"Original Complaint for Patent Infringement", Midwest Energy Emissions Corp., et al., v. Vistra Energy Corp., et al. - Case 1:19-cv-01334-UNA, 31 pgs.	
	"Plaintiff's Answer to Defendant's Counterclaims", Midwest Energy Emissions Corp., et al., v. Vistra Energy Corp., et al. - Case 1:19-cv-01334-RGA, 37 pgs.	
	OLSON, E.S., et al., "Chemical mechanisms in mercury emission control technologies", J. Phys. IV France 107, Proc. of the XIIth Intl. Conference on Heavy Metals in the Environment Volume II, pp. 979-982, (2003), 6 pgs.	
	OLSON, EDWIN S., "Abstract - Multiple Site Model for Flue Gas - Mercury interactions on Activated Carbons: The Basic Site", Abstracts of Papers Part 1, 225th ACS National Meeting, New Orleans, LA, (2003), 3 pgs.	

EXAMINER /AMBER R ORLANDO/ **DATE CONSIDERED** 11/19/2019

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

Modified form PTO/SB/08A(04-07) OMB 651-0031
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	Application Number	15/997,091
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	Examiner Name	Amber Orlando
Sheet 2 of 2	Attorney Docket No: 4820.001U10	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
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	OLSON, EDWIN, et al., "The Multiple Site Model for Flue Gas - Mercury Interactions on Activated Carbons: The Basic Site", Fuel Chemistry Preprints, 48(1), (2003), 3 pgs.	

EXAMINER /AMBER R ORLANDO/ **DATE CONSIDERED** 11/19/2019

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

REQUEST FOR CONTINUED EXAMINATION (RCE) TRANSMITTAL		
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Confirmation Number	5161
	Group Art Unit	1776
	Examiner Name	Amber Orlando
	Attorney Docket Number	4820.001U10
	Customer No.	21186

This is a Request for Continued Examination (RCE) under 37 C.F.R § 1.114 of the above-identified application entitled
SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

1. Submission required under 37 C.F.R. § 1.114:

   X Petition to Withdraw from Issue under 37 CFR 1.313(c)(2) submitted as a web-based ePetition via EFS-Web.

   X Certification And Request For Consideration Of An Information Disclosure Statement Filed After Payment Of The Issue Fee Under The QPIDS Pilot Program (1 page), Form 1449 (2 page), and copies of cited documents (14).

   X Certification And Request For Prioritized Examination (Track 1) (1 pg.)

2. Fees

   X Subject to the conditions of the QPIDS Pilot Program as stated above: Authorization to charge deposit account 19-0743 in the amount of $1900.00 to pay the subsequent RCE filing fee required under 37 C.F.R. § 1.17(e)(2).

   X Authorization to charge deposit account 19-0743 in the amount of $240.00 to pay the fee for IDS submission required under 37 C.F.R. § 1.17(p).

   X Authorization to charge deposit account 19-0743 in the amount of $140.00 for the fee under 37 CFR 1.17(h).

   X Authorization to charge deposit account 19-0743 in the amount of $4000.00 for the Prioritized Examination (Track 1) filing fee as set forth in 37 C.F.R. § 1.17(c); and Authorization to charge Deposit Account 19-0743 for the Processing Fee (Track 1) set forth in 37 C.F.R. § 1.17(i) in the amount of $140.00.

The Commissioner is hereby authorized to charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

CERTIFICATION AND REQUEST FOR CONSIDERATION OF AN INFORMATION DISCLOSURE STATEMENT FILED AFTER PAYMENT OF THE ISSUE FEE UNDER THE QPIDS PILOT PROGRAM

Non-Provisional Application No. 15/997,091	Filing date: June 4, 2018

First Named Inventor: Edwin S. Olson et al.

Title of Invention: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

THE UNDERSIGNED HEREBY CERTIFIES AND REQUESTS THE FOLLOWING FOR THE ABOVEIDENTIFIED APPLICATION.

1. Consideration is requested of the information disclosure statement (IDS) submitted herewith, which is being filed after payment of the issue fee.

2. Check the box next to the appropriate selection:

☐ Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(1).

OR

☒ No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the IDS was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(2).

OR

☐ See attached certification statement in compliance with 37 CFR 1.97(e).

3. Please charge the IDS fee set forth in 37 CFR 1.17(p) to Deposit Account No. 19-0743..

4. A Petition to Withdraw from Issue After Payment of the Issue Fee (37 CFR 1.313(c)(2)), including the petition fee set forth in 37 CFR 1.17(h), is submitted herewith as a **Web-based ePetition**.
WARNING: Do not submit the petition as a follow-on paper via EFS-Web. Submit the petition as a Webbased ePetition by signing on to EFS-Web as a registered user, selecting the radio button next to "Existing application/patent," and then selecting the radio button next to "ePetition (for automatic processing and immediate grant, if all petitions requirements are met)." Failure to use the Web-based ePetition interface will result in automatic entry of the RCE.

5. A request for continued examination (RCE) under 37 CFR 1.114 and the RCE fee under 37 CFR 1.17(e) are submitted herewith.

6. The RCE will be treated as a "conditional" RCE. In the event the examiner determines that any item of information contained in the IDS necessitates the reopening of prosecution in the application, the undersigned understands that (i) the RCE will be processed and treated as an RCE under 37 CFR 1.114 and therefore (ii) the IDS fee under 37 CFR 1.17(p) will be returned in accordance with 37 CFR 1.97(b)(4). In the event that no item of information in the IDS necessitates reopening prosecution, the undersigned understands that the RCE will not be processed and the RCE fee under 37 CFR 1.17(e) will be returned.

7. This certification and request is being filed as a **Web-based ePetition** and is not accompanied by an amendment to the application. Inclusion of an amendment will result in automatic entry of the RCE.

Signature	Date
/Nicholas P. Lanzatella/	November 11, 2019
Name (Print/Typed) Nicholas P. Lanzatella	Practitioner Registration Number (If applicable) 63,803

Note: *Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.**

☒ *Total of ___1___ form is submitted.

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 2	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-10,471,412	11/12/2019	Olson, Edwin S, et al.
	US-20050274307A1	12/15/2005	Lissianski, Vitali Victor, et al.
	US-20190329179A1	10/31/2019	Olson, Edwin S., et al.
	US-20190329215A1	10/31/2019	Olson, Edwin S, et al.
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	"Application Serial No. 15/974,343, Corrected Notice of Allowability mailed 10-23-19", 2 pgs	
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	OLSON, EDWIN S., "Abstract - Multiple Site Model for Flue Gas - Mercury interactions on Activated Carbons: The Basic Site", Abstracts of Papers Part 1, 225th ACS National Meeting, New Orleans, LA, (2003), 3 pgs.	

EXAMINER **DATE CONSIDERED**

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Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
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	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 2 of 2	Attorney Docket No: 4820.001U10	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
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	OLSON, EDWIN, et al., "The Multiple Site Model for Flue Gas - Mercury Interactions on Activated Carbons: The Basic Site", Fuel Chemistry Preprints, 48(1), (2003), 3 pgs.	

EXAMINER **DATE CONSIDERED**

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CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e)

(Page 1 of 1)

First Named Inventor:	Edwin S. Olson	Nonprovisional Application Number (if known):	15/997,091
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	Docket No.:	4820.001U10

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. **Request for Continued Examination – Prioritized Examination under § 1.102(e)(2)**

   i. A request for continued examination has been filed with, or prior to, this form.
   ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
   iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C 371.
   iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
   v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Nicholas P. Lanzatella/	Date November 11, 2019
Name (Print/Typed) Nicholas P. Lanzatella	Practitioner Registration Number: 63,803

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

*Total of 1 forms are submitted.

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Janal M. Kalis/Megan Reed
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
RCE- 2ND AND SUBSEQUENT REQUEST	1820	1	1900	1900
		Total in USD ($)		**6280**

Electronic Acknowledgement Receipt

EFS ID:	37715967
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Janal M. Kalis/Megan Reed
Filer Authorized By:	Janal M. Kalis
Attorney Docket Number:	4820.001US10
Receipt Date:	11-NOV-2019
Filing Date:	04-JUN-2018
Time Stamp:	16:48:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$6280
RAM confirmation Number	E2019AAG48358617
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SIGNED_4820_001U10_RCE_QPIDS_Track1.pdf	273306 516a7586e8e6fbde6571b97fcb99753ad0605004	yes	5
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Request for Continued Examination (RCE)		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	4	
	TrackOne Request		5	5	
Warnings:					
Information:					
2	Non Patent Literature	0001_2_npl_4820001u11_nonfinalofficeactionresponseprioritized_f.pdf	526929 ef0b9e75d008d53fa4cf6d89dadca1bbde80d982	no	26
Warnings:					
Information:					
3	Non Patent Literature	0002_2_npl_4820001u12_oarnpe_10232019_f.pdf	1143427 86f58db94196ea7de5e4aa2b4da8b51846a7bce5	no	26
Warnings:					
Information:					
4	Non Patent Literature	0003_2_npl_4820001us9_cnoa_10232019_f.pdf	101253 7aff6952660e431093c886e6c0eebd8d0ed1639a	no	2
Warnings:					
Information:					

5	Non Patent Literature	0004_2_npl_4820003us2_cnoa_10112019_f.pdf	101037 a440a33f290ca6ba6fe2bb0ae9f61b3dc64ce674	no	2
Warnings:					
Information:					
6	Non Patent Literature	0005_2_npl_4820004us1_amendmentresponsefinalofficeaction_f.pdf	484739 a2dc62081bd78ac723b990ec6c08a63ac3f6d204	no	23
Warnings:					
Information:					
7	Non Patent Literature	0006_2_npl_4820007us5_oarn_10172019_f.pdf	1057697 00a2993ffe49297fa08b3f780b405d9f188f3522	no	24
Warnings:					
Information:					
8	Non Patent Literature	0007_2_npl_me2c_aep_answer_counterclaim_10092019_f.pdf	472359 750e6cfbd7b78f4f186f7b7b566570ed77ca7c78	no	71
Warnings:					
Information:					
9	Non Patent Literature	0008_2_npl_me2c_aep_plaintiff_answer_10302019_f.pdf	359806 366691c3e1b53c31288a6d8e476f1ded876cf2a4	no	37
Warnings:					
Information:					
10	Non Patent Literature	0009_2_npl_me2c_vistra_complaint_07172019_f.pdf	233926 2715dc5a22f13bf5de3d36cff419eb8a7e95e326	no	31
Warnings:					
Information:					
11	Non Patent Literature	0010_2_npl_olson_chemicalmechanisms_2003_f.pdf	3555311 ef0d98175d48c3dbe9f26a24e5ccb1f7ec745170	no	6
Warnings:					
Information:					

12	Non Patent Literature	0011_2_npl_olson_improvedmodel_2003_f.pdf	710676 61b3beb7290141b79ebd20dd6256779a85434e9e	no	8
Warnings:					
Information:					
13	Non Patent Literature	0012_2_npl_olson_multiplesite_2003_f.pdf	503809 b91274a5ff78815b4929d8804ebe88ee98493c3f	no	3
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
14	Non Patent Literature	0013_2_npl_olson_multiplesite_abstract_2003_f.pdf	1478989 ac9c47c51535a32871f76314ccc267d8c0756e49	no	3
Warnings:					
Information:					
15	Non Patent Literature	0014_2_npl_steam_42_ch_35_2015_f.pdf	4031937 ca72d9fcb24d04a5914c0a83c7b78f3c668d19da	no	24
Warnings:					
Information:					
16	Fee Worksheet (SB06)	fee-info.pdf	35636 32c34021e2da2c88d5f64331cfd734a95930f09a	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	15070837	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	15997091
Filing Date	04-Jun-2018
First Named Inventor	Edwin Olson
Art Unit	1776
Examiner Name	AMBER ORLANDO
Attorney Docket Number	4820.001US10
Title	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

- ○ Small Entity
- ○ Micro Entity
- ◉ Regular Undiscounted

Reason for withdrawal from issue

○ One or more claims are unpatentable	
◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees)	
○ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).	
RCE request,submission, and fee.	
☒ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on 2019.07.11	
☐ Are attached.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES	
I certify, in accordance with 37 CFR 1.4(d)(4) that I am:	
◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application.	
○ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity.	
○ A sole inventor	
○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application	
○ A joint inventor; all of whom are signing this e-petition	
Signature	/Nicholas P. Lanzatella/
Name	Nicholas P. Lanzatella
Registration Number	63803

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Janal M. Kalis/Megan Reed
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**140**

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : November 11, 2019

In re Application of :

Edwin Olson

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 15997091

Filed : 04-Jun-2018

Attorney Docket No : 4820.001US10

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed November 11, 2019 to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 1776 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt

EFS ID:	37715847
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Janal M. Kalis/Megan Reed
Filer Authorized By:	Janal M. Kalis
Attorney Docket Number:	4820.001US10
Receipt Date:	11-NOV-2019
Filing Date:	04-JUN-2018
Time Stamp:	16:42:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$140
RAM confirmation Number	E2019AAG42258519
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition automatically granted by EFS	petition-request.pdf	31762 c7762aeacd1a2ba40408e016f9274dbd12308c99	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30677 3f039c1d0c8ab21dbdaadf3a091627f1504dc40c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	62439		

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New Applications Under 35 U.S.C. 111

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 10/23/2019

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER
ORLANDO, AMBER ROSE

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
10/23/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

CORRECTED ***Notice of Allowability***	**Application No.** 15/997,091	**Applicant(s)** Olson et al.	
	Examiner AMBER R ORLANDO	**Art Unit** 1776	**AIA (FITF) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the IDS filed 09/13/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Continuation of 3. The allowed claim(s) is/are: 1,9-10,12,16 and 18-42

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15997091
Filing Date	2018-06-04
First Named Inventor	Edwin S. Olson
Art Unit	1776
Examiner Name	Amber Orlando
Attorney Docket Number	4820.001U10

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5556447		1996-09-17	Srinivasachar, Srivats, et al.	
	2	7361209		2008-04-22	Durham, Michael D, et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020114749	A1	2002-08-22	Cole, Jerald Alan	
	2	20030113239	A1	2003-06-19	Pahlman, John E, et al.	
	3	20030161771	A1	2003-08-28	Oehr, Klaus H	
	4	20040244657	A1	2004-12-09	Srinivasachar, Srivats, et al.	

/AMBER R ORLANDO/ 10/12/2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15997091
Filing Date	2018-06-04
First Named Inventor	Edwin S. Olson
Art Unit	1776
Examiner Name	Amber Orlando
Attorney Docket Number	4820.001U10

	5	20070259781	A1	2007-11-08	Sinha, Rabindra K	
	6	20140099244	A1	2014-04-10	Olson, Edwin S, et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	"Application Serial No. 16/509,071, Non Final Office Action mailed 09-11-19", 21 pgs.	
	2	"Application Serial No. 14/712,558, Non Final Office Action mailed 09-12-19", 15 pgs.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

/AMBER R ORLANDO/ 10/12/2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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First Named Inventor	Edwin S. Olson
Art Unit	1776
Examiner Name	Amber Orlando
Attorney Docket Number	4820.001U10

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

/AMBER R ORLANDO/ 10/12/2019

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15997091
Filing Date	2018-06-04
First Named Inventor	Edwin S. Olson
Art Unit	1776
Examiner Name	Amber Orlando
Attorney Docket Number	4820.001U10

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Nicholas P. Lanzatella/	Date (YYYY-MM-DD)	2019-09-13
Name/Print	Nicholas P. Lanzatella	Registration Number	63,803

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/997,091	06/04/2018	1776	2720	4820.001US10	20	1

CONFIRMATION NO. 5161

CORRECTED FILING RECEIPT

21186
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402



Date Mailed: 10/02/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Edwin S. Olson, Grand Forks, ND;
Michael J. Holmes, Thompson, ND;
John H. Pavlish, East Grand Forks, MN;

Applicant(s)

Midwest Energy Emissions Corp., Lewis Center, OH;

Power of Attorney: The patent practitioners associated with Customer Number 21186

Domestic Priority data as claimed by applicant

This application is a CON of 15/974,343 05/08/2018
which is a CON of 15/951,970 04/12/2018
which is a CON of 14/712,558 05/14/2015
which is a CON of 14/318,270 06/27/2014 PAT 9757689
which is a CON of 13/966,768 08/14/2013 PAT 8821819
which is a CON of 13/427,665 03/22/2012 PAT 8512655
which is a CON of 12/419,219 04/06/2009 PAT 8168147
which is a CON of 12/201,595 08/29/2008 ABN
which is a CON of 11/209,163 08/22/2005 PAT 7435286
which claims benefit of 60/605,640 08/30/2004

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/21/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/997,091**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Preliminary Class

423

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign

patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION RE: UPDATE TO APPLICATION DATA SHEET

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicants hereby request that the information provided on the Application Data Sheet filed in the above-referenced application on June 4, 2018, be updated with the information as provided on the enclosed marked up Application Data Sheet.

We therefore submit a marked up copy of the Application Data Sheet which shows an update to the Applicant Information.

Once this request is entered, it is respectfully requested that the USPTO update their records and provide confirmation of the above request by way of an Updated Filing Receipt.

It is believed that no fee is required to fulfill this request, however, if necessary, please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

Schwegman Lundberg & Woessner, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 09/27/2019 By /Nicholas P. Lanzatella/

Nicholas P. Lanzatella
Reg. No. 63,803

Amended PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 15/974,343, filed on May 8, 2018 .

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: John H. Pavlish Date (Optional): 9-27-2019

Signature: John H Pavlish

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION RE: LATE SUBMISSION OF DECLARATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with 37 CFR 1.63, we submit the Signed Declaration. Corresponding fees with regard to the late submission were paid with the filing of the application on June 4, 2018 therefore applicants believe no additional fees are due at this time.

Applicants assume the application is now in proper order and in condition for allowance. Please direct any inquiries to the undersigned at (612) 349-9580. If necessary, please charge any additional fees or credit overpayment to Deposit Account 19-0743.

Respectfully submitted,

Schwegman Lundberg & Woessner, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 09/27/2019

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:CMG:dmj

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket No.:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION RE: FEE ADDRESS

Mail Stop Issue Fee
Commissioner for Patents
P.O.Box 1450
Alexandria, VA 22313-1450

In response to the Notice of Allowance and Issue Fee Due, please record the Fee Address under the provisions of 37 CFR 1.363 as the following:

Customer Number 21186

Please direct any inquiries to the undersigned attorney at (612) 349-9580.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 09/27/2019 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:CMG:dmj

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21186 7590 09/18/2019
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

TITLE OF INVENTION: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	12/18/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
ORLANDO, AMBER ROSE	1776	423-210000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☒ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Schwegman Lundberg
2 & Woessner, P.A.
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Midwest Energy Emissions Corp.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Lewis Center, OH

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 19-0743

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date 09/27/2019

Typed or printed name Nicholas P. Lanzatella Registration No. 63,803

PAC ET AL. EXHIBIT 1024
Page 73

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	December 18, 2019
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Notice of Allowance Date: September 18, 2019

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following:

X	Authorization to charge Deposit 19-0743 in the amount of $1,000.00 to cover the Large Entity Issue Fee Payment.
X	Issue Fee Transmittal (Form PTOL-85).
X	Communication Re: Fee Address (1 page).
X	Communication Re: Late Submission of Declaration (1 pg.).
X	Signed Declaration (1 pg.).
X	Communication Re: Update to Application Data Sheet (1 Pg.).
X	Marked Up Application Data Sheet (6 Pgs.).
X	Statement Under 37 CFR 3.73 (c) (2 pgs.)
X	Copy of Signed Assignment (20 pgs.)

Please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN LUNDBERG & WOESSNER, P.A. By /Nicholas P. Lanzatella/
Customer No.: 21186 Nicholas P. Lanzatella
NPL:CMG:dmj Reg. No. 63,803

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 27th day of September, 2019.

Diana Johnson — Name
/Diana Johnson/ — Signature

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	James Lee Shands/Diana Johnson
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1000**

Electronic Acknowledgement Receipt

EFS ID:	37303545
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	James Lee Shands/Diana Johnson
Filer Authorized By:	James Lee Shands
Attorney Docket Number:	4820.001US10
Receipt Date:	27-SEP-2019
Filing Date:	04-JUN-2018
Time Stamp:	15:28:14
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1000
RAM confirmation Number	E20199QF28515360
Deposit Account	190743
Authorized User	Diana Johnson

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		4820001U10IssuefeeSigned.pdf	18322477 05e4a4ba8b96b858529b0d25d6dd9cb9696209ef	yes	35

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	15	35
Assignee showing of ownership per 37 CFR 3.73	13	14
Application Data Sheet	7	12
Request for Corrected Filing Receipt	6	6
Oath or Declaration filed	5	5
Miscellaneous Incoming Letter	4	4
Miscellaneous Incoming Letter	3	3
Issue Fee Payment (PTO-85B)	2	2
Transmittal Letter	1	1

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30311 6d00e2b880def7c181f5478736693ecc44b7a467	no	2

Warnings:

Information:

Total Files Size (in bytes):	18352788

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

CONFIRMATORY ASSIGNMENT

THIS CONFIRMATORY ASSIGNMENT is made by Edwin S. Olson residing at 223 Circle Hills Dr, Grand Forks, ND 58201 ("Assignor"), to Energy and Environmental Research Center Foundation, a North Dakota nonprofit corporation having a business address of 15 N. 23rd Street, Stop 9018, Grand Forks, North Dakota, 58202-9018 ("Assignee") and is effective as of the date this Confirmatory Assignment is executed by Assignor.

WHEREAS, Assignor has invented the inventions disclosed in the patents and patent applications listed in Exhibit A attached (collectively, and including all such inventions and all patents and patent applications for such inventions that have now been, or may in the future be, filed and/or granted for such inventions, including without limitation those patents and patent applications listed in Exhibit A, "Inventions") and, for good and valuable consideration, has agreed to assign, and has assigned, all of Assignor's right, title and interest in and to the Inventions to Assignee; and

WHEREAS, Assignor desires to confirm and assure the assignment, sale and transfer to Assignee of any and all right, title, and interest Assignor has in the Inventions; and

WHEREAS, this Confirmatory Assignment confirms that all Inventions listed in Exhibit A belong exclusively to Assignee and that Assignor has assigned, sold and transferred to Assignee, and hereby further assigns, sells and transfers to Assignee, without any requirement of further consideration, the entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation all rights to claim priority in and to any and all improvements which are disclosed in the Inventions, and that upon the request of the Assignee, Assignor will take such further actions, including without limitation execution and delivery of instruments of conveyance, as may be appropriate to give full and proper effect to such assignment.

NOW THEREFORE, in consideration of the foregoing premises, the sum of Ten Dollars ($10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor hereby assigns, sells and transfers to Assignee Assignor's entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation: (1) all rights to claim priority in and to the Inventions and/or any and all improvements which are disclosed in the Inventions; (2) all rights with respect to the Inventions, including all United States patents and/or other

governmental grants and/or issuances that may be granted with respect to the Inventions and/or from any direct and/or indirect divisionals, continuations, continuations-in-part and/or other patent applications claiming priority rights from the Inventions; (3) all reissues, reexaminations, extensions and/or registrations of the foregoing; (4) all non-United States patents, patent applications and/or counterparts relating to the foregoing, including without limitation certificates of invention, utility models, industrial design protection, design patent protection and other governmental grants and/or issuances, and including the right to file United States and/or foreign applications directly in the name of Assignee, its successors and assigns; (5) all causes of action and/or remedies related to the foregoing (including without limitation, the right to sue for past, present and/or future infringement, misappropriation and/or violation of rights related to any of the foregoing and the right to collect royalties and/or other payments under or on account of any of the foregoing); and, (6) any and all other rights and/or interests arising out of, in connection with and/or in relation to the foregoing.

Assignor hereby covenants that no assignment, sale, agreement or encumbrance has been or will be made or entered into which would conflict with this Confirmatory Assignment.

Assignor agrees now, and at any time and from time to time in the future, upon request of Assignee, Assignee's successors, legal representatives and/or assigns, and at Assignee's expense, to take, execute, acknowledge, and deliver all such further acts and deeds, assignments, instruments of transfer or conveyance, registrations for assignments, powers of attorney, declarations and/or assurances as may be required for the assigning, selling, transferring, assuring and confirming to Assignee, and Assignee's successors and assigns, and/or for aiding and assisting in collecting and reducing to possession, the rights assigned, sold and transferred under this Confirmatory Assignment, to participate in proceedings regarding such rights (including without limitation, any litigation and/or patent office proceedings) and/or to or perfect and/or defend title to such rights.

Assignor requests the respective patent office or governmental agency in each jurisdiction to issue any and all patents, certificates of invention, utility models and/or other governmental grants and/or issuances that may be granted upon the rights assigned, sold and transferred under this Confirmatory Assignment in the name of the Assignee, as the assignee to the entire interest therein.

The terms and conditions of this Confirmatory Assignment will inure to the benefit of Assignee, and Assignee's successors, legal representatives and assigns, and will be binding upon Assignor, and Assignor's successors, legal representatives and assigns.

By: _____
(Edwin S. Olson, *Signature MUST be attested*)

ATTESTATION

ATTESTATION OF SIGNATURE PURSUANT TO 28 U.S.C. 1746

The undersigned witnessed the signature of Edwin S. Olson to the above Confirmatory Assignment and makes the following statements:

1. I am over the age of 18 and competent to testify as to the facts in this Attestation block if called upon to do so.

2. Edwin S. Olson is personally known to me (or proved to me on the basis of satisfactory evidence) and appeared before me on August 25, 2014 to execute the above Confirmatory Assignment.

3. Edwin S. Olson subscribed to the above Confirmatory Assignment.

I declare under penalty of perjury under the laws of the United States of America that the statements made in the three (3) numbered paragraphs immediately above are true and correct.

EXECUTED on August 25, 2014 (date)

_____
Print Name: James R Duncan

Exhibit A

1. U.S. Patent No. 7,435,286, issued October 14, 2008, titled "Sorbents for the Oxidation and Removal of Mercury"

2. U.S. Patent No. 7,615,101, issued November 10, 2009, titled "High Energy Dissociation for Mercury Control Systems"

3. U.S. Patent No. 7,628,969, issued December 8, 2009, titled "Multifunctional Abatement of Air Pollutants in Flue Gas"

4. U.S. Patent No. 8,168,147, issued May 1, 2012, titled "Sorbents for the Oxidation and Removal of Mercury"

5. U.S. Patent No. 8,173,566, issued May 8, 2012, titled "Process for Regenerating a Spent Sorbent"

6. U.S. Patent No. 8,312,822, issued November 20, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

7. U.S. Patent No. 8,440,585, issued May 14, 2013, titled "Process for Regenerating a Spent Sorbent"

8. U.S. Patent No. 8,512,655, issued August 20, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

9. U.S. Patent No. 8,652,235, issued February 18, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

10. U.S. Patent No. 8,807,056, issued August 19, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

11. U.S. Patent Application Serial No. 13/453,274, filed on April 23, 2012, titled "Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream"

12. U.S. Patent Application Serial No. 13/544,971, filed on July 9, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

13. U.S. Patent Application Serial No. 13/966,768, filed on August 14, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

14. U.S. Patent Application Serial No. 14/102,896, filed on December 11, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

15. U.S. Patent Application Serial No. 14/318,270, filed on June 27, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

16. U.S. Patent Application Serial No. 14/195,360, filed on March 6, 2013, titled "Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same"

17. U.S. Patent Application Serial No. 14/446,992, filed on July 30, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

18. U.S. Provisional Patent Application Serial No. 60/605,640, filed on August 30, 2004, titled "Sorbents for the Oxidation and Removal of Mercury"

19. U.S. Provisional Patent Application Serial No. 60/464,868, filed on April 23, 2003, titled "Process for Regenerating a Spent Sorbent"

20. U.S. Provisional Patent Application Serial No. 60/947,543, filed on July 2,2007, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

21. U.S. Provisional Patent Application Serial No. 61/773,549, filed on March 6, 2013, titled "Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same"

CONFIRMATORY ASSIGNMENT

THIS CONFIRMATORY ASSIGNMENT is made by John H. Pavlish residing at 42204 210th St SW, East Grand Forks, MN ("Assignor"), to Energy and Environmental Research Center Foundation, a North Dakota nonprofit corporation having a business address of 15 N. 23rd Street, Stop 9018, Grand Forks, North Dakota, 58202-9018 ("Assignee") and is effective as of the date this Confirmatory Assignment is executed by Assignor.

WHEREAS, Assignor has invented the inventions disclosed in the patents and patent applications listed in Exhibit A attached (collectively, and including all such inventions and all patents and patent applications for such inventions that have now been, or may in the future be, filed and/or granted for such inventions, including without limitation those patents and patent applications listed in Exhibit A, "Inventions") and, for good and valuable consideration, has agreed to assign, and has assigned, all of Assignor's right, title and interest in and to the Inventions to Assignee; and

WHEREAS, Assignor desires to confirm and assure the assignment, sale and transfer to Assignee of any and all right, title, and interest Assignor has in the Inventions; and

WHEREAS, this Confirmatory Assignment confirms that all Inventions listed in Exhibit A belong exclusively to Assignee and that Assignor has assigned, sold and transferred to Assignee, and hereby further assigns, sells and transfers to Assignee, without any requirement of further consideration, the entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation all rights to claim priority in and to any and all improvements which are disclosed in the Inventions, and that upon the request of the Assignee, Assignor will take such further actions, including without limitation execution and delivery of instruments of conveyance, as may be appropriate to give full and proper effect to such assignment.

NOW THEREFORE, in consideration of the foregoing premises, the sum of Ten Dollars ($10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor hereby assigns, sells and transfers to Assignee Assignor's entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation: (1) all rights to claim priority in and to the Inventions and/or any and all improvements which are disclosed in the Inventions; (2) all rights with respect to the Inventions, including all United States patents and/or other

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governmental grants and/or issuances that may be granted with respect to the Inventions and/or from any direct and/or indirect divisionals, continuations, continuations-in-part and/or other patent applications claiming priority rights from the Inventions; (3) all reissues, reexaminations, extensions and/or registrations of the foregoing; (4) all non-United States patents, patent applications and/or counterparts relating to the foregoing, including without limitation certificates of invention, utility models, industrial design protection, design patent protection and other governmental grants and/or issuances, and including the right to file United States and/or foreign applications directly in the name of Assignee, its successors and assigns; (5) all causes of action and/or remedies related to the foregoing (including without limitation, the right to sue for past, present and/or future infringement, misappropriation and/or violation of rights related to any of the foregoing and the right to collect royalties and/or other payments under or on account of any of the foregoing); and, (6) any and all other rights and/or interests arising out of, in connection with and/or in relation to the foregoing.

Assignor hereby covenants that no assignment, sale, agreement or encumbrance has been or will be made or entered into which would conflict with this Confirmatory Assignment.

Assignor agrees now, and at any time and from time to time in the future, upon request of Assignee, Assignee's successors, legal representatives and/or assigns, and at Assignee's expense, to take, execute, acknowledge, and deliver all such further acts and deeds, assignments, instruments of transfer or conveyance, registrations for assignments, powers of attorney, declarations and/or assurances as may be required for the assigning, selling, transferring, assuring and confirming to Assignee, and Assignee's successors and assigns, and/or for aiding and assisting in collecting and reducing to possession, the rights assigned, sold and transferred under this Confirmatory Assignment, to participate in proceedings regarding such rights (including without limitation, any litigation and/or patent office proceedings) and/or to or perfect and/or defend title to such rights.

Assignor requests the respective patent office or governmental agency in each jurisdiction to issue any and all patents, certificates of invention, utility models and/or other governmental grants and/or issuances that may be granted upon the rights assigned, sold and transferred under this Confirmatory Assignment in the name of the Assignee, as the assignee to the entire interest therein.

The terms and conditions of this Confirmatory Assignment will inure to the benefit of Assignee, and Assignee's successors, legal representatives and assigns, and will be binding upon Assignor, and Assignor's successors, legal representatives and assigns.

By: _____
(John H. Pavlish, *Signature MUST be attested*)

ATTESTATION

ATTESTATION OF SIGNATURE PURSUANT TO 28 U.S.C. 1746

The undersigned witnessed the signature of John H. Pavlish to the above Confirmatory Assignment and makes the following statements:

1. I am over the age of 18 and competent to testify as to the facts in this Attestation block if called upon to do so.

2. John H. Pavlish is personally known to me (or proved to me on the basis of satisfactory evidence) and appeared before me on August 25, 2014 to execute the above Confirmatory Assignment.

3. John H. Pavlish subscribed to the above Confirmatory Assignment.

I declare under penalty of perjury under the laws of the United States of America that the statements made in the three (3) numbered paragraphs immediately above are true and correct.

EXECUTED on August 25, 2014 (date)

_____
Print Name: James R Duzan

Exhibit A

1. U.S. Patent No. 7,435,286, issued October 14, 2008, titled "Sorbents for the Oxidation and Removal of Mercury"

2. U.S. Patent No. 7,615,101, issued November 10, 2009, titled "High Energy Dissociation for Mercury Control Systems"

3. U.S. Patent No. 7,628,969, issued December 8, 2009, titled "Multifunctional Abatement of Air Pollutants in Flue Gas"

4. U.S. Patent No. 8,168,147, issued May 1, 2012, titled "Sorbents for the Oxidation and Removal of Mercury"

5. U.S. Patent No. 8,173,566, issued May 8, 2012, titled "Process for Regenerating a Spent Sorbent"

6. U.S. Patent No. 8,312,822, issued November 20, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

7. U.S. Patent No. 8,440,585, issued May 14, 2013, titled "Process for Regenerating a Spent Sorbent"

8. U.S. Patent No. 8,512,655, issued August 20, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

9. U.S. Patent No. 8,652,235, issued February 18, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

10. U.S. Patent No. 8,807,056, issued August 19, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

11. U.S. Patent Application Serial No. 13/453,274, filed on April 23, 2012, titled "Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream"

12. U.S. Patent Application Serial No. 13/544,971, filed on July 9, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

13. U.S. Patent Application Serial No. 13/966,768, filed on August 14, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

14. U.S. Patent Application Serial No. 14/102,896, filed on December 11, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

15. U.S. Patent Application Serial No. 14/318,270, filed on June 27, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

16. U.S. Patent Application Serial No. 14/195,360, filed on March 6, 2013, titled "Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same"

17. U.S. Patent Application Serial No. 14/446,992, filed on July 30, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

18. U.S. Provisional Patent Application Serial No. 60/605,640, filed on August 30, 2004, titled "Sorbents for the Oxidation and Removal of Mercury"

19. U.S. Provisional Patent Application Serial No. 60/464,868, filed on April 23, 2003, titled "Process for Regenerating a Spent Sorbent"

20. U.S. Provisional Patent Application Serial No. 60/947,543, filed on July 2,2007, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

21. U.S. Provisional Patent Application Serial No. 61/773,549, filed on March 6, 2013, titled "Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same"

CONFIRMATORY ASSIGNMENT

THIS CONFIRMATORY ASSIGNMENT is made by Michael J. Holmes residing at 2124 S 38th St, Grand Forks, ND ("Assignor"), to Energy and Environmental Research Center Foundation, a North Dakota nonprofit corporation having a business address of 15 N. 23rd Street, Stop 9018, Grand Forks, North Dakota, 58202-9018 ("Assignee") and is effective as of the date this Confirmatory Assignment is executed by Assignor.

WHEREAS, Assignor has invented the inventions disclosed in the patents and patent applications listed in Exhibit A attached (collectively, and including all such inventions and all patents and patent applications for such inventions that have now been, or may in the future be, filed and/or granted for such inventions, including without limitation those patents and patent applications listed in Exhibit A, "Inventions") and, for good and valuable consideration, has agreed to assign, and has assigned, all of Assignor's right, title and interest in and to the Inventions to Assignee; and

WHEREAS, Assignor desires to confirm and assure the assignment, sale and transfer to Assignee of any and all right, title, and interest Assignor has in the Inventions; and

WHEREAS, this Confirmatory Assignment confirms that all Inventions listed in Exhibit A belong exclusively to Assignee and that Assignor has assigned, sold and transferred to Assignee, and hereby further assigns, sells and transfers to Assignee, without any requirement of further consideration, the entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation all rights to claim priority in and to any and all improvements which are disclosed in the Inventions, and that upon the request of the Assignee, Assignor will take such further actions, including without limitation execution and delivery of instruments of conveyance, as may be appropriate to give full and proper effect to such assignment.

NOW THEREFORE, in consideration of the foregoing premises, the sum of Ten Dollars ($10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor hereby assigns, sells and transfers to Assignee Assignor's entire right, title and interest in and to the Inventions, in the United States and its territorial possessions, and in all foreign countries, including without limitation: (1) all rights to claim priority in and to the Inventions and/or any and all improvements which are disclosed in the Inventions; (2) all rights with respect to the Inventions, including all United States patents and/or other

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governmental grants and/or issuances that may be granted with respect to the Inventions and/or from any direct and/or indirect divisionals, continuations, continuations-in-part and/or other patent applications claiming priority rights from the Inventions; (3) all reissues, reexaminations, extensions and/or registrations of the foregoing; (4) all non-United States patents, patent applications and/or counterparts relating to the foregoing, including without limitation certificates of invention, utility models, industrial design protection, design patent protection and other governmental grants and/or issuances, and including the right to file United States and/or foreign applications directly in the name of Assignee, its successors and assigns; (5) all causes of action and/or remedies related to the foregoing (including without limitation, the right to sue for past, present and/or future infringement, misappropriation and/or violation of rights related to any of the foregoing and the right to collect royalties and/or other payments under or on account of any of the foregoing); and, (6) any and all other rights and/or interests arising out of, in connection with and/or in relation to the foregoing.

Assignor hereby covenants that no assignment, sale, agreement or encumbrance has been or will be made or entered into which would conflict with this Confirmatory Assignment.

Assignor agrees now, and at any time and from time to time in the future, upon request of Assignee, Assignee's successors, legal representatives and/or assigns, and at Assignee's expense, to take, execute, acknowledge, and deliver all such further acts and deeds, assignments, instruments of transfer or conveyance, registrations for assignments, powers of attorney, declarations and/or assurances as may be required for the assigning, selling, transferring, assuring and confirming to Assignee, and Assignee's successors and assigns, and/or for aiding and assisting in collecting and reducing to possession, the rights assigned, sold and transferred under this Confirmatory Assignment, to participate in proceedings regarding such rights (including without limitation, any litigation and/or patent office proceedings) and/or to or perfect and/or defend title to such rights.

Assignor requests the respective patent office or governmental agency in each jurisdiction to issue any and all patents, certificates of invention, utility models and/or other governmental grants and/or issuances that may be granted upon the rights assigned, sold and transferred under this Confirmatory Assignment in the name of the Assignee, as the assignee to the entire interest therein.

The terms and conditions of this Confirmatory Assignment will inure to the benefit of Assignee, and Assignee's successors, legal representatives and assigns, and will be binding upon Assignor, and Assignor's successors, legal representatives and assigns.

By: _____
(Michael J. Holmes, *Signature MUST be attested*)

ATTESTATION

ATTESTATION OF SIGNATURE PURSUANT TO 28 U.S.C. 1746

The undersigned witnessed the signature of Michael J. Holmes to the above Confirmatory Assignment and makes the following statements:

1. I am over the age of 18 and competent to testify as to the facts in this Attestation block if called upon to do so.

2. Michael J. Holmes is personally known to me (or proved to me on the basis of satisfactory evidence) and appeared before me on August 22, 2014 to execute the above Confirmatory Assignment.

3. Michael J. Holmes subscribed to the above Confirmatory Assignment.

I declare under penalty of perjury under the laws of the United States of America that the statements made in the three (3) numbered paragraphs immediately above are true and correct.

EXECUTED on August 22, 2014 (date)

_____
Print Name: James R Duzan

Exhibit A

1. U.S. Patent No. 7,435,286, issued October 14, 2008, titled "Sorbents for the Oxidation and Removal of Mercury"

2. U.S. Patent No. 7,615,101, issued November 10, 2009, titled "High Energy Dissociation for Mercury Control Systems"

3. U.S. Patent No. 7,628,969, issued December 8, 2009, titled "Multifunctional Abatement of Air Pollutants in Flue Gas"

4. U.S. Patent No. 8,168,147, issued May 1, 2012, titled "Sorbents for the Oxidation and Removal of Mercury"

5. U.S. Patent No. 8,173,566, issued May 8, 2012, titled "Process for Regenerating a Spent Sorbent"

6. U.S. Patent No. 8,312,822, issued November 20, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

7. U.S. Patent No. 8,440,585, issued May 14, 2013, titled "Process for Regenerating a Spent Sorbent"

8. U.S. Patent No. 8,512,655, issued August 20, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

9. U.S. Patent No. 8,652,235, issued February 18, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

10. U.S. Patent No. 8,807,056, issued August 19, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

11. U.S. Patent Application Serial No. 13/544,971, filed on July 9, 2012, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

12. U.S. Patent Application Serial No. 13/966,768, filed on August 14, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

13. U.S. Patent Application Serial No. 14/102,896, filed on December 11, 2013, titled "Sorbents for the Oxidation and Removal of Mercury"

14. U.S. Patent Application Serial No. 14/318,270, filed on June 27, 2014, titled "Sorbents for the Oxidation and Removal of Mercury"

15. U.S. Patent Application Serial No. 14/446,992, filed on July 30, 2014, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

16. U.S. Provisional Patent Application Serial No. 60/605,640, filed on August 30, 2004, titled "Sorbents for the Oxidation and Removal of Mercury"

17. U.S. Provisional Patent Application Serial No. 60/464,868, filed on April 23, 2003, titled "Process for Regenerating a Spent Sorbent"

18. U.S. Provisional Patent Application Serial No. 60/947,543, filed on July 2,2007, titled "Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds"

ASSIGNMENT

THIS ASSIGNMENT is made and effective as of April 24, 2017 by and between the ENERGY AND ENVIRONMENTAL RESEARCH CENTER FOUNDATION ("**EERC Foundation**"), a non-profit corporation organized under the laws of the State of North Dakota, having its principal place of business at 15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202, and MIDWEST ENERGY EMISSIONS CORP., a Delaware corporation ("**ME_2C**"), having its principal place of business at 670 D Enterprise Drive, Lewis Center, Ohio 43035.

WHEREAS, EERC Foundation owns by ASSIGNMENT from the named inventors recorded in the United States Patent and Trademark Office, the right, title, and interest in the patents and patent applications listed in **Appendix A** attached hereto; and

WHEREAS, ME_2C desires to own EERC Foundation's entire right, title, and interest in and to the patents and patent applications listed in **Appendix A**.

NOW THEREFORE, be it known that, for good and valuable consideration, receipt of which is hereby acknowledged, the EERC Foundation hereby sells, assigns, transfers and sets over to ME_2C, its lawful successors and assigns, all rights, titles, interests, and accrued causes of action for damages for infringement of, all patents, patent applications, all divisions, substitutions, continuations, continuations-in-part, reissues, reexaminations, and extensions thereof, together with all foreign counterparts thereof and patents issuing thereon derived from or claiming priority of the United States provisional patent application or other provisional patent application filed for an issued patent or patent application as set forth in **Appendix A**;

AND, EERC Foundation hereby represents, warrants and agrees that EERC Foundation has the full right to convey the interests assigned by this ASSIGNMENT, and has obtained the approval from the U.S. Department of Energy and from the U.S. Environmental Protection Agency necessary to transfer the interests assigned hereby to ME_2C;

AND, this ASSIGNMENT may be executed in counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

IN WITNESS WHEREOF, each party has caused its authorized representative to execute this ASSIGNMENT, effective as of the date indicated above.

Energy and Environmental Research Center Foundation

By: _____
Name: Ron Ness
Title: President

Midwest Energy Emissions Corp.

By: _____
Name: Richard H. Gross
Title: Chief Financial Officer

ACKNOWLEDGMENT

State of North Dakota)
) ss:
County of Burleigh)

KAY A. ROTH
Notary Public
State of North Dakota
My Commission Expires September 4, 2021

On the 27th day of April, 2017, before me, the undersigned, personally appeared Ron Ness, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed this instrument on behalf of Energy and Environmental Research Center Foundation, and acknowledged that he executed it in such representative capacity.

Kay A. Roth
Notary Public

ACKNOWLEDGMENT

State of Ohio)
) ss:
County of Delaware)

On the 19 day of May April, 2017, before me, the undersigned, personally appeared Richard H. Gross, personally known to me or proved to me on the basis of satisfactory evidence to be the person who executed this instrument on behalf of Midwest Energy Emissions Corp., and acknowledged that he executed it in such representative capacity.

Geraldine A Craig
Notary Public

GERALDINE A. CRAIG - NOTARY PUBLIC
STATE OF OHIO

APPENDIX A
PATENTS AND PATENT APPLICATIONS

Issued Patents

U.S. Patents

- U.S. Patent 7,435,286 – Sorbents for the Oxidation and Removal of Mercury (05-001)
- U.S. Patent 8,173,566 – Process for Regenerating a Spent Sorbent (PAC Regen) (03-023)
- U.S. Patent 8,168,147 – Sorbents for the Oxidation and Removal of Mercury (09-012)
- U.S. Patent 8,312,822 – Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds (06-001)
- U.S. Patent 8,440,585 – Process for Regenerating a Spent Sorbent (03-023US1 CONT)
- U.S. Patent 7,615,101 – High Energy Dissociation for Mercury Control Systems (05-015)
- U.S. Patent 7,628,969 – Multifunctional Abatement of Air Pollutants in Flue Gas (09006CIP of 05-015)
- U.S. Patent 8,807,056 – Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds (06-001CONT)
- U.S. Patent 8,512,655 – Sorbents for the Oxidation and Removal of Mercury (09-012CONT1)
- U.S. Patent 8,652,235 – Sorbents for the Oxidation and Removal of Mercury (09-013CIP)
- U.S. Patent 8,821,819 – Sorbents for the Oxidation and Removal of Mercury (09-012CONT2)
- U.S. Patent 9,011,805 – Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream (12-001)
- U.S. Patent 9,155,997 – Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds (06-001CONT2)
- U.S. Patent 9,468,886- Sorbents for the Oxidation and Removal of Mercury (09-013CIP CONT1)

Foreign Patents

- Canada Patent 2,523,132 – Process for Regenerating a Spent Sorbent (03-023)
- Canada Patent 2,584,327 – Sorbents for the Oxidation and Removal of Mercury (05-001)
  Canadian Patent 2,757,309 Sorbents for the Oxidation and Removal of Mercury (09-013)

- China Patent ZL200580037037.0 (Certificate No. 635764) – Sorbents and Flue Gas Additives for the Oxidation and Removal of Mercury (05-001)

- Europe Patent 1 796 816 – Sorbents for the Oxidation and Removal of Mercury (05-001EP)
- Europe Divisional No. 2 431 087 – Removal of Mercury from Flue Gas (05-001EU Div1)
  - Validating the patent application in Germany for issuance of patent
  - Validating the patent application in the Netherlands for issuance of patent
  - Validating the patent application in the United Kingdom for issuance of patent
- Europe Patent 2 429 685 – Sorbents for the Oxidation and Removal of Mercury (09013EP)
  - Validating the patent application in Germany for issuance of patent
  - Validating the patent application in the Netherlands for issuance of patent
  - Validating the patent application in the United Kingdom for issuance of patent 200480017704.4
- China Patent ZL200680041485.2 – High-Energy Dissociation for Mercury Control Systems (05-015CN)
- Europe Patent 1 931 449 – High-Energy Dissociation for Mercury Control Systems (05015EP)
  - Validating the patent application in Germany for issuance of patent
  - Validating the patent application in the Netherlands for issuance of patent
  - Validating the patent application in the United Kingdom for issuance of patent
- China Patent ZL201080017698.8 Process for Regenerating a Spent Sorbent (PAC Regen) (09-013CN)
- China Patent ZL200480017704.4 Process for Regenerating a Spent Sorbent (PAC Regen) (03-023CN)

Pending Patent Applications

U.S. Patents

- Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same – Application Serial No. 14/195,360 (13-004)
- Sorbents for the Oxidation and Removal of Mercury – Application Serial No. 14/318,270 (09-012CONT3)
- Sorbents for the Oxidation and Removal of Mercury – Application Serial No. 15/295,594 (09-013CONT2)
- Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream – Application Serial No. 14/564,860 (12-001Cont)
- Sorbents for the Oxidation and Removal of Mercury – Application Serial No. 14/712,558 (09-012CONT4)
- Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds – Application Serial No. 14/880,463 (06-001CONT3)
- Promoted Ammonium Salt-Protected Activated Carbon Sorbent Particles For Removal of Mercury From Gas Streams-Application Serial No. 15/382,114 (13-004 CIP)

- Sorbent Comprising Carbon and Nitrogen and Methods of Using the Same—Application Serial No. 15/449,112 (13-004 CIP2)
- Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream – Application Serial No. 15/452,527 (12-001Cont2)

Foreign Patents

- Process for Regenerating a Spent Sorbent (PAC Regen) (03-023)
  - Application pending in European Patent Office – Application Serial No. 04750664.7
- Sorbents and Flue Gas Additives for the Oxidation and Removal of Mercury (05-001)
- Note: A different divisional – Application Serial No. 11 189 249.3 – was abandoned as unpatentable over prior art
- Carbon Nanocomposite Sorbent and Methods of Using the Same for Separation of One or More Materials from a Gas Stream (12-001PCT)
  - Application pending in Europe
  - Application pending in China
  - Application pending in Canada
- Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same (13-004PCT)
  - Application pending in Canada
  - Application pending in China
  - Application pending in Europe

Provisional Patent Applications

U.S. Patents

- Sorbents for the Oxidation and Removal of Mercury – U.S. Provisional Patent Application Serial No. 60/605,640 (05-001PRV)
- Process for Regenerating a Spent Sorbent – U.S. Provisional Patent Application Serial No. 60/464,868 (03-023PRV)
- Mercury Control Using Moderate-Temperature Dissociation of Halogen Compounds – U.S. Provisional Patent Application Serial No. 60/947,543 (06-001PRV)
- Activated Carbon Sorbent Including Nitrogen and Methods of Using the Same – Application Serial Number 61/773,549 (13-004PRV)

Appendix A

Application #	SLW File #	Patent #
11/209,163	4820.001US1	7,435,286
10/554,018	4820.002US1	8,173,566
12/419,219	4820.001US3	8,168,147
12/167,054	4820.008US1	8,312,822
13/425,288	4820.002US2	8,440,585
11/220,810	4820.009US1	7,615,101
12/177,771	4820.010US1	7,628,969
13/544,971	4820.008US2	8,807,056
13/427,665	4820.001US4	8,512,655
12/429,058	4820.007US1	8,652,235
13/966,768	4820.001US5	8,821,819
13/453,274	4820.006US1	9,011,805
14/446,992	4820.008US3	9,155,997
14/102,896	4820.007US2	9,468,886
14/195,360	4820.003US1	9,669,355
14/318,270	4820.001US6	
15/295,594	4820.007US3	
14/564,860	4820.006US2	9,662,629
14/712,558	4820.001US7	
14/880,463	4820.008US4	9,675,931
15/382,114	4820.004US1	
15/449,112	4820.005US1	
15/452,527	4820.006US3	
60/605,640	4820.001PRV	
60/464,868	4820.002PRV	
60/947,543	4820.008PRV	
61/773,549	4820.003PRV	

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Midwest Energy Emissions Corp.

Application No./Patent No.: 15/997,091 Filed/Issue Date: June 4, 2018

Titled: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Midwest Energy Emissions Corp. a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3 ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/ Nicholas P. Lanzatella /

Signature

09/27/2019

Date

Nicholas P. Lanzatella

Printed or Typed Name

USPTO Reg. No. 63,803

Title or Registration Number

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor:

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix

Residence Information (Select One) ☐ US Residency ☐ Non US Residency ☐ Active US Military Service

City		State/Province		Country of Residence	

Mailing Address of Inventor:

Address 1	
Address 2	

City		State/Province	
Postal Code		Country	

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence Information of this application.

Customer Number	
Email Address	

Application Information:

Title of the Invention			
Attorney Docket Number		Small Entity Status Claimed ☐	
Application Type			
Subject Matter			
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country Publication

Publication Information:

☐ **Request Early Publication (Fee required at time of Request 37 CFR 1.219)**

☐ **Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.**

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	☐ Customer	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number			

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Foreign Priority Information:

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

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This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)i the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the POX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Parent Filing Date (YYYY-MM-DD)	Access Code (if applicable)

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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	Application Number	15/997,091
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This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant must opt-out of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is ONLY reviewed and processed with the INITIAL filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ **A. Applicant DOES NOT authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.**

☐ **B. Applicant DOES NOT authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.**

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Modified PTO/AIA/14 (12-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant: ~~Midwest Energy Emissions Corp~~ Midwest Energy Emissions Corp.

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor
☐ Person to whom the inventor is obligated to assign	☐ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

☐ Deceased	☐ Legally incapacitated

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here: ☒

Organization Name: ~~Midwest Energy Emissions Corp~~ Midwest Energy Emissions Corp.

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information:

Address 1	670 D Enterprise Drive		
Address 2			
City	Lewis Center	State/Province	OH
Country	United States of America	Postal Code	43035
Phone Number			
Email Address			

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001U10
	Application Number	15/997,091
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is **a juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Nicholas P. Lanzatella/			Date (YYYY-MM-DD)	2019-09-27
First Name	Nicholas	Last Name	Lanzatella	Registration Number	63,803

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-14**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

21186 7590 09/18/2019
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER
ORLANDO, AMBER ROSE

ART UNIT	PAPER NUMBER
1776	

DATE MAILED: 09/18/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

TITLE OF INVENTION: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	12/18/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21186 7590 09/18/2019
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

TITLE OF INVENTION: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	12/18/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
ORLANDO, AMBER ROSE	1776	423-210000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 09/18/2019

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	
ART UNIT	**PAPER NUMBER**
1776	

DATE MAILED: 09/18/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/997,091	Applicant(s) Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the correspondence filed 08/30/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Continuation of 3. The allowed claim(s) is/are: 1,9-10,12,16 and 18-42

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Terminal Disclaimer

The terminal disclaimer filed on 08/28/2019 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of **7,435,286; 8,168,147; 8,512,655; 8,821,819; 9,757,689; 9,468,886; 8,652,235; 15/295,594; 15/589,359; 15/853,029; 14/712, 558; 15951,870; 15/382,114; 15/798,760; 15/974,343** has been reviewed and is accepted. The terminal disclaimer has been recorded.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ROSE ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Monday-Thursday 7:00-5:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571)272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AMBER ROSE. ORLANDO
Primary Examiner
Art Unit 1776

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	Art Unit
	AMBER R ORLANDO	1776

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Text Search (See east search history)	07/23/2018	AO
Inventor Search (DAV)	07/23/2018	AO
Text Search (See east search history)	10/29/2018	AO
Text Search (See east search history)	01/07/2019	AO
IDS Search (EAST and DAV)	08/17/2019	AO

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	SEE EAST SEARCH HISTORY	09/09/2019	AO

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	**Art Unit**
	AMBER R ORLANDO	1776

CPC						
Symbol					**Type**	**Version**
B01D	/	53	/	64	F	2013-01-01
B01D	/	53	/	10	I	2013-01-01
B01J	/	20	/	20	I	2013-01-01
B01J	/	20	/	22	I	2013-01-01
B01D	/	2253	/	102	A	2013-01-01
B01D	/	2257	/	602	A	2013-01-01
Y10S	/	95	/	901	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	09 September 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	11

U.S. Patent and Trademark Office — Part of Paper No.: 20190909

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	**Art Unit**
	AMBER R ORLANDO	1776

INTERNATIONAL CLASSIFICATION				
CLAIMED				
B01D	/	53	/	64
B01D	/	53	/	10
B01J	/	20	/	20
B01J	/	20	/	22

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	30	
/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	09 September 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	11

U.S. Patent and Trademark Office — Part of Paper No.: 20190909

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	**Art Unit**
	AMBER R ORLANDO	1776

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	09 September 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	11

U.S. Patent and Trademark Office

Part of Paper No.: 20190909

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS			
Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document

FOREIGN PATENT DOCUMENTS				
Examiner Initial *	Foreign Document Number	Publication Date	Name of Patentee or Applicant of cited Document	T 1

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 1
	"Application Serial No. 14/712,558, Response filed 07-10-19 to Final Office Action mailed - 1-11-19", 57 pgs.	
	"Application Serial No. 15/295,594, Final Office Action mailed 08-02-19", 18 pgs	
	"Application Serial No. 15/589,359, Notice of Allowance mailed 07-31-19", 7 pgs	
	"Application Serial No. 15/589,359, Response filed 07-16-19 to Non Final Office Action mailed 06-21-19", 7 pgs.	
	"Application Serial No. 15/974,343, Non Final Office Action mailed 08-21-19", 13 pgs	
	"Application Serial No. 15/974,343, Response Filed 07-10-2019 to Final Office Action mailed 01-14-19", 81 pgs	

EXAMINER /AMBER R ORLANDO/ DATE CONSIDERED 09/09/2019

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15997091
Filing Date	2018-06-04
First Named Inventor	Edwin S. Olson
Art Unit	1776
Examiner Name	Amber Orlando
Attorney Docket Number	4820.001U10

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5556447		1996-09-17	Srinivasachar, Srivats, et al.	
	2	7361209		2008-04-22	Durham, Michael D, et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020114749	A1	2002-08-22	Cole, Jerald Alan	
	2	20030113239	A1	2003-06-19	Pahlman, John E, et al.	
	3	20030161771	A1	2003-08-28	Oehr, Klaus H	
	4	20040244657	A1	2004-12-09	Srinivasachar, Srivats, et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15997091
	Filing Date	2018-06-04
	First Named Inventor	Edwin S. Olson
	Art Unit	1776
	Examiner Name	Amber Orlando
	Attorney Docket Number	4820.001U10

	5	20070259781	A1	2007-11-08	Sinha, Rabindra K	
	6	20140099244	A1	2014-04-10	Olson, Edwin S, et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	"Application Serial No. 16/509,071, Non Final Office Action mailed 09-11-19", 21 pgs.	
	2	"Application Serial No. 14/712,558, Non Final Office Action mailed 09-12-19", 15 pgs.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15997091
	Filing Date	2018-06-04
	First Named Inventor	Edwin S. Olson
	Art Unit	1776
	Examiner Name	Amber Orlando
	Attorney Docket Number	4820.001U10

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15997091
	Filing Date	2018-06-04
	First Named Inventor	Edwin S. Olson
	Art Unit	1776
	Examiner Name	Amber Orlando
	Attorney Docket Number	4820.001U10

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Nicholas P. Lanzatella/	Date (YYYY-MM-DD)	2019-09-13
Name/Print	Nicholas P. Lanzatella	Registration Number	63,803

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	David L. Buck/Jamie Johnson
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	37164378
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	David L. Buck/Jamie Johnson
Filer Authorized By:	David L. Buck
Attorney Docket Number:	4820.001US10
Receipt Date:	13-SEP-2019
Filing Date:	04-JUN-2018
Time Stamp:	17:28:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	E20199CH28559927
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	15997091_ids_09-13-2019.pdf	626706 462385230e0c8ceb3d9647f7fddca78b276abb7a	no	5
Warnings:					
Information:					
2	Non Patent Literature	0001_2_npl_4820001u11_oarnpe_20190911_f.pdf	919625 be77f8a0223c428c1430376e4ce89a6435783ad9	no	21
Warnings:					
Information:					
3	Non Patent Literature	0002_2_npl_4820001us7_oarn_09122019_f.pdf	707212 20b74b46aa12c11fdb31bbd6854cf1ee78a35d2c	no	15
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30656 c464cbc984303bb499edfbaf5eb993fb2897a756	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2284199		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
* 15/997,091 *	15/997,091	Olson et al.	
	Examiner	**Art Unit**	
	ORLANDO, AMBER ROSE	1776	

Document Code - DISQ	**Internal Document - DO NOT MAIL**

TERMINAL DISCLAIMER	☑ APPROVED	☐ DISAPPROVED
Date Filed: 28 August 2019	**This patent is subject to a Terminal Disclaimer**	

Approved/Disapproved by:

/JEAN PROCTOR/

Technology Center: OPLC

Telephone: (571)272-1040

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10

CONFIRMATION NO. 5161

21186
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

POA ACCEPTANCE LETTER

OC000000110784491

Date Mailed: 08/30/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/28/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/fly/

Amended PTO/AIA/82B(07-13)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: **21186**

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

☒ The address associated with the above mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Midwest Energy Emissions Corp.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	John Pavlish	Date (Optional)	6/9/2017
Name	John Pavlish		
Title	Chief Technology Officer		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Midwest Energy Emissions Corp

Application No./Patent No.: 15/997,091 Filed/Issue Date: June 4, 2018

Titled: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Midwest Energy Emissions Corp a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3 ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 042647, Frame 0351-0359, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

   1. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

   2. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Amended PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/ Nicholas P. Lanzatella /

Signature

August 28, 2019

Date

Nicholas P. Lanzatella

Printed or Typed Name

USPTO Reg. No. 63,803

Title or Registration Number

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Edward James Sandor/Beth Moon
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
STATUTORY OR TERMINAL DISCLAIMER	1814	1	160	160
		Total in USD ($)		**400**

Electronic Acknowledgement Receipt

EFS ID:	37007123
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Edward James Sandor/Beth Moon
Filer Authorized By:	Edward James Sandor
Attorney Docket Number:	4820.001US10
Receipt Date:	28-AUG-2019
Filing Date:	04-JUN-2018
Time Stamp:	15:55:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$400
RAM confirmation Number	E20198RF58132288
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		signed4820_001U10_NFOA_TD _POA_SIDS.pdf	3744905 1dfc63d6147f81cd7de2a44f6b972825b6143c55	yes	23

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	1
Amendment/Req. Reconsideration-After Non-Final Reject	2	2
Claims	3	8
Applicant Arguments/Remarks Made in an Amendment	9	16
Miscellaneous Incoming Letter	17	18
Information Disclosure Statement (IDS) Form (SB08)	19	19
Terminal Disclaimer Filed	20	20
Power of Attorney	21	21
Assignee showing of ownership per 37 CFR 3.73	22	23

Warnings:

Information:

2	Non Patent Literature	npl1_4820001U10_OARN_0823 2019.pdf	1415213 82e99d7aeee8913bcc69c1142a40bad6c697395c	no	14

Warnings:

Information:

3	Non Patent Literature	npl2_4820007US3_FOAR_0802 2019.pdf	1878950 641caeec846be5b8f4f82836921e3fd4838bba89	no	18

Warnings:					
Information:					
4	Non Patent Literature	npl3_4820003US2_NOAR_07312019.pdf	1126931 f2c93637028800514d0b15699722fab44e8a92f6	no	7
Warnings:					
Information:					
5	Non Patent Literature	npl4_4820003US2_AARN_07-16-19.pdf	118986 9788f7869e88c1fce840d36db4710cf0077e1625	no	7
Warnings:					
Information:					
6	Non Patent Literature	npl5_4820001US9_OARN-PE_08212019.pdf	1240882 8990fa62f3e2bbe07fbc3c9967a673a3dd157f41	no	13
Warnings:					
Information:					
7	Non Patent Literature	npl6_4820001US8_20190710_Rsp.pdf	13134577 bc339491f8f4dd4d51579dc7c940d56f6f025b31	no	81
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	31882 33c5c0983b5630496c264ae88a1cb4a05df9bbf2	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	22692326	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	November 23, 2019
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X Amendment and Response under 37 C.F.R. § 1.111 (15 pgs.)
X Information Disclosure Statement (2 pgs.), Form 1449 (1 pg.) Copies of Cited References (6).
X Authorization to charge Deposit Account 19-0743 in the amount of $240.00 to cover the fee for consideration of Information Disclosure Statement under 37 C.F.R. § 1.97(c).
X Terminal Disclaimer (1 pg.)
X Authorization to charge Deposit Account 19-0743 in the amount of $160.00 to cover the fee for the Terminal Disclaimer
X Power of Attorney (1 pg.)
X Statement Under 37 CFR 3.73 (c) (2 pgs.)

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By _____
Nicholas P. Lanzatella
Reg. No. 63,803

Modified form PTO/SB/08A(04-07) OMB 651-0031
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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS			
Examiner Initial *	**USP Document Number**	**Publication Date**	**Name of Patentee or Applicant of cited Document**

FOREIGN PATENT DOCUMENTS				
Examiner Initial *	**Foreign Document Number**	**Publication Date**	**Name of Patentee or Applicant of cited Document**	**T 1**

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
Examiner Initial *	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T 1**
	"Application Serial No. 14/712,558, Response filed 07-10-19 to Final Office Action mailed - 1-11-19", 57 pgs.	
	"Application Serial No. 15/295,594, Final Office Action mailed 08-02-19", 18 pgs	
	"Application Serial No. 15/589,359, Notice of Allowance mailed 07-31-19", 7 pgs	
	"Application Serial No. 15/589,359, Response filed 07-16-19 to Non Final Office Action mailed 06-21-19", 7 pgs.	
	"Application Serial No. 15/974,343, Non Final Office Action mailed 08-21-19", 13 pgs	
	"Application Serial No. 15/974,343, Response Filed 07-10-2019 to Final Office Action mailed 01-14-19", 81 pgs	

EXAMINER **DATE CONSIDERED**

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

Modified PTO/AIA/26 (04-14)
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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT

Docket Number 4820.001U10

In re Application of: Edwin S. Olson et al.

Application No.: 15/997,091

Filed: June 4, 2018

For: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

The applicant, **Midwest Energy Emissions Corp**, owner of the entire interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent No.(s)/prior Application No.(s)** **7,435,286; 8,168,147, 8,512,655, 8,821,819, 9,757,689, 9,468,886, 8,652,235, 15/295,594, 15/589,359, 15/853,029, 14/712,558, 15/951,970, 15/382,114, 15/978,760, 15/974,343** as the term of said **prior patent(s)/prior Application No.(s)** is presently shortened by any terminal disclaimer. The applicant hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent(s)** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the applicant does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent(s)**, "as the term of said **prior patent(s)** is presently shortened by any terminal disclaimer," in the event that said **prior patent(s)** later:

- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ The undersigned is the applicant. If the applicant is an assignee, the undersigned is authorized to act on behalf of the assignee.

I hereby acknowledge that any willful false statements made are punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

2. ☒ The undersigned is an attorney or agent of record. Reg. No. 63,803

/ Nicholas P. Lanzatella / — **Nicholas P. Lanzatella**

August 28, 2019 — **Date**

Attorney — **Title**

612-349-9580 — **Telephone Number**

☒ Terminal disclaimer fee under 37 CFR 1.20(d) included.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.	Examiner: Amber Orlando
Serial No.: 15/997,091	Group Art Unit: 1776
Filed: June 4, 2018	Docket No.: 4820.001U10
Customer No.: 21186	Confirmation No.: 5161

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In response to the Office dated January 11, 2019, please amend the application as follows:

IN THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A method for reducing mercury in a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, the coal comprising an additive comprising Br_2, HBr, a bromide compound, or a combination thereof, to form the mercury-containing gas; and

collecting mercury in the mercury-containing gas with a sorbent added to the mercury-containing gas, the sorbent comprising activated carbon.

2.-8. (Canceled)

9. (Original) The method of claim 1, further comprising injecting an alkaline sorbent into the mercury-containing gas stream.

10. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

11. (Canceled)

12. (Original) The method of claim 1, wherein the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof.

13-15. (Canceled)

16. (Previously Presented) The method of claim 1, wherein the sorbent has a composition comprising from about 1 to about 30 grams of the element bromine per 100 grams of activated carbon.

17. (Canceled)

18. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas.

19. (Previously Presented) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas with the sorbent.

20. (Previously Presented) The method of claim 1, further comprising:

measuring mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content,

an injection rate of injecting the sorbent comprising activated carbon into the mercury-containing gas,

an amount of the additive comprising the Br_2, HBr, bromide compound, or a combination thereof, added to the coal, or

a combination thereof.

21. (Previously Presented) The method of claim 20, wherein the measuring of the mercury content of the mercury-containing gas is performed substantially continuously.

22. (Previously Presented) The method of claim 1, further comprising:

modifying, in response to a measured mercury content,

an injection rate of injecting the sorbent comprising activated carbon into the mercury-containing gas,

an amount of the Br_2, HBr, bromide compound, or a combination thereof, added to the coal, or

a combination thereof.

23. (Previously Presented) The method of claim 1, wherein the coal comprises a subbituminous coal.

24. (Previously Presented) The method of claim 1, wherein the coal comprises a lignite coal.

25. (Previously Presented) The method of claim 1, wherein the coal comprises the added Br_2, HBr, the bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber.

26. (Previously Presented) The method of claim 1, wherein the combustion chamber comprises the added Br_2, HBr, the bromide compound, or a combination thereof.

27. (Previously Presented) The method of claim 1, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br_2, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br_2, HBr, bromide compound, or combination thereof, to the coal is performed at the coal-combustion facility.

28. (Previously Presented) The method of claim 1, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br_2, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br_2, HBr, bromide compound, or combination thereof, to the coal is performed at a site other than the coal-combustion facility.

29. (Previously Presented) The method of claim 1, wherein the combustion chamber is an electric utility coal combustion chamber.

30. (Currently Amended) The method of claim 1, ~~wherein the combustion chamber is a coal combustion furnace~~further comprising:

measuring mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content, an injection rate of injecting the sorbent comprising activated carbon into the mercury-containing gas.

31. (Previously Presented) The method of claim 1, wherein the mercury-containing gas comprises about 1 g to about 30 g of the element bromine per 100 g of the sorbent.

32. (Currently Amended) The method of claim 1, ~~wherein the sorbent that collects the mercury comprises the element bromine and mercury~~further comprising:

measuring mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content, an amount of the additive comprising the Br_2, HBr, bromide compound, or a combination thereof, added to the coal.

33. (Previously Presented) The method of claim 1, wherein the sorbent in the mercury-containing gas comprises about 1 g to about 30 g of the added Br_2, HBr, the bromide compound, or a combination thereof, per 100 g of the sorbent.

34. (Previously Presented) The method of claim 1, wherein the Br_2, HBr, or the bromide compound is contacted with the sorbent in vapor form, gaseous form, liquid form, or in an organic solvent.

35. (Previously Presented) The method of claim 1, wherein the sorbent injected into the mercury-containing gas is a sorbent obtained by contacting a base sorbent with a halogen or halide promoter prior to injection of the sorbent to the mercury-containing gas.

36. (Previously Presented) The method of claim 1, wherein the sorbent injected into the mercury-containing gas is free of contact with a halogen or halide promoter prior to injection of the sorbent into the mercury-containing gas.

37. (Previously Presented) The method of claim 1, wherein the injection of the sorbent into the mercury-containing gas occurs upstream of a particulate separator or a scrubber.

38. (Previously Presented) The method of claim 37, wherein the particulate separator comprises an electrostatic precipitator, a baghouse, a fabric filter, or a combination thereof.

39. (Previously Presented) The method of claim 1, wherein the coal comprises added halide sorbent enhancement additive that comprises the added Br_2, HBr, the bromide compound, or combination thereof.

40. (Previously Presented) The method of claim 1, wherein the sorbent enhancement additive comprises the bromide compound.

41. (Currently Amended) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, wherein

the coal comprises added Br_2, HBr, bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br_2, HBr, bromide compound, or a combination thereof, or

a combination thereof; and

collecting mercury in the mercury-containing gas with a sorbent added to the mercury-containing gas, the sorbent comprising activated carbon.

42. (Currently Amended) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein the mercury-containing gas comprises a halogen or halide promoter comprising HBr, Br^-, or a combination thereof, wherein

the coal comprises added Br_2, HBr, bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br_2, HBr, bromide compound, or a combination thereof, or

a combination thereof;

collecting mercury in the mercury-containing gas with a sorbent added to the mercury-containing gas, the sorbent comprising activated carbon;

separating the sorbent contacted with the mercury from the mercury-containing gas;

measuring the mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content of the mercury-containing gas,

an injection rate of injecting the sorbent into the mercury-containing gas,

an amount of the Br_2, HBr, bromide compound, or a combination thereof, added to the coal or the combustion chamber, or

a combination thereof.

REMARKS

This responds to the Office Action dated January 11, 2019.

Claims 1, 30, 32, and 41-42 are amended, no claims are canceled, and no claims are added; as a result, claims 1, 9-10, 12, 16, and 18-42 are now pending in this application.

Independent claims 1, 41, and 42 are presently amended to recite "...collecting mercury in the mercury-containing gas with a sorbent added to the mercury-containing gas, the sorbent comprising activated carbon...." Support can be found in the present published U.S. application at Figure 11 and paragraph [0237].

Dependent claim 30 is presently amended to recite "...~~wherein the combustion chamber is a coal combustion furnace~~further comprising: measuring mercury content of the mercury-containing gas; and modifying, in response to the measured mercury content, an injection rate of injecting the sorbent comprising activated carbon into the mercury-containing gas." Dependent claim 32 is presently amended to recite "...~~wherein the sorbent that collects the mercury comprises the element bromine and mercury~~further comprising: measuring mercury content of the mercury-containing gas; and modifying, in response to the measured mercury content, an amount of the additive comprising the Br_2, HBr, bromide compound, or a combination thereof, added to the coal." Amended claims 30 and 32 recite features from dependent claim 20.

No new matter is added via the amendments herein.

The Rejection of Claims Under § 112

I. The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as allegedly being indefinite. The Office Action rejected claim 11 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being allegedly incomplete for omitting essential steps, such omission amounting to a gap between the steps.

The Office Action states that "[t]he omitted steps are: the sorbent being added to the mercury containing gas stream."

It is believed that the Office Action intended to refer to "claim 1" instead of "claim 11".

These rejections are respectfully traversed.

Independent claims 1, 41, and 42 are presently amended to recite "...collecting mercury in the mercury-containing gas with a sorbent added to the mercury-containing gas, the sorbent comprising activated carbon...."

Dependent claims 9, 10, 12, 16, and 18-40 are rejected solely due to dependence on independent claim 1. Therefore, dependent claims 9, 10, 12, 16, and 18-40 are patentable for the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejections of claims 1, 9, 10, 12, 16, and 18-42 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph.

Double Patenting Rejections

II. Double patenting rejections.

II(A). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 7,435,286 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-30 of U.S. patent no. 7,435,286 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(B). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-25 of patent no. 8,168,147 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-25 of U.S. patent no. 8,168,147 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(C). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,512,655 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-60 of U.S. patent no. 8,512,655 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(D). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,821,819 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-60 of U.S. patent no. 8,821,819 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(E). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-33 of U.S. patent no. 9,757,689 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-33 of U.S. patent no. 9,757,689 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(F). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of U.S. patent no. 9,468,886 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of U.S. patent no. 9,468,886 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(G). The Office Action rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,652,235 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-30 of U.S. patent no. 8,652,235 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(H). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/295,594 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-16 of copending application no. 15/295,594 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(I). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 8-20 of copending application no. 15/589,359 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 8-20 of copending application no. 15/589,359 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(J). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(K). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 14/712,558 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 14/712,558 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(L). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/951,970 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 15/951,970 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(M). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/382,114 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 15/382,114 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(N). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang. This rejection appears to be a duplicate of the rejection listed herein at **II(J)**.

However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(O). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/978,760 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-20 of copending application no. 15/978,760 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

II(P). The Office Action provisionally rejected claims 1, 9, 10, 12, 16, and 18-42 on the ground of nonstatutory double patenting over claims 1-10, 14, and 21-25 of copending application no. 15/974,343 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 9, 10, 12, 16, and 18-42 are obvious over claims 1-10, 14, and 21-25 of copending application no. 15/974,343 in view of Felsvang. However, merely to expedite prosecution, a Terminal Disclaimer in compliance with 37 C.F.R. § 1.321 is enclosed herewith to obviate these rejections.

Applicant therefore respectfully requests reconsideration and withdrawal of the double patenting rejection.

CONCLUSION

Applicant respectfully submit that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 349-9580 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, Minnesota 55402
(612) 349-9580

Date August 28, 2019

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.	Examiner: Amber Orlando
Serial No.: 15/997,091	Group Art Unit: 1776
Filed: June 4, 2018	Docket: 4820.001U10
Customer No.: 21186	Confirmation No.: 5161

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. Applicant respectfully requests that this Information Disclosure Statement be entered and the documents listed on the attached PTO 1449 Form be considered by the Examiner and made of record. Pursuant to the provisions of MPEP 609, Applicant requests that a copy of the PTO 1449 Form, initialed as being considered by the Examiner, be returned to the Applicant with the next official communication.

Pursuant to 37 C.F.R. § 1.97(c)(2), Applicant hereby authorizes the Commissioner to charge the fee of $240.00 as set forth in 37 C.F.R. § 1.17(p), to Deposit Account No. 19-0743. Please charge any additional fees or deficiencies, or credit any overpayment to Deposit Account No. 19-0743.

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicant acknowledges the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date August 28, 2019 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:bam

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/997,091	Filing Date 06/04/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	08/28/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 30	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/BRENDA V HARRISON/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 08/23/2019
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
08/23/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Office Action Summary	Application No. 15/997,091	Applicant(s) Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 07/10/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1,9-10,12,16 and 18-42 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1,9-10,12,16 and 18-42 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☑ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 07/10/2019 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 11 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps are: the sorbent being added to the mercury containing gas stream.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise

extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 7,435,286 ('286) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '286 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. US 8,168,147 ('147) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '147 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,512,655 ('655) in view of Felsvang et al. US 5,435,980.

'655 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '655 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,821,819 ('819) in view of Felsvang et al. US 5,435,980.

'819 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '819 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-33 of U.S. Patent No. US 9,757,689 ('689) in view of Felsvang et al. US 5,435,980.

'689 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '689 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of U.S. Patent No. US 9,468,886 ('886) in view of Felsvang et al. US 5,435,980.

'886discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '886 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. 8,652,235 ('235) in view of Felsvang et al. US 5,435,980.

'235discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '235 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/295594 ('594) in view of Felsvang et al. US 5,435,980.

'594 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '594 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 8-20 of copending Application No. 15/589359 ('359).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '359.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 14/712558 ('558). Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '558.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/951970 ('970). Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '970.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/382114 ('114) in view of Felsvang et al. US 5,435,980.

'114 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '114 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4,

lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/978,760 ('760) in view of Felsvang et al. US 5,435,980.

'760 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '760 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 9, 10, 12, 16 and 18-42 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-10, 14 and 21-25 of copending Application No. 15/974,343 ('343).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '760.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ROSE ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Monday-Thursday 7:00-5:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571)272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AMBER ROSE. ORLANDO
Primary Examiner
Art Unit 1776

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Examiner-Initiated Interview Summary	Application No. 15/997,091	Applicant(s) Olson et al.		
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA (First Inventor to File) Status No	Page 1 of 2

All participants (applicant, applicants representative, PTO personnel):

1. AMBER R ORLANDO (Primary Examiner); Telephonic 2. Nicholas Lansatella (Attorney); Telephonic

Date of Interview: 15 August 2019

Claims Discussed: 1, 41, 42

Amendment proposed: An amendment to claims 1, 41 and 42 to overcome 112 issues was discussed.

Issues Discussed:

Item(s) under 35 U.S.C. 112:
The examiner stated that essential steps were missing from the method. Specifically how the sorbent is capable of collecting mercury in the gas if the sorbent does not necessarily have to be within the mercury containing gas.

Proposed Amendments:
The applicant suggested changing the claims to state "collecting mercury in the mercury containing gas with a sorbent added to the mercury containing gas, the sorbent comprising activated carbon". The examiner agreed that this would overcome the 112 issue but the pending double patenting rejections preclude the examiner from making the application allowable.

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	Art Unit
	AMBER R ORLANDO	1776

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Text Search (See east search history)	07/23/2018	AO
Inventor Search (DAV)	07/23/2018	AO
Text Search (See east search history)	10/29/2018	AO
Text Search (See east search history)	01/07/2019	AO
IDS Search (EAST and DAV)	08/17/2019	AO

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-10,343,114	7/9/2019	Olson, Edwin S, et al.
	US-20120100053A1	4/26/2012	Durham, Michael D, et al.
	US-20130157845A1	6/20/2013	Nalepa, Christopher J, et al.

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Examiner Initial *	Foreign Document Number	Publication Date	Name of Patentee or Applicant of cited Document	T1
	WO-2012030560A1	3/8/2012	Nalepa, Christopher J, et al.	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T1
	"Application Serial No. 15/382,114, Final Office Action mailed 06-21-19", 31 pgs	
	"Application Serial No. 15/589,359, Advisory Action mailed 05-22-19", 3 pgs	
	"Application Serial No. 15/589,359, Non Final Office Action mailed 06-21-19", 7 pgs	
	"Application Serial No. 15/978,760, Notice of Allowability mailed 05-30-19", 3 pgs	
	"Application Serial No. 15/978,760, Notice of Allowance mailed 05-08-19", 7 pgs	

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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 2	Attorney Docket No: 4820.001U10	

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	"Application Serial No. 15/295,594, Response filed 4-23-19 to Non Final Office Action mailed 10-23-18", 45 pgs	
	"Application Serial No. 15/382,114, Response filed 3-12-19 to Non Final Office Action mailed 12-12-18", 24 pgs	
	"Application Serial No. 15/589,359, Final Office Action mailed 03-01-19", 10 pgs	
	"Application Serial No. 15/589,359, Response filed 04-30-19 to Final Office Action mailed 03-01-19", 11 pgs.	
	"Application Serial No. 15/978,760, Ex Parte Quayle Action mailed 04-19-19", 13 pgs	
	"Application Serial No. 15/978,760, Response filed 03-20-19 to Final Office Action mailed 12-26-18", 90 pgs.	
	"Application Serial No. 15/978,760, Response filed 4-23-19 to Ex Parte Quayle Action mailed 04-19-19", 15 pgs	
	"Coal Combustion Products (CCPs): Characteristics, Utilization and Beneficiation", Edited by Tom Robl, et al., Woodhead Publishing (Elsevier), (2017), 565 pgs	
	"Control of Mercury Emissions from Coal Fired Electric Utility Boilers: An Update", US EPA Air Pollution Prevention and Control Division, National Risk Management Research Laboratory, Office of Research and Development, (February 18, 2005), 59 pgs	
	"Sorbent Enhancement Additives for Mercury Control", US DOE Office of Fossil Energy, National Energy Technology Laboratory, (June 2008), 4 pgs	
	BENSON, STEVEN A., et al., "JV Task 73 - Mercury Control Technologies for Electric Utilities Burning Subbituminous Coals - Draft Final Report", University of North Dakota Energy and Environmental Research Center, (June 2005), 165 pgs	
	BENSON, STEVEN A., et al., "Pilot-and Full-Scale Demonstration of Advanced Mercury Control Technologies for Lignite-Fired Power Plants", University of North Dakota Energy and Environmental Research Center, (February 2005), 97 pgs	
	BERRY, MARK, et al., "Mercury control evaluation of calcium bromide injection into a PRB-fired furnace with an SCR", Proc. of the Air Quality VI Conference, Arlington, VA, (2007), 9 pgs	

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	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 2 of 2	Attorney Docket No: 4820.001U10	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
Examiner Initial *	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T 1**
	BROWN, THOMAS D., et al., "Mercury Measurement and Its Control: What We Know, Have Learned, and Need to Further Investigate", Journal of the Air and Waste Management Association, 49(6), (June 1999), 98 pgs	
	FEELEY, THOMAS J., et al., "A Review of DOE/NETL's Mercury Control Technology R and D Program for Coal-Fired Power Plants", DOE/NETL Hg R and D Program Review, (April 2003), 32 pgs	
	FRENCH, CHARLES L., et al., "Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units - Final Report to Congress: Volume 1", US EPA Office of Air Quality Planning and Standards, (February 1998), 502 pgs	
	GHORISHI, BEHROOZ S., et al., "In-Flight Capture of Elemental Mercury by Chlorine-Impregnated Activated Carbon", Proc. of the 94th Annual Meeting of the Air and Waste Management Association, Orlando, FL, (June 2001), 14 pgs	
	JONES, ANDREW P., et al., "DOE/NETL's Phase II Mercury Control Technology Field Testing Program: Preliminary Economic Analysis of Activated Carbon Injection", Environmental Science and Technology, 41(4), (2007), 7 pgs	
	KEATING, MARTHA H., et al., "Mercury Study Report to Congress Volume 1: Executive Summary", US EPA Office of Air Quality Planning and Standards, (December 1997), 95 pgs	
	KILGROE, JAMES D., et al., "Control of Mercury Emissions from Coal-Fired Electric Utility Boilers: Interim Report", US EPA Office of Research and Development, National Risk Management Laboratory, Air Pollution Prevention and Control Division, (December 2001), 485 pgs	
	NELSON, SID JR., et al., "How China Can Leapfrog the World in Mercury Emission Reductions", Proc. of the AWMA Intl. Specialty Conference on Leapfrogging Opportunities for Air Quality Improvement, (2010), 24 pgs	
	PAVLISH, JOHN H., et al., "Status review of mercury control options for coal-fired power plants", Fuel Processing Technology, Vol. 82, (2003), 77 pgs	
	YANG, YANG, et al., "Effect of HBr formation on mercury oxidation via CaBr(2) addition to coal during combustion", RSC Advances, 6(64), (2016), 7 pgs	

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	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-20190009247A1	1/10/2019	Olson, Edwin S, et al.

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	"Application Serial No. 14/712,558, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-19-18", 28 pgs	
	"Application Serial No. 14/712,558, Final Office Action mailed 01-11-19", 27 pgs	
	"Application Serial No. 15/382,114, Non Final Office Action mailed 12-12-18", 46 pgs	
	"Application Serial No. 15/589,359, Amendment and Response filed 01-17-19 to Non Final Office Action mailed 10-22-18", 14 pgs	
	"Application Serial No. 15/974,343, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-29-18", 37 pgs	
	"Application Serial No. 15/974,343, Final Office Action mailed 01-14-19", 25 pgs	
	"Application Serial No. 15/978,760, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-10-18", 25 pgs	
	"Application Serial No. 15/978,760, Final Office Action mailed 12-26-18", 21 pgs	

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	"20120100053"	US-PGPUB; USPAT	ADJ	ON	2019/08/17 11:40
L2	1	"20130157845"	US-PGPUB; USPAT	ADJ	ON	2019/08/17 11:40
S1	45	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S2	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorben and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S3	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:20
S7	73	("20020150516" | "4786483" | "5409522" | "5505766" | "6383981" | "6878358" | "20020033097" | "4530765" | "5346674" | "6080281" | "4708853" | "6027551" | "6136072" | "6258334" | "6818043" | "20060057044" | "20080207443" | "20010002387" | "3826618" | "4814152" | "4820318" | "4889698" | "5891324" | "6528030" | "20050227146" | "5419834" | "7942566" | "20080134888" | "3662523" | "3849267" | "4196173" | "4500327" | "6942840" | "20020134242" | "20030136509" | "20050147549" | "20060112823" | "20080134888" | "6471936" | "20010003116" | "20050019240" | "20060048646" | "4956162" | "5575982" | "6372187" | "6375909" | "7435286" | "7514052" | "20050074380" | "20090081092" | "5288306" | "1984164" | "4101631" | "5695726" | "6080281" | "6848374" | "20050000197" | "5300137" | "5607496" | "5672323" | "6214304" | "6953494" | "5245120" | "20070168213" | "7938571" | "20040003716" | "20040013589" | "3194629" | "3786619" | "5827352" | "20040109800" | "20070295347" | "5435980" | "6136749" | "20030206846").PN.	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:25
S8	13	"11209163"	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S9	3	"11209163" and non carbon	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S10	161	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10,	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:49

		B01D53/10).cpc. and (halogen or halide of HBr) with sorbent				
S11	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S12	116	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S13	172	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S14	67	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S15	67	"6136749"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:11
S16	20	"684374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S17	1	"20040003716"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S18	68	"6848374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S19	41	"7435286"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S20	13	"8168147"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S21	69	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S22	181	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S25	28	"5266280"	US-PGPUB; USPAT	ADJ	ON	2016/06/07 13:41
S26	281	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:01
S27	148	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:02
S28	159	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 16:18

S29	206	(sorbent or activated carbon) with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4 and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 16:22
S30	195	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/09/30 13:48
S33	6	"20040003719"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:56
S34	49	"2004003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:57
S35	81	"6848374"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:58
S36	56	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:02
S37	7	olson.in. and ("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:04
S38	0	("40" microns and halocarbon sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S39	0	(halocarbon sorbent).clm. and "40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S40	65	"40" microns and olson.in.	US-PGPUB;	ADJ	ON	2016/11/16

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			11:06
S41	3907	("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S42	29	("40" microns and sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
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S44	36	(sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S45	0	(sorbent).clm. and olson.in. and "40" micron	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S46	17	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:09
S47	2	"20110233133"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:27
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S51	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
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S56	4	"8747505"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:57
S57	2	"14318270"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 12:06
S58	13	pac with size with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 12:13
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S63	2	"20100083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S64	2	absorp$5 with mea with methanol with acid	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:36
S65	2	"20070283813"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:39
S66	21	"4469596"	US-PGPUB; USPAT	ADJ	ON	2016/11/21 08:29
S67	4	"2003229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S68	2	"20030229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S69	45	"5,338,458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S70	45	"5338458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S71	213	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:02
S72	64	("1786483" | "1984164" | "2317857" | "20010002387" | "20010003116" | "20020134242" | "20020150516" | "20030136509" | "20040003716" | "20040013589" | "20050019240" | "20060048646" | "20060191835" | "20090062119" | "20100047146" | "20120183458" | "20140056787" | "3194629" | "3662523" | "3786619" |	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:20

		"3826618" | "3849267" | "4196173" | "4500327" | "4814152" | "4820318" | "4889698" | "4959162" | "5300137" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "7101631" | "7435286" | "7479263" | "7514052" | "7563311" | "7611564" | "8007749" | "8168147" | "8168149" | "8512655").PN.				
S73	3	("20090235848" | "20110076210" | "20150246315").PN.	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:31
S79	3	("20090235848" | "20110076210" | "20140224121").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:36
S80	96	("1984164" | "2317857" | "20010002387" | "20010003116" | "20020043496" | "20020134242" | "20020150516" | "20030104937" | "20030136509" | "20040003716" | "20040013589" | "20040076570" | "20050019240" | "20060048646" | "20060191835" | "20080182747" | "20080292512" | "20090062119" | "20090136401" | "20090320678" | "20100047146" | "20110168018" | "20120183458" | "20130280156" | "20140056787" | "20140255279" | "20140308188" | "20150098878" | "3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "3876393" | "4094777" | "4101631" | "4196173" | "4338896" | "4500327" | "4708853" | "4786483" | "4814152" | "4820318" | "4889698" | "4956162" | "5300137" | "5336835" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6638485" | "6808692" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "6960329" | "7081434" | "7211707" | "7435286" | "7479263" | "7514052" | "7521032" | "7544338" | "7563311" | "7611564" | "7622092" | "7722843" | "7767174" | "7780765" | "8007749" | "8168147" | "8168149" | "8216535" | "8512655" | "8652235" | "8821819" | "9011805").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:41
S81	593	honeycomb with plug$4 and plug$4 with length	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S82	0	honeycomb with plug$4 and plug$4 with length with less than with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S83	0	honeycomb with plug$4 and plug$4 with length with less than	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S84	127	honeycomb with plug$4 and plug$4 with	US-PGPUB;	ADJ	ON	2017/06/27

		length with "5"	USPAT			14:46
S85	241	honeycomb with plug$4 and plug$4 with length with mm	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:47
S86	41	honeycomb with plug$4 and plug$4 with length with "3 mm "	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:49
S87	28	honeycomb with plug$4 and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:52
S88	28	honeycomb and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:53
S89	43	honeycomb and plug$4 with porosity with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:06
S90	20	honeycomb and plug$4 with pore (size or diameter) with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:07
S91	8	saw with honeycomb with filter	US-PGPUB; USPAT	ADJ	ON	2017/06/29 13:31
S92	230	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/12/01 14:36
S93	2	"20060260468"	US-PGPUB; USPAT	ADJ	ON	2018/07/03 10:34
S94	19	engine with air with inlet with filter$4 with cone	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:26
S95	36	engine with air with inlet with filter$4 with (cone or conical or (diameter with (increas$4 or decreas$4)))	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:27
S96	24	("3771638" | "3870495" | "3872012" | "4157902" | "4702754" | "5125940" | "5522909" | "5549724" | "5632793").PN. OR ("5888260").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S97	41	("0153535" | "0439091" | "1398685" | "1530163" | "1887052" | "2087688" | "4003836" | "4018580" | "4032455" | "4039308" | "4065276" | "4261710" | "4410341" | "4414110" | "4699715" | "5106397" | "5178656" | "5522909" | "5549722" | "5549724" | "5888260" | "6397842" | "6508052" | "D401597" | "D401942" | "D403414" | "D403416").PN. OR ("6808552").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S98	15	("D403416").URPN.	USPAT	ADJ	ON	2018/07/03 15:33
S99	0	"20030089233"	USPAT	ADJ	ON	2018/07/04 12:29
S100	3	"20030089233"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S101	26	"6833023"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S102	2	"20070168213"	US-PGPUB; USPAT;	ADJ	ON	2018/07/09 13:08

			USOCR; FPRS; EPO; JPO			
S103	14	carbocations with sorbent with bromine	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:14
S104	0	a side forming a cross sectional shape of each of the first	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:47
S105	0	non of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S106	0	none of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S107	0	none of sides forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S109	13	olson.in. and (alkali and promoter and earth).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S110	0	olson.in. and (alkali and promoter and earth with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S111	10	olson.in. and (alkali and promoter with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S112	0	"2015008283"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S113	2	"20150082833"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S114	24	olson.in. and liquid.clm. and promoted	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:50
S115	75	remov$4 with mercury and (br or bromine) with liquid with carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:54
S116	0	separating greater than "70" wt% of the mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17
S117	0	((separating greater) with (of the mercury)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17

S118	20	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:43
S119	40	(during with after with mercury with sorbent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:38
S120	304	sorbent with mercury and sorbent with boiler	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:39
S121	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:41
S122	18	before with burn$4 with coal with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:42
S123	204	("0174348" | "0202092" | "0208011" | "0224649" | "0229159" | "0298727" | "0346765" | "0347078" | "0367014" | "0537926" | "0537998" | "0541025" | "0625754" | "0647622" | "0685719" | "0688782" | "0700888" | "0744908" | "0846338" | "0894110" | "0896876" | "0911960" | "0945331" | "0945846" | "1112547" | "1167471" | "1167472" | "1183445" | "1788466" | "1984164" | "20020065581" | "20020114749" | "20020184817" | "20030088370" | "20030103882" | "20040003716" | "20040013589" | "20040086439" | "20040219083" | "20050039598" | "20060047526" | "20060210463" | "2016821" | "2059388" | "2089599" | "2511288" | "3194629" | "3288576" | "3437476" | "3599610" | "3662523" | "3725530" | "3764496" | "3823676" | "3838190" | "3849267" | "3849537" | "3956458" | "3961020" | "3974254" | "4040802" | "4075282" | "4094777" | "4101631" | "4115518" | "4148613" | "4174373" | "4196173" | "4226601" | "4233274" | "4272250" | "4280817" | "4305726" | "4322218" | "4377599" | "4387653" | "4394354" | "4440100" | "4472278" | "4474896" | "4519807" | "4519995" | "4555392" | "4582936" | "4602918" | "4629721" | "4693731" | "4716137" | "4741278" | "4758418" | "4764219" | "4786483" | "4804521" | "4807542" | "4824441" | "4830829" | "4873930" | "4886519" | "4892567" | "4915818" | "4933158" | "4936047" | "4964889" | "5013358" | "5024171" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/01 17:42

		"5049163" | "5116793" | "5126300" | "5137854" | "5162598" | "5190566" | "5238488" | "5350728" | "5368617" | "5409522" | "5435980" | "5447703" | "5460643" | "5505746" | "5505766" | "5571490").PN. OR ("5587003" | "5618508" | "5635150" | "5659100" | "5670122" | "5733516" | "5738834" | "5787823" | "5810910" | "5897688" | "5910292" | "5989506" | "6024931" | "6083289" | "6240859" | "6258334" | "6372187" | "6375909" | "6475451" | "6521021" | "6528030" | "6533842" | "6558454" | "6610263" | "6613110" | "6719828" | "6732055" | "6737031" | "6746531" | "6790420" | "6808692" | "6848374" | "6878358" | "6942840" | "6953494" | "6962617" | "6974564" | "6975975" | "7468170" | "7507083" | "7674442" | "7758827" | "7776301").PN.				
S124	1	"15573128"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:07
S125	2	"20110207597"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:08
S126	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S127	71	sorbent with before with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S128	234	"6953494"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:38
S129	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:40
S130	35	promoter with sorbent and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S131	28	promoter with sorbent with mercury and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S132	4	promoter with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:20

S133	4	promot$4 with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:23
S134	4	promot$4 with sorbent with mercury and pre.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:41
S135	2	promot$4 with sorbent with mercury and pre-heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:42
S136	2	promot$4 with sorbent with mercury and pre heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S137	57	promot$4 with sorbent with mercury and pre	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S138	24	sorbent with preheat$4 with coal	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:39
S139	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:47
S140	23	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:28
S141	5	"14102896"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:48
S142	7	"12429058"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:09
S143	4	"12202595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:23
S144	20	"12201595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:24

S145	3	"14564860"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:27
S146	1	"15978760"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:28
S147	1	"15589359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:32
S148	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:37
S149	8	"15997091"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S150	6	"14712558"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S151	2	"15951970"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:18
S152	4	"15382114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:47
S153	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:51
S154	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:18
S155	69	"4279873"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:42
S156	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 07:59

S157	4	"15295594"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 08:08
S158	1	("20180257030").PN.	US-PGPUB; USPAT	ADJ	ON	2018/10/04 09:31
S159	86	"5569436"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:32
S160	6	"5785935"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S161	8	"6475471"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S162	53	"6103205"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:46
S163	0	pyrolysis with char with mercury with activated	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S164	17	pyrolysis with char with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S165	121	pyrolysis with char with activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S166	0	pyrolysis with char with activated carbon with mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S167	43	pyrolysis with char with activated carbon and mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S168	118	pyrolysis with char with tire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 12:04
S169	58	pyrolysis with char with activated carbon and mercury	US-PGPUB; USPAT; USOCR;	ADJ	ON	2018/10/04 12:04

			FPRS; EPO; JPO			
S170	8	"20040081724"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 15:07
S171	4	"14128179"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 15:10
S172	84	activat$4 carbon with boiler with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S173	88	activat$4 carbon with boiler with coal and (remov$4 or filter$4 or absorb$4 or adsorb$4) with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S174	0	mercury with stabiliz$4 with sulfer dioxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 14:23
S175	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 15:07
S176	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:48
S177	17	"8821819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:51
S178	15	"8652235"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:55
S179	93	"6136749"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/24 09:08
S180	4	"9757689"	US-PGPUB; USPAT	ADJ	ON	2018/10/24 12:37
S181	9	"8939388"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 09:59

S182	669	urea with inject$4 with filter$4 with exhaust	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:15
S183	2	urea with inject$4 with filter$4 with exhaust and urea with quench$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:16
S184	13	"3615165"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:35
S185	136	urea with quench$4 with remov$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:39
S186	48	urea dust with scrub$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 11:25
S187	38	"6221155"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 12:04
S188	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 14:12
S189	773	ammonium with remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:14
S190	108	ammonium with salt with remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:15
S191	45	ammonium with salt with remov$4 with mercury and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:15
S192	42	"5556447"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:21
S193	174	"4500327"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:21

S194	72	"4500327" and ammonium	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:23
S195	3	anionic couterion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S196	3480	anionic counterion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S197	2422	anionic counterion and ammonium with salt	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S198	9	anionic counterion and ammonium with salt and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S199	52	"6960329"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:50
S200	4	"20040003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/06 11:23
S201	1	"45219176".FMID.	US-PGPUB; USPAT; FPRS	ADJ	ON	2018/12/06 13:32
S202	0	pyrolysis with char with activated carbon with mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/01/07 09:41
S203	284	(sorbent or activated carbon) with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4 and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/04/15 14:29
S204	88	activat$4 carbon with boiler with coal and (remov$4 or filter$4 or absorb$4 or adsorb$4) with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/04/15 14:29
S205	42	"6132790"	US-PGPUB; USPAT	ADJ	ON	2019/06/12 16:06
S206	19	remov$4 with mercury and calcium nitrate with sorbent	US-PGPUB; USPAT	ADJ	ON	2019/06/12 16:55

S207	1	remov$4 with mercury with calcium nitrate	US-PGPUB; USPAT	ADJ	ON	2019/06/12 16:57
S208	1	"20040146613"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/06/13 12:59
S209	71	("6372187").URPN.	USPAT	ADJ	ON	2019/06/18 10:24
S210	48	("6372187").URPN. and (iodide or HI)	USPAT	ADJ	ON	2019/06/18 10:25
S211	61	(iodide or HI) with inject$4 and mercury with remov$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/06/18 10:30
S212	85	(iodide or HI) with coal and mercury with remov$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/06/18 10:35
S213	131	"6558454"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/06/18 10:41
S214	5	"15295594"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/07/30 12:48
S215	82	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/07/30 16:29
S216	65	"4013516"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/07/30 21:01
S217	24	"4699896"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2019/07/30 21:01

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SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

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NOTIFICATION DATE	DELIVERY MODE
07/16/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 15/997,091	**Applicant(s)** Olson et al.	
	Examiner BRIAN W BROWN	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 10 July 2019 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination.** The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to BRIAN BROWN at (571)272-5338.

In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/BRIAN W BROWN/ Petitions Examiner, OPET	

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e)

(Page 1 of 1)

First Named Inventor:	Edwin S. Olson	Nonprovisional Application Number (if known):	15/997,091
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	Docket No.:	4820.001U10

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. **Request for Continued Examination – Prioritized Examination under § 1.102(e)(2)**

   i. A request for continued examination has been filed with, or prior to, this form.
   ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
   iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C 371.
   iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
   v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Nicholas P. Lanzatella/	Date July 10, 2019
Name (Print/Typed) Nicholas P. Lanzatella	Practitioner Registration Number: 63,803

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

*Total of 1 forms are submitted.

REMARKS

This responds to the Final Office Action dated January 11, 2019.

Claims 1, 16, and 19-20 are presently amended. Claims 4, 6-8, 11, 13-15, and 17 are presently canceled, and claims 2-3 and 5 were canceled previously. New claims 21-41 are presently added. As a result, claims 1, 9-10, 12, 16, and 18-42 are now pending in this application.

Support for the new claims is as follows.

New claim	Support in present published U.S. application
21	[0059]
22	[0090]
23	[0105]
24	[0123]
25	FIG. 11 and [0237]
26	FIG. 11 and [0237]
27	[0069] and Example 10 at [0122]
28	[0077]
29	[0069]
30	[0112]
31	[0146]
32	FIG. 2
33	[0012] and [0021]
34	[0015] and [0051]
35	[0047]
36	[0123]
37	[0058] and FIG. 11
38	[0109]
39	[0007], [0053], [0072], [0208], [0219]
40	[0007], [0053], [0072], [0208], [0219]
41	See, current claims 1 and 20
42	[0025], [0072], [0090], see also, current claims 1 and 20

New claims 21-42 are dependent on independent claim 1. As such, these dependent claims incorporate all the features of claim 1. Accordingly, claims 21-42 are patentable for at least the reasons given herein for patentability of claim 1.

New independent claims 41 and 42 include features that are similar to the features of independent claim 1. Claims 41 and 42 are therefore patentable for the reasons given herein for patentability of independent claim 1.

37 CFR § 1.132 Declarations

A 37 CFR § 1.132 declaration by John Pavlish filed with the Response of 3/20/2019 for U.S. patent application no. 15/978,760 is submitted herewith that describes objective evidence of nonobviousness ("Declaration A"). The 37 CFR § 1.132 declaration by John Pavlish submitted with the last response was revised and filed with the Response of 3/20/2019 for U.S. patent application no. 15/978,760 and is submitted herewith ("Declaration B"). A 37 CFR § 1.132 declaration by John Pavlish and Nicholas Lentz filed with the Response of 3/20/2019 for U.S. patent application no. 15/978,760 is submitted herewith that explains that Br_2 is not HBr and does not include HBr, and Cl_2 is not HCl and does not include HCl; that Br_2 is not and does not include Br^-, and Cl_2 is not and does not include Cl^-; NaBr is a salt that includes Na^+ ions and Br^- ions; and that NaCl is a salt that includes Na^+ ions and Cl^- ions ("Declaration C"). A 37 CFR § 1.132 declaration by John Pavlish filed with the Response of 3/20/2019 for U.S. patent application no. 15/978,760 is submitted herewith that explains that data from Nelson's experimental setup and from the pilot-scale unit of item 8 of Declaration B are validly comparable ("Declaration D").

Summary of Arguments

Response to Examiner's Rejection under 35 USC § 103

The Claims at issue stand rejected over Felsvang in view of Nelson based on the Examiner's assessment that Felsvang teaches in-flight sorbent promotion using a chlorine-based material and Nelson teaches that bromine-based materials are superior for promoting sorbents. This was, respectfully, in error. As explained below, the Examiner has not established a *prima facia* case of obviousness.

The Cited Refences Do Not Provide a Motivation to Attempt In-Flight Promotion With HBr or Br· Over Pre-Treatment of Sorbents

As an initial matter, while Felsvang does mention supplying chloride to coal and providing activated carbon in flue gas, Felsvang does not teach that this process promotes the activated carbon. The Examiner fails to identify any teaching in the art that exposure of activated carbon to halogen- or halide-containing flue gas (as opposed to, e.g., concentrated halogen or halide gas) would generate a promoted sorbent, as opposed to, for example, the activated carbon and the halogen or halide in the flue gas providing independent, albeit complementary, mechanisms for mercury removal. For example, a person with a cold may expect aspirin and a decongestant to work well together at reducing symptoms, but that does not mean that taking the two compounds together will cause an additional beneficial chemical reaction.

To be sure, writing a decade later, Sidney Nelson acknowledges that chlorine and bromine can be used to promote carbon sorbents in-flight in the flue gas.[1] But, as the Examiner acknowledges, the Nelson reference does not teach in-flight promotion in the flue gas as a way to create a promoted sorbent, nor does Nelson teach adding any chemical to the flue gas would improve mercury removal. Quite the contrary, Nelson describes pre-treating sorbent (i.e., outside of flue gas) as an "essential element" of his invention.[2] He offers specific reasons as to why pre-treatment was viewed as essential. For example, he notes that bromine species can be "quite corrosive,"[3] the carbon should be "uniformly exposed to and reacted with the bromine,"[4] the carbon should be purged of H_2O which interferes with bromination,[5] and he describes a mixing time for HBr and activated carbon of 90 minutes or more[6]. As explained more fully below, a person of ordinary skill in the art would recognize that the combustor and flue gas ductwork are composed of

[1] Declaration A at item 18.
[2] Nelson at paragraph [0040].
[3] Nelson at paragraph [0044].
[4] Nelson at paragraph [0046].
[5] Nelson at paragraphs [0048] and [0051].
[6] Nelson at page 8, paragraph [0087] and the table at the top of the second column. For HBr-treated activated carbon, the adsorption rate was 1 gram of HBr absorbed per 1 kg of activated carbon per minute, or 0.1 wt% HBr absorbed per minute, meaning that to reach the 9 wt% HBr reported in the table required about 90 minutes. Note that Figure 14 reports results for 10 wt% HBr, and Figure 15 reports results for 9 wt% HBr. For Br_2-treated activated carbon, the adsorption rate was 10 grams of Br_2 absorbed per 1 kg of activated carbon per minute, or 1 wt% Br_2 absorbed per minute, meaning that to reach the 15 wt% Br_2 reported in the table required about 15 minutes. Note that Figures 14 and 15 report results for 1.5 wt%, 5 wt%, and 15 wt% Br_2, according to the table requiring about 1.5 to 15 minutes to form.

corrodible metal, the concentration of halogen in the flue gas would be low, the flue gas would contain significant H_2O (e.g., 7% as per Nelson)[7], and that in-flight mixing would allow for only several seconds of contact time between the activated carbon and the promoter rather than 90 minutes. Thus, Nelson would motivate a person of ordinary skill in the art to promote sorbents in a controlled setting outside of a flue gas, not to attempt in-flight promotion in a flue gas. At the very least, Examiner has not shown that a person of ordinary skill in the art would be motivated to modify Felsvang in view of Nelson.

Objective Evidence Confirms the Patentability of the Claims

The arguments above are reflected in the story of the claimed invention. Submitted herewith is Declaration A by inventor John Pavlish that describes objective evidence of nonobviousness. Mr. Pavlish explains—with support from extensive contemporaneous documentation—how the EPA kicked off a race for the development of new mercury removal technologies. From early on though, the conventional wisdom was that sorbents should be pre-treated before injection into the flue gas. While at the Energy & Environmental Research Center ("EERC"), Mr. Pavlish and his co-inventors fought against this conventional wisdom and eventually obtained millions of dollars in federal grant money to develop the claimed invention. Their efforts were so successful that the Department of Energy specifically highlighted their work as a significant achievement. Since then, this technology has been recognized as one of the most widely adopted technologies for mercury control in the U.S.

The claimed invention has had such a significant impact on the industry, that even Sidney Nelson himself (the author of the Nelson reference) eventually touted the benefits of in-flight promotion in the flue gas with bromine. In doing so, he acknowledged that this approach differed from the conventional approach of pre-treating sorbent, and he specifically cited the work of the EERC as demonstrating the benefits of in-flight promotion in the flue gas with bromine. This objective evidence of non-obviousness further establishes the patentability of these claims. *Crocs, Inc. v. Int'l Trade Comm'n*, 598 F.3d 1294, 1310 (Fed. Cir. 2010) (internal quotation marks omitted) (objective evidence "can be the most probative evidence of nonobviousness in the record, and enables the court to avert the trap of hindsight").

[7] Nelson at paragraph [0079].

What follows is a detailed description of support for the arguments above, rebuttal evidence showing that the presently claimed invention has properties that could not be predicted from any cited reference, and responses to the Examiner's arguments.

Table of contents.

I. The Office Action rejected claims 1, 4, and 6-20 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent no. 5,435,980 ("Felsvang"). 13

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I(A)(2). There would be no motivation for a person of ordinary skill in the art to use Nelson's HBr in place of Felsvang's HCl or Cl^- in Felsvang's process. 15

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I(A)(2)(b). A person of ordinary skill in the art would not combine Nelson with Felsvang as alleged because they would not know or expect in-flight promotion of the activated carbon sorbent would occur. 17

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I(C)(2). There would be no way for a person of ordinary skill in the art to predict this advantage from the from the cited references. 66

I(C)(3). Reply to Examiner's response to arguments. 66

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I(D)(1). Even if a person of ordinary skill in the art compared the mercury removal of Felsvang to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties per wt% HCl. 68

I(D)(2). Reply to response to arguments. 70

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II. Double patenting rejections. 73

The Rejection of Claims Under §103

I. The Office Action rejected claims 1, 4, and 6-20 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed.

As explained herein at **I(A)**, a person of ordinary skill in the art would not combine Nelson and Felsvang as alleged. Part **I(B)** discusses in-flight promotion with HBr or Br^- in the flue gas versus treatment outside the flue gas. As explained herein at **I(B)(1)**, in-flight promotion with HBr or Br^- promoters is more effective for mercury removal than treating the sorbent with HBr, Br^-, or Br_2 outside the mercury-containing gas, and as explained herein at **I(B)(2)**, there would be no way for a person of ordinary skill in the art to predict this advantage from the cited references. Part **I(C)** discusses in-flight promotion in the flue gas with HBr or Br^- versus HCl or Cl^-. As explained herein at **I(C)(1)**, in-flight promotion with HBr or Br^- promoters is more effective for mercury removal than in-flight promotion with HCl or Cl^- promoters, and as explained herein at **I(C)(2)**, there would be no way for a person of ordinary skill in the art to predict this advantage from the cited references. Part **I(D)** explains that a person of ordinary skill in the art would find that treatment of activated

carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl^- in the flue gas. As explained herein at **I(D)(1)**, even if a person of ordinary skill in the art compared the mercury removal of activated carbons promoted with HCl or Cl^- in the flue gas to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties per wt% HCl. Section **I(E)** discusses objective evidence of non-obviousness of the claimed invention. Sections **I(A)(3), I(B)(3), I(C)(3), and I(D)(2)** reply to the Examiner's responses to arguments made in the Response of 12/3/2018.

I(A). A person of ordinary skill in the art would not combine Nelson and Felsvang as alleged.

As explained herein at **I(A)(1)**, Br_2 is not HBr and does not include HBr, and Cl_2 is not HCl and does not include HCl; also, Br_2 is not and does not include Br^-, and Cl_2 is not and does not include Cl^-. As explained herein at **I(A)(2)**, there would be no motivation for a person of ordinary skill in the art to use Nelson's HBr in place of Felsvang's HCl or Cl^- in Felsvang's process. Section **I(A)(3)** includes replies to the Examiner's responses to arguments in the Response of 12/3/2018.

I(A)(1). Br_2 is not HBr and does not include HBr, and Cl_2 is not HCl and does not include HCl; also, Br_2 is not and does not include Br^-, and Cl_2 is not and does not include Cl^-.

As explained in Declaration C at item 17, hydrogen halides are diatomic molecules including a halogen atom and a hydrogen atom; in contrast, elemental halogens are diatomic molecules including two of the same halogen atom. HBr and HCl each include a hydrogen atom and one halogen atom, while Br_2 and Cl_2 each include two halogen atoms. Hydrogen halides have different properties than elemental halogens and are therefore different compounds. HBr has a molecular weight of 80.91 g/mol, while Br_2 has a molecular weight of 159.81 g/mol; HBr has a boiling point of -67 °C, while Br_2 has a boiling point of 58.8 °C; HBr has a melting point of -87 °C, while Br_2 has a melting point of -7.2 °C. HCl has a molecular weight of 36.46 g/mol, while Cl_2 has a molecular weight of 70.91 g/mol; HCl has a boiling point of -85 °C, while Cl_2 has a boiling point of 70.91 g/mol; HCl has a melting point of -114 °C, while Cl_2 has a melting point of -101 °C. Hydrogen halides are not part of and cannot be extracted or isolated from elemental halides; rather,

only via a chemical reaction that results in a chemical and structural change can hydrogen halides be formed from elemental halides. Hydrogen bromide is produced by reacting hydrogen and Br_2 at about 200-400 °C, a reaction that is typically catalyzed by platinum or asbestos. Hydrogen chloride is produced by reacting hydrogen and chlorine with one another. Therefore, elemental halogens are not hydrogen halides, and do not include hydrogen halides—Br_2 is not HBr and does not include HBr, and Cl_2 is not HCl and does not include HCl.

As explained in Declaration C at item 18, chlorine has an atomic number of 17, meaning it has 17 protons and 17 electrons, giving it an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^5$, having 7 electrons in its outer shell. Bromine has an atomic number of 35, meaning it has 35 protons and 35 electrons, giving it an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$, also having 7 electrons in its outer shell. According to the octet rule, a halogen atom desires to fill its outer shell with 8 electrons total by gaining one electron. A halide ion is a halogen atom that has accepted an electron from an electron doner, in the case of chloride (Cl^-) giving it 18 total electrons to give a total charge of -1, and in the case of bromide (Br^-) giving it 36 total electrons to give a total charge of -1. Halogen atoms do not donate electrons to other atoms, because this would result in a halogen atom losing an electron to have 6 electrons in its outer shell, an unstable configuration according to the octet rule. In the case of an elemental halogen, which exists as a diatomic molecule, instead of donating electrons to one another, each halogen atom shares one of its electrons in the outer shell with the other halogen atom via overlapping electron orbitals in a covalent bond, allowing each halogen atom to have a filled octet while the diatomic molecule remains neutrally charged. Therefore, a halogen atom does not donate electrons to another halogen atom to form a halide, and a diatomic halogen molecule never includes a halide; Br_2 is not and does not include Br^-, and Cl_2 is not and does not include Cl^-.

I(A)(2). There would be no motivation for a person of ordinary skill in the art to use Nelson's HBr in place of Felsvang's HCl or Cl^- in Felsvang's process.

Independent claim 1 recites "…combusting coal in a combustion chamber, the coal[[that]] compris[[es]]ing an additive comprising Br_2, HBr, [[Br^-]]a bromide compound, or a combination thereof, to form the mercury-containing gas…."

The Office Action admits that Felsvang fails to describe or suggest a halogen or halide promoter that is Br_2, HBr, or Br^-. Nelson fails to describe or suggest in-flight promotion of activated carbon with a halide or hydrogen halide in the flue gas. The Office Action alleges that one of ordinary skill in the art would replace Felsvang's HCl or Cl^- with Nelson's HBr to accomplish the presently claimed method, stating that such a modification of Felsvang would be made "…to promote activated carbon (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury." (Office Action, page 4, last sentence of second full paragraph). Applicant respectfully disagrees. As explained below, a person of ordinary skill in the art would not be motivated to use Nelson's HBr in Felsvang's process, because Nelson fails to describe or suggest that HBr-treatment of activated carbon provides similar, let alone improved, mercury-removal ability as compared to HCl or Cl^--treatment of activated carbon.

As explained herein at **I(A)(2)(a)**, Felsvang focuses on HCl or Cl^- concentration in the flue gas. As explained herein at **I(A)(2)(b)**, a person of ordinary skill in the art would not combine Nelson with Felsvang as alleged because Felsvang fails to describe or suggest in-flight promotion can occur. As explained herein at **I(A)(2)(c)**, a person of ordinary skill in the art would not be motivated to use Felsvang's process with activated carbon. As explained herein at **I(A)(2)(d)**, Nelson provides no motivation to replace Felsvang's HCl or Cl^- treatment with Nelson's HBr treatment.

I(A)(2)(a). Felsvang focuses on HCl or Cl^- concentration in the flue gas.

Felsvang is directed to adding chlorine (Cl_2) or chloride (Cl^-) materials to the coal or combustion products. Felsvang makes clear that addition of chlorine or chloride material increases the amount of chloride supplied to the flue gas, or to the drying-absorption zone, see, Abstract and col. 3, lines 40-44. Felsvang states at col. 3, line 67 bridging to col. 4, line 4: "[i]t has been experienced that the increase of the Hg-removing effect of chloride addition to the drying-absorption zone in a process treating flue gases of low chloride content is especially remarkable when activated carbon is present…." Felsvang states at col. 4, lines 51-55: "…most chloride or chlorine containing compounds will release gaseous chlorides when introduced into the combustion zone of a coal fired boiler…." Felsvang states at col. 6, lines 3-11:

> **If the chloride content is found to be below a certain value as defined above and in the attached claims arrangements are taken according to the invention for increasing the gas chloride content. This may be done in connection with an introduction of activated carbon which in itself also has a Hg removing effect and together with chloride addition exihibts a synergistic effect enabling an extremely efficient Hg removal.**

At column 3, lines 53-55, Felsvang states that "[t]he term 'chloride' is intended to mean chloride ions as such or gaseous hydrogene chloride or compounds which by heating in the presence of coal forms Cl^- or HCl." Thus, Felsvang gives a definition of "chloride" that includes both HCl and Cl^-.

I(A)(2)(b). A person of ordinary skill in the art would not combine Nelson with Felsvang as alleged because they would not know or expect in-flight promotion of the activated carbon sorbent would occur.

As explained herein at **I(A)(2)(b)(i)**, a person of ordinary skill in the art would not combine Nelson with Felsvang as alleged because Felsvang fails to describe or suggest in-flight promotion can occur. As explained herein at **I(A)(2)(b)(ii)**, promoter concentration in flue gas is low compared to during treatment outside of flue gas. As explained herein at **I(A)(2)(b)(iii)**, contact time between promotors in the flue gas and activated carbon is very short compared to treatment outside the flue gas. As explained herein at **I(A)(2)(b)(iv)**, a person of ordinary skill in the art would believe that hydrogen halides in the flue gas would be consumed via corrosion or scavenging.

I(A)(2)(b)(i). A person of ordinary skill in the art would not combine Nelson with Felsvang as alleged because Felsvang fails to describe or suggest in-flight promotion can occur.

Felsvang fails to describe or suggest that any reaction occurs between activated carbon and HCl in the flue gas. Felsvang's primary focus is the enhancement of HCl or Cl^- concentration in the flue gas, with addition of activated carbon being optional and not required to experience the effect of the invention. At col. 6, lines 29-33, Felsvang states "...the chloride introduction may

alternatively be performed separately from the introduction of activated carbon or it may be performed without using activated carbon." At col. 6, lines 8-11, Felsvang explains that, in addition to increasing the chloride content, (emphasis added) "[t]his may be done in connection with an introduction of activated carbon which in itself also has a Hg removing effect and together with chloride addition exhibits a synergistic effect enabling an extremely efficient Hg removal." Felsvang therefore describes that activated carbon removes mercury, and that increasing HCl or Cl^- content removes mercury, and when the two are used together they operate side-by-side, failing to describe or suggest any reaction that occurs between the HCl or Cl^- and the activated carbon. Only a portion of Felsvang's Example 4 demonstrates the use of activated carbon with HCl or Cl^-, finding only a small increase in mercury-removal activity (discussed herein at **I(A)(2)(c)**), while the majority of Felsvang's Examples (1-3) are devoid of any mention of activated carbon.

In contrast, Nelson describes a chemical reaction that occurs between the halogens and the activated carbon, and disparages simple impregnation or physical adsorption of halogens onto the activated carbon, explaining at paragraphs [0017] and [0044] that physical adsorption leads to desorption from the activated carbon. Nelson explains at paragraphs [0044] and [0053] that elevated temperatures should be used during the treatment of the activated carbon with the bromine gas to minimize physical absorption and maximize chemical reaction between the bromine and the activated carbon which avoids desorption of the bromine during transport, storage, and upon injection into a hot gas stream.

A person of ordinary skill in the art would have to understand that a reaction can occur between Felsvang's HCl or Cl^- and the activated carbon in Felsvang's flue gas in order to understand that Nelson's bromine-treated sorbents have any similarity to the sorbents of Felsvang. With Felsvang's failure to describe or suggest any chemical reaction between the activated carbon and the HCl or Cl^- in the flue gas, a person of ordinary skill in the art would have no idea that Nelson's hydrogen bromide could be used in place of Felsvang's HCl or Cl^-. Therefore, a person of ordinary skill in the art would not replace Felsvang's HCl or Cl^- with HBr or Br^-. Independent claim 1 is patentable for at least this reason.

I(A)(2)(b)(ii). Promoter concentration in flue gas is low compared to during treatment outside of flue gas.

At paragraph [0051] Nelson gives a preference for the use of pure Br_2 or HBr to treat the activated carbon. Nelson's Examples do not mention the use of a carrier gas to dilute the halogen gases used to prepare the treated sorbents used therein.

Forming HBr or Br^- in the flue gas from bromide salts such as NaBr on coal gives a very low concentration of HBr/Br^- in the flue gas compared to pure HBr. A person of ordinary skill in the art would believe the concentration of HBr/Br^- in the flue gas would be too low to result in effective treatment of activated carbon injected into the flue gas, especially considering the short contact time between the HBr/Br^- and the activated carbon as discussed herein at **I(A)(2)(b)(iii)**.

I(A)(2)(b)(iii).Contact time between promotors in the flue gas and activated carbon is very short compared to treatment outside the flue gas.

As explained in Declaration A at item 10, Nelson states repeatedly that the bromine-containing gas is to be contacted with the activated sorbent "for a sufficient time" to increase the ability of the activated carbon to adsorb mercury. See, e.g., Abstract and paragraphs [0023] and [0028]. Nelson at page 8, paragraph [0087] and the table at the top of the second column describes contact times required to form HBr- and Br_2-treated activated carbons. For HBr-treated activated carbon, the adsorption rate was 1 gram of HBr absorbed per 1 kg of activated carbon per minute, or 0.1 wt% HBr absorbed per minute, meaning that to reach the 9 wt% HBr reported in the table required about 90 minutes. Note that Figure 14 reports results for 10 wt% HBr, and Figure 15 reports results for 9 wt% HBr. For Br_2-treated activated carbon, the adsorption rate was 10 grams of Br_2 absorbed per 1 kg of activated carbon per minute, or 1 wt% Br_2 absorbed per minute, meaning that to reach the 15 wt% Br_2 reported in the table required about 15 minutes. Note that Figures 14 and 15 report results for 1.5 wt%, 5 wt%, and 15 wt% Br_2, according to the table requiring about 1.5 to 15 minutes to form. In contrast, as explained in Declaration A at item 10, contact times between a promoter in the flue gas and activated carbon injected therein are generally less than 10 seconds.

As explained in Declaration A at item 8, before the priority date of the present claims, the EPA did not recommend in-flight sorbent enhancement in the flue gas by spraying additives on coal or injecting halogens into the boiler. Rather, it described research into methods for *pre-treating*

sorbents with various additives, including chlorine, and then injecting those pre-treated sorbents downstream from the boiler. This approach ensured that the sorbent additive would have plenty of time to react with the sorbent—the EPA explained that, for many plants, injected sorbents would have only a few seconds to find and react with mercury present in the flue gas, with high and costly carbon-to-Hg ratios needed to achieve adequate mercury removal.

A person of ordinary skill in the art would believe the contact time between HBr/Br⁻ in the flue gas would be too short to increase the ability of the activated carbon injected into the flue gas to adsorb mercury, especially considering the low concentration of HBr/Br⁻ in the flue gas as discussed herein at **I(A)(2)(b)(ii)**.

I(A)(2)(b)(iv).Consumption of hydrogen halides in the flue gas via corrosion or scavenging.

As explained in Declaration A at item 10, Nelson states at paragraph [0044] that a corrosion-resistant material should line the equipment used to mix the bromine gas and the activated carbon "…because the bromine species can be quite corrosive." Nelson states at paragraph [0051] that "[i]t it not a preferred embodiment of this invention to include water with the bromine gas vapor if this causes corrosion problems in the processing equipment that outweigh any advantages."

As explained in Declaration A at item 8, before the priority date of the presently claimed invention, the EPA did not recommend in-flight sorbent enhancement in the flue gas by spraying additives on coal or injecting halogens into the boiler. Rather, it described research into methods for *pre-treating* sorbents with various additives, including chlorine, and then injecting those pre-treated sorbents downstream from the boiler. This approach ensured that, e.g., chlorinating agents could react with the sorbent material without being "scavenged" by other chemicals present in the boiler.

A person of ordinary skill in the art would believe that HBr in the flue gas would be consumed via corrosion of the combustion chamber and other metallic areas of the coal-combustion plant in contact with the flue gas, or via scavenging by other species present in the flue gas. As a result, a person of ordinary skill in the art would believe that an inadequate concentration of HBr would be present for reaction with activated carbon injected into the flue gas, especially considering the low concentration of HBr/Br⁻ in the flue gas as discussed herein at **I(A)(2)(b)(ii)**, and the short contact time between the HBr/Br⁻ and the activated carbon as discussed herein at **I(A)(2)(b)(iii)**.

I(A)(2)(c). A person of ordinary skill in the art would not be motivated to use Felsvang's process with activated carbon.

Felsvang gives no data showing that the addition of HCl or Cl^- additives to coal can produce enhanced HCl or Cl^- concentrations in the activated carbon. Felsvang includes only a single Example showing the use of activated carbon for mercury removal, Example 4, the relevant portions of which are reproduced below (col. 9, lines 21-46):

> HCl concentration in the flue gas was 142 mg/Nm^3. Mercury was measured in and out of the system. The following results were achieved:

Inlet µgHg/Nm^3 at 5% O_2	Outlet µgHg/Nm^3 at 5% O_2	% Removal
5.4	0.14	97
5.2	0.18	97
5.0	0.20	96
4.7	0.18	96

> Average removal with this system is 96%.
> The above process was modified by adding activated carbon through conduit 14 to the stream of flue gas in duct 4 upstream of the drying chamber. Mercury was measured in and out of the system.
> The following results were achieved:

Amount of carbon mg/Nm^3	Inlet µgHg/Nm^3 at 5% O_2	Outlet µgHg/Nm^3 at 5% O_2	% Removal
8	4.0	0.10	98
8	4.4	<0.01	>99.8
36	6.2	0.01	99.8
36	5.6	<0.01	>99.7

Felsvang finds in Example 4 that HCl alone provided 96-97% mercury removal, while the addition of activated carbon provided 98-99.8% mercury removal, an improvement of only 1-3.8%. In contrast, Felsvang's Comparative Examples 1-3, performed with no added HCl or Cl^- in the flue

gas and no activated carbon, had a mercury removal of 1-37%. The activated carbon in Example 4 provided scarcely any improvement, with the vast majority of mercury removal improvement occurring in the presence of HCl alone without activated carbon. An improvement of 1-3.8% does not demonstrate a synergistic effect between HCl and activated carbon, especially in view of the 60-96% improvement in mercury removal achieved by HCl alone when Example 4 is compared to Comparative Examples 1-3. One of ordinary skill in the art would know that such a small improvement could have been caused by variability in combustion gas conditions and the accuracy of the measurements—evidence for any improvement from the use of activated carbon with the HCl in Felsvang is very weak and may not have occurred at all.

In addition, Felsvang fails to describe or suggest that in-flight promotion of activated carbon with HCl or Cl^- in the flue gas provides better mercury removal than treatment of activated carbon outside the flue gas with HCl. If one of ordinary skill in the art were hypothetically considering whether to use Felsvang's HCl or Cl^- treatment of activated carbon in the flue gas or Nelson's treatment of activated carbon outside the flue gas to remove mercury, that person would pick the process that results in the best mercury removal. As an initial matter, before considering modifying either one of the references, the person of ordinary skill would notice the extremely poor improvement (if any improvement actually occurred) caused by addition of activated carbon in Felsvang's sole Example showing the use of activated carbon (Example 4) and would question whether Felsvang's process is an efficient way to use activated carbon for mercury removal as compared to Nelson's process. If one of ordinary skill in the art were to investigate Felsvang's embodiments including activated carbon and compare the relative mercury-removal ability to that of activated carbon treated with HCl outside the flue gas, as shown herein at **I(D)**, they would find that treatment of activated carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl^- in the flue gas, which would lead one of ordinary skill in the art away from using Felsvang's process in the first place.

Therefore, a person of ordinary skill in the art hypothetically having Felsvang and Nelson in-hand would not select the Felsvang process to follow or modify and therefore would not be motivated to combine Felsvang and Nelson as alleged. Independent claim 1 is patentable over Felsvang and Nelson for this additional reason.

I(A)(2)(d). Nelson provides no motivation to replace Felsvang's HCl or Cl^- treatment with Nelson's HBr treatment.

For a person of ordinary skill in the art to be motivated to replace Felsvang's HCl- or Cl^--treatment with treatment by another material to provide an effective activated carbon sorbent for mercury removal, that person would need to think that the material they are using to replace the HCl or Cl^- would result in the same or better mercury-removal efficiency. However, as explained below, Nelson fails to describe or suggest that treatment of activated carbon with HBr provides the same, let alone better, mercury removal efficiency as activated carbon treated with HCl or Cl^-.

At paragraph [0017], Nelson states:

> **[0017]** The particular advantages of using bromine, rather than iodine or iodides, or chlorine or chlorides, with activated carbons for mercury control have not been previously appreciated. Gaseous bromine and hydrogen bromide have been combined with carbon substrates before, but not to sequester mercury from hot combustion-gas streams. For example, Greinke U.S. Pat. No. 5,372,619 found that bromine-treated carbon can make a superior natural-gas storage medium. In another example, SKC Inc. sells a small tube with hydrobromic acid-treated charcoal to sample air for ethylene oxide. However, with both of these uses it is

> important that the adsorption targets, natural gas and ethylene oxide, be easily desorbable from the carbon, the exact opposite of what is required in a mercury vapor sequestration application. In a similar vein, in U.S. Pat. No. 6,475,461 Ohsaki describes a process for treating carbon substrates with gaseous bromine or chlorine, but then explicitly desorbs them to achieve his desired product. Seki U.S. Pat. No. 3,961,020; Yoshida and Seki et al. U.S. Pat. No. 4,174,373; and Knoblauch et al. U.S. Pat. No. 5,179,058 impregnate activated carbon with bromine to produce a catalyst for reacting nitrogen oxide with ammonia to form nitrogen and water. In this application too, the bromine of the carbon does not act as a sequestration agent, permanently tying up its target. Rather, it serves as a catalyst, taking part in a repeated series of desired chemical reactions, but not becoming permanently consumed by any of them. Perhaps it is understandable that the tenacity of carbon-bromine-mercury complexes could be overlooked.

The first sentence of paragraph [0017] refers to the "…particular advantages of using bromine…" for treatment of activated carbons for mercury control, which must mean either elemental bromine (Br_2) or the element bromine generally, and is not a specific reference to bromides (Br^-). The "…particular advantages of using bromine…" is compared to iodine (I_2), iodides (I^-), chlorine (Cl_2), and chlorides (Cl^-), but no specific comparison is made between bromides (Br^-) and chlorides (Cl^-). However, it does not make sense for Nelson to refer to the element bromine generally while specifically distinguishing between chlorine (Cl_2) and chlorides (Cl^-), and iodine (I_2) and iodides (I^-) in the same sentence. If Nelson wanted to compare both elemental bromine (Br_2) and hydrogen bromide (HBr) to the other halides specifically disclosed in the first sentence, Nelson would have specifically distinguished between bromine (Br_2) and bromides (Br^-); therefore, "…bromine…" in the first sentence of paragraph [0017] would be interpreted as elemental bromine (Br_2), and not as the element bromine generally.

No "…particular advantages of using bromine…" are explicitly described in paragraph [0017], with the remainder of the paragraph focusing on the failure of the prior art to use bromine with activated carbon for mercury control, describing various disadvantages of other processes, such as the desorbability of Br_2, HBr, or Cl_2 from the activated carbon, or the failure of the Br_2 or HBr to act as a mercury sequestration agent. The paragraph concludes with a statement that it is

understandable that "…the tenacity of carbon-bromine-mercury complexes…" could be overlooked, which must refer to complexes including either elemental bromine (Br_2) or the element bromine generally, with no specific reference to bromide (Br^-) or complexes formed therefrom. The concluding statement of paragraph [0017] is directed toward the discussion in the bulk of paragraph [0017]—the prior art fails to use bromine with activated carbon for mercury control and therefore fails to generate carbon-bromine-mercury complexes—rather than as a statement of any relative advantage of bromine over other halogens or halides. The "…tenacity of carbon-bromine-mercury complexes…" is not specifically compared to the strength of any other complexes, such as carbon-chlorine-mercury complexes, carbon-chloride-mercury complexes, carbon-iodine-mercury complexes, or carbon-iodide-mercury complexes; therefore, at best, the "…tenacity…" of the complexes described in the last sentence of paragraph [0017] can be regarded as a general statement, rather than as a comparative one. Paragraph [0017] fails to attribute any advantage of Nelson's invention specifically to HBr or Br^-, and, moreover, fails to describe or suggest that HBr or Br^- treatment of activated carbon could provide equal, let alone better, mercury removal than HCl or Cl^- treatment of the activated carbon.

At paragraphs [0019]-[0022], Nelson states:

> **[0019]** Accordingly, it is an object of the present invention to provide a sorbent material that can be injected into a hot mercury-containing combustion gas, so that a significant portion of the mercury is adsorbed onto the sorbent and removed from the flue gas with the combustion fly ash.
>
> **[0020]** Further, it is an object of the present invention to provide a flexible, retrofitable mercury-control method that can be applied to a number of combustion gas streams and a wide range of exhaust system equipment configurations.
>
> **[0021]** In addition, it is an object of the present invention to provide a mercury sorbent material that is simple and inexpensive to manufacture and use.
>
> **[0022]** It is also an object of the present invention to provide a mercury sorbent material that causes the adsorbed gas-phase mercury to become essentially permanently-sequestered from future interactions with the environment.

Paragraphs [0019]-[0022] describe several general advantages of Nelson's activated carbon treatment, including the ability to remove mercury from a hot mercury-containing combustion gas, a flexible and retrofittable method that can be applied to a wide range of equipment configurations, simplicity and ease of use, and permanent sequestration of the mercury from environmental interactions. None of the advantages include equal or greater mercury-removal ability of HBr- or Br^--treated activated carbon as compared to HCl- or Cl^--treated activated carbon.

At paragraphs [0023]-[0024], similarly to what is stated in the Abstract and paragraphs [0028]-[0029], Nelson states:

> The mercury sorbent is prepared by treating a carbonaceous substrate with an effective amount of a bromine-containing gas for a sufficient time to increase the ability of the carbonaceous substrate to adsorb mercury and mercury-containing compounds.
>
> **[0024]** In some aspects of the invention, the bromine-containing gas comprises at least one of: elemental bromine and hydrogen bromide. In some aspects of the invention, the carbonaceous substrate comprises activated carbon.

Nelson therefore states that elemental bromine (Br_2) or hydrogen bromide (HBr) can be used to treat an activated carbon outside of a flue gas to increase the ability of the activated carbon to absorb mercury.

At paragraph [0041], Nelson states:

> **[0041]** I have discovered that the simple act of exposing a carbonaceous material, preferably powdered activated carbon (PAC), to gaseous bromine, $Br_2(g)$, or to gaseous hydrogen bromide, HBr(g), significantly increases the carbonaceous material's ability to remove mercury species when injected into high-temperature coal-fired flue-gas compositions. Surprisingly, gaseous bromine produces a much more effective and appropriate carbon sorbent for mercury in hot combustion gases than do iodine or iodide species, or chlorine or chloride species, in contrast to what has been taught in the prior art.

Paragraph [0041] begins by stating that gaseous bromine (defined as Br_2) or hydrogen bromide (HBr) increases the mercury absorption capacity of activated carbon. Then, paragraph

[0041] goes on to explicitly state that gaseous bromine, defined as Br_2 in the prior sentence, produces a more effective mercury-absorbing carbon sorbent than iodine (I_2), iodide (I^-), chlorine (Cl_2), or chloride (Cl^-). With the precise definitions given for gaseous bromine and hydrogen bromide, and then reference only to gaseous bromine in the next sentence, Nelson makes clear that the comparison of efficacy is only with respect to elemental bromine (Br_2) and not hydrogen bromide. Like paragraph [0017], paragraph [0041] also fails to describe or suggest that hydrogen bromide treatment of activated carbons is more effective for mercury removal than HCl or Cl^- treatment of activated carbons.

At paragraph [0042], Nelson states:

> **[0042]** The combination of carbon and gaseous bromine produces an inexpensive sorbent material that can be simply injected into the ductwork of a power plant ahead of an existing electrostatic precipitator, without the need for large volumes of sorbent, retrofitted flue-gas cooling, or extended sorption time on an additional fabric filter.

Paragraph [0042]'s reference to "gaseous bromine" refers only to elemental bromine (Br_2) due to the explicit definition given in the preceding paragraph [0041]. Paragraph [0042] expands on the advantage mentioned at paragraphs [0020]-[0021], stating that an advantage of the invention includes simple injection of the treated activated carbon sorbent into the ductwork ahead of an ESP, without the need for large volumes of sorbent, retrofitted flue-gas cooling, or extended sorption time on a filter.

At paragraph [0043], Nelson states:

> **[0043]** While not intending to be limited by hypothesized chemistry, it appears that in exposing PAC to concentrated bromine gas, a relatively large quantity of the bromine reacts with the carbon, forming surface compounds on the large surface-area of the carbon. When the PAC is then injected into the flue gas, the elemental mercury and oxidized mercury species there appear to react with at least one form of the bromine-carbon surface compounds that were created and are held fast. When the carbon particles are removed from the flue gas along with the fly ash by the electrostatic precipitator (ESP) or fabric filter, the mercury is removed

> with them. The mercury sorbents are then disposed of with the fly ash. Because the mercury has been chemically adsorbed, rather than just physically adsorbed, the captured mercury appears to be very stable and does not revolatilize or leach.

Paragraph [0043] expands on the general advantage described in paragraph [0022] of permanent sequestration of the mercury from environmental interactions. The advantage is not described or suggested to include equal or greater mercury-removal ability of HBr- or Br^--treated activated carbon as compared to HCl- or Cl^--treated activated carbon.

At paragraph [0044], Nelson states:

> **[0044]** Production of the new mercury sorbent materials is simple and inexpensive. The carbon material and the bromine gas need simply be contacted with each other for the advantageous mercury-reactive surface compounds to quickly form. Elemental bromine is a liquid at ambient temperature, but turns to a gas at only a modestly elevated temperature. Hydrogen bromide is a gas at even ambient temperature. Using a gas-phase carbon reactant considerably simplifies the production of the sorbent and leads to the low costs which are a requirement for a sorbent to be used as a once-through duct injectant. Any common mixing method and equipment can be use to contact the gaseous bromine species with the carbon-based substrates, although it is preferably lined with corrosion-resistant material, because the bromine species can be quite corrosive. It is also preferable that the mixing of bromine gas and carbon be done at an elevated temperature. This keeps the bromine gas in the gaseous form, but also minimizes the amount of any bromine physically-adsorbed into the pores of the carbon. Such physically adsorbed bromine is not chemically bound to the carbon lattice and can be emitted in handling, in storage, and especially, when the sorbent is injected into a hot flue gas.

Paragraph [0044] expands on the general advantage described in paragraph [0021] of simple and inexpensive generation and use of the treated activated carbon sorbent. Paragraph [0044] also describes that elevated temperature during treatment can provide an advantage of reduced physical-adsorption of the elemental bromine or the hydrogen bromide, which helps to avoid emission during

handling, storage, and during injection into a hot flue gas. The advantages are not described or suggested to include equal or greater mercury-removal ability of HBr- or Br^--treated activated carbon as compared to HCl- or Cl^--treated activated carbon.

At paragraph [0047], Nelson states:

> the process. An example would be a powdered activated carbon (PAC). Such a material would already have some gas-phase mercury adsorption capability which the treatment process of this invention will greatly amplify.

Nelson therefore states that the treatment process therein amplifies the mercury absorption capabilities of activated carbon. The advantage is not described or suggested to include equal or greater mercury-removal ability of HBr- or Br^--treated activated carbon as compared to HCl- or Cl^--treated activated carbon.

At paragraph [0049], Nelson states:

> **[0049]** A critical element in the process is that a bromine-containing gas 3 is used to treat the carbonaceous substrate. Preferably this gas comprises elemental bromine, $Br_2(g)$, although other bromine-containing gases, such as hydrogen bromide, HBr, will also have the advantageous effect of the invention.

Nelson therefore states that elemental bromine (Br_2) or hydrogen bromide (HBr) gas can be used to treat an activated carbon outside of a flue gas. Nelson also states that use HBr to treat the activated carbon "…will also have the advantageous effect of the invention." Nelson uses the singular "…effect…" and does not state that HBr can have all of the advantageous effects of Br_2 described therein; however, which particular advantageous effect does Nelson refer to? Further, Nelson refers generally to the advantageous effect of "…the advantageous effect of the invention…" but does not state that HBr can have all the advantageous effects of elemental bromine (Br_2); rather, Nelson states that HBr, like Br_2, can have "…the advantageous effect of the invention." By "…advantageous effect of the invention…" Nelson refers to general advantages of "…the invention…" and not specifically to advantages of Br_2; therefore, advantages specifically attributed to Br_2 in Nelson would not be imputed to HBr by the last sentence of paragraph [0049].

Nelson describes several general advantages at paragraph [0019]-[0022] that are not attributed specifically to Br_2 and that could be referred to by paragraph [0049]'s general reference to

"…the advantageous effect of the invention…", such as the ability to remove mercury from a hot mercury-containing combustion gas (expanded on at paragraph [0047]), a flexible and retrofittable method that can be applied to a wide range of equipment configurations (expanded on at paragraph [0042]), simplicity and ease of use (expanded on at paragraphs [0042] and [0044]), and permanent sequestration of the mercury from environmental interactions (expanded on at paragraph [0043]). Paragraphs [0044] and [0053] also describe that elevated temperature during treatment can provide an advantage of reduced physical-adsorption of the elemental bromine or the hydrogen bromide, which helps to avoid emission during handling, storage, and during injection into a hot flue gas. Paragraph [0062] states that mercury sorbents prepared according to Nelson's invention can capture mercury in at least the lower range of 300 °C to 400 °C. Paragraph [0065] states that injection of the treated activated carbon prior to a fabric filter can provide a longer residence time of the sorbent, higher utilization levels, as well as the possibility of recovering and reinjecting the sorbent at lower costs.

Paragraph [0017] refers to the "…particular advantages of using bromine, rather than iodine or iodides, or chlorine or chlorides, with activated carbon…" but, as explained herein, "…bromine…" would be interpreted as elemental bromine (Br_2); moreover, paragraph [0017] fails to describe or suggest any "…particular advantages of using bromine…." Paragraph [0017]'s concluding statement referring to the "…tenacity of carbon-bromine-mercury complexes…" fails to compare the strength of such complexes to the strength of any other complexes, such as carbon-chlorine-mercury complexes, carbon-chloride-mercury complexes, carbon-iodine-mercury complexes, or carbon-iodide-mercury complexes; therefore, at best, the "…tenacity…" of the complexes described in the last sentence of paragraph [0017] can be regarded as a general statement, rather than as a comparative one.

Paragraph [0041] begins by stating that gaseous bromine (defined as Br_2) or hydrogen bromide (defined as HBr) increases the mercury absorption capacity of activated carbon. Then, paragraph [0041] goes on to explicitly state that gaseous bromine, defined as Br_2 in the prior sentence, produces a more effective mercury-absorbing carbon sorbent than iodine (I_2), iodide (I^-), chlorine (Cl_2), or chloride (Cl^-). With the precise definitions given for gaseous bromine (Br_2) and hydrogen bromide, and then reference only to gaseous bromine (Br_2) in the next sentence, Nelson makes clear that the comparison of efficacy is only with respect to elemental bromine (Br_2) and not

hydrogen bromide. Paragraph [0041] fails to describe a general advantage of Nelson's invention; instead, paragraph [0041] specifically and particularly describes an advantage of elemental bromine (Br_2), which cannot be regarded as a general advantageous effect of "...the invention..." as it only applies to elemental bromine (Br_2). Accordingly, advantages explicitly attributed to Br_2 in paragraph [0041] of Nelson cannot be imputed to HBr by the last sentence of paragraph [0049].

Therefore, paragraph [0049] fails to describe or suggest that hydrogen bromide treatment of activated carbons is more effective for mercury removal than HCl or Cl^- treatment of activated carbons.

At paragraph [0050], Nelson states:

> **[0050]** In the liquid form at ambient temperatures, elemental bromine is dense and compact, with advantages in transport and storage. To be utilized in this invention, however, it must first be heated to at least about 60° C. and turned into a gaseous state. In such a state it can more uniformly treat the carbonaceous materials at low levels and provide the desired effect of increasing their mercury sequestration capabilities. A preferred method of converting the liquid bromine to a bromine-containing gas is to use a heated lance. Liquid bromine can be metered into such a heated-lance system at one end and be distributed as a gas to the substrate materials at the other end.

Nelson therefore states that an advantage of elemental bromine (Br_2) is that it is dense and compact which provides advantages in transport and storage.

At paragraph [0051], Nelson states:

> **[0051]** In some applications it may be beneficial to utilize a diluting carrier gas to better distribute the $Br_2(g)$ or HBr(g) among the carbonaceous substrate particles. However, if the process of this invention is practiced in a batch mode, it can be preferable to use pure $Br_2(g)$ or HBr(g). These can be

Nelson therefore states that elemental bromine (Br_2) or hydrogen bromide can be dispersed in a carrier gas during the treatment of the activated carbon.

At paragraph [0053], Nelson states:

> reactive towards mercury. By exposing the carbon to the bromine at an elevated temperature, less of the bromine species will volatilize off from the sorbents during their transport and storage or upon their injection into the hot combustion stream.

Paragraph [0053] describes that elevated temperature during treatment can provide an advantage of reduced volatilization during transport, storage, or during injection into the hot flue gas, expanding on the advantage described at paragraph [0044].

At paragraph [0054], Nelson states:

> **[0054]** Any level of bromination of carbonaceous substrates appears to increase their mercury-removal performance. While over 30 wt % of $Br_2(g)$ can be adsorbed into some powdered activated carbons, for example, significant increases in mercury reactivity will be observed with only about 1 wt % $Br_2(g)$ in the PAC. Greater degrees of bromination do correlate with greater maximum mercury capacities for a particular carbonaceous substrate. However, with the sorbent-injection application of this invention, only a fraction of a material's maximum possible mercury capacity is typically utilized, so the optimum level of bromine to combine with the carbon substrate may vary with the particular situation. If a PAC substrate is used, brominating to 1 wt % provides a highly-capable mercury sorbent, although a 5 wt % material performs better and may be preferable. Brominating to 15 wt % Br_2 generally produces an even more capable mercury sorbent, but as some of the bromine is held at less-energetic sites, there is a greater possibility that some degree of bromine may evolve off under some circumstances. Mercury sorbents with higher bromine concentrations will take longer to produce and cost more as well.

Paragraph [0054] refers to bromination of activated carbon, referring only to specific amounts of Br_2 used to treat the activated carbon and not giving any reference to, let alone specific amounts of, hydrogen bromide.

At paragraph [0062], Nelson states:

> **[0062]** **FIG. 4** describes the possible application of the sorbents to a plant which has a "hot-side" ESP, a particularly difficult situation for mercury control. In this equipment arrangement, the air preheater **22** follows the ESP **32**, so the temperature of the mercury-containing flue gas in the ductwork **64** before the particulate collection is very high, in the range of 300-to-400° C. Plain powdered activated carbons do not capture any mercury at these temperatures and PACs impregnated with iodine or sulfur lose their impregnates. Surprisingly, the mercury sorbents prepared according to the process of this invention appear to capture mercury in at least the lower end of this temperature range. Consequently, the sorbents from bin **71** can be useful even when injected at **72** into the very hot, low-oxygen, mercury-containing gases in ductwork **64**. The sorbents would be collected with the other gas stream particulates in the hot-side ESP **32** and the cleaned gas would proceed through ductwork **65** to the smokestack.

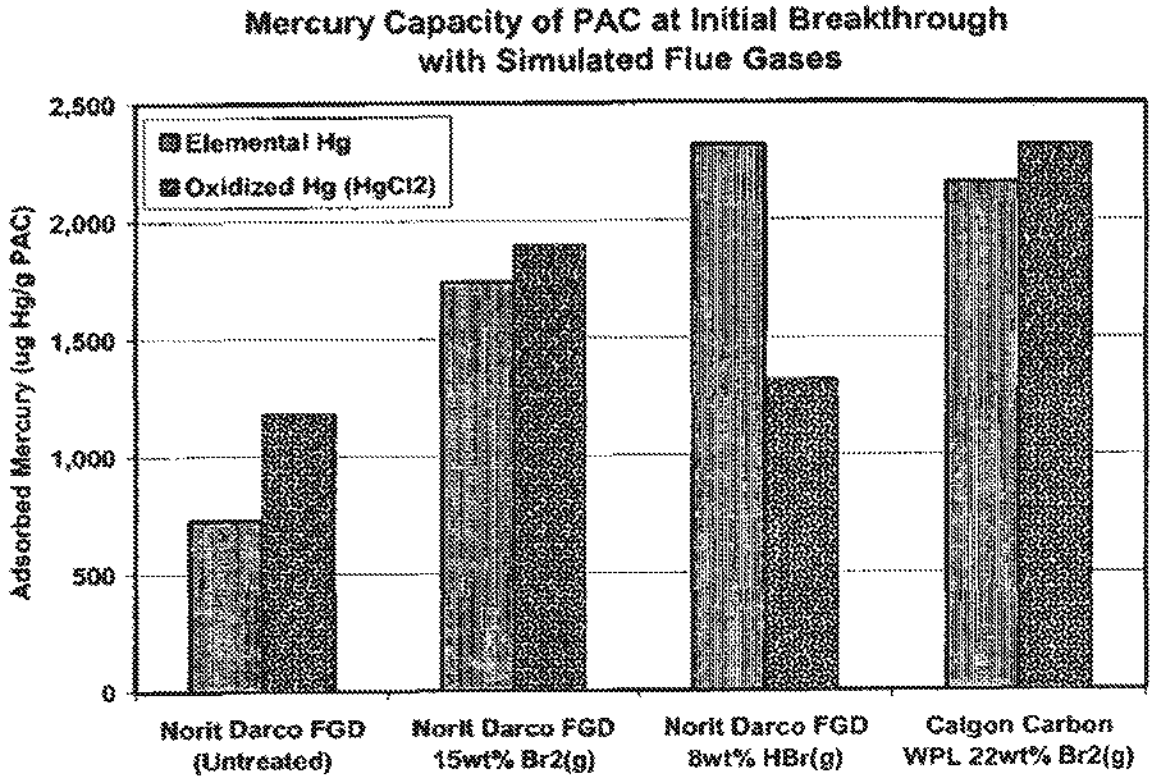
Paragraph [0062] states that mercury sorbents prepared according to Nelson's invention can capture mercury in at least the lower range of 300 °C to 400 °C, unlike activated carbons impregnated with iodine or sulfur.

At paragraph [0065], Nelson states:

> **[0065]** Two such arrangements bear particular mention. **FIG. 5** applies the sorbents in a "TOXECON®" arrangement. Here the mercury sorbents **71** are injected after an ESP **32** into the almost particulate-free ductwork **67** before a small, high-velocity fabric filter **33**. In this manner the fly ash **80** does not become mixed with the carbonaceous sorbents, allowing the fly ash to be sold for concrete use. Moreover, the filter cake of fabric filter **33** would predominantly be mercury sorbent, allowing a longer residence time, higher utilization levels, and the possibility of recovering and reinjecting the sorbent to lower costs. The superior reactivity and capacities of the mercury sorbents of this invention make them prime candidates for use in such an arrangement.

Paragraph [0065] states that injection of the treated activated carbon prior to a fabric filter can provide a longer residence time of the sorbent, higher utilization levels, as well as the possibility of recovering and reinjecting the sorbent at lower costs.

Figure 12 of Nelson is reproduced below.



Paragraph [0080], discussing figure 12, states that:

> ...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

Both of the Br_2-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is "important."

The majority of Nelson's Examples (1-4 and 8) focus only on Br_2. Nelson's Examples 5-7 demonstrate the use of HBr-treated sorbent; however, none of these Examples or any other parts of Nelson compare the mercury-absorption performance of HBr-treated activated carbon to HCl-treated activated carbon. Although figures 14 and 15 illustrate HBr-treated activated carbon and Cl_2-treated activated carbon, Cl_2-treated activated carbon is not HCl-treated or Cl^--treated carbon and these figures fail to show any comparison to HCl- or Cl^--treated activated carbon.

At paragraph [0085], Nelson states:

> sorbents of this invention. See **FIG. 14**. About three times as much chlorine-gas treated PAC was required to achieve the same degree of mercury removal as with bromine. The

Figure 14 of Nelson is reproduced below:

Figure 14.

Duct-Injection Pilot Plant with ESP

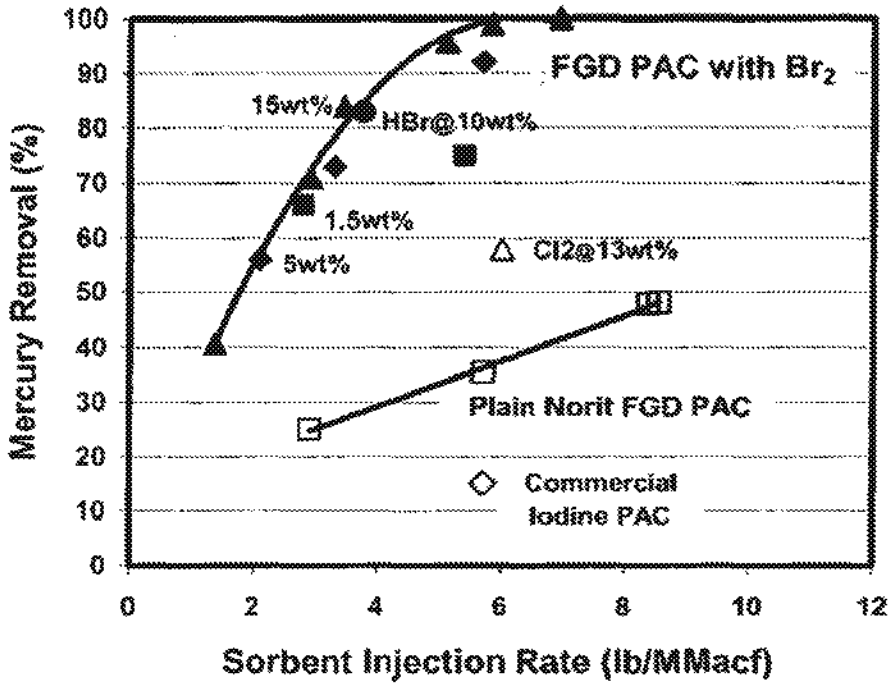


Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br_2-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated

carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl_2-treated activated carbon and the 5 wt% Br_2-treated activated carbon which had a percent mercury removal that was about the same. Further, with regard to figure 14, Nelson states at paragraph [0084] that "[t]here was not much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity." Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized.

At paragraph [0087], and the following table, Nelson states:

> **[0087]** Manufacture of the elemental bromine sorbents was much faster than for the others. The elemental bromine was adsorbed and reacted with the PACs much faster than was the elemental chlorine, for example—one-hundred-times faster. This allowed for quick and inexpensive manufacture of these sorbents. See the table below with rate data in terms of grams of gas adsorbed per kilogram of PAC per minute. The PAC adsorption of gaseous hydrogen bromide, HBr(g), was ten times faster than it was for chlorine.

Gaseous Halogen	Final Loading on FGD PAC (wt %)	Adsorption Rate (gm of gas) (kg PAC = min)	Concentration in Storage Vessel (ppm)
Br_2 (g)	5%	10	0
Br_2 (g)	15%	10	0.5
HBr (g)	9%	1	N.A.
Cl_2 (g)	13%	0.1	>40

Paragraph [0087] states that the activated carbon adsorbed elemental bromine (Br_2) and hydrogen bromide (HBr) faster than chlorine (explicitly shown as Cl_2 in the Table). The table shows the amount of treatment material (Br_2, HBr, or Cl_2) absorbed on the activated carbon and the rate of adsorption of the treatment material on the activated carbon. Paragraph [0087] and the table

that follows make no statements describing or suggesting mercury removal rates of the treated activated carbon.

Figure 15 of Nelson is reproduced below:

Figure 15.

Lausche Plant Duct-Injection ESP Trials

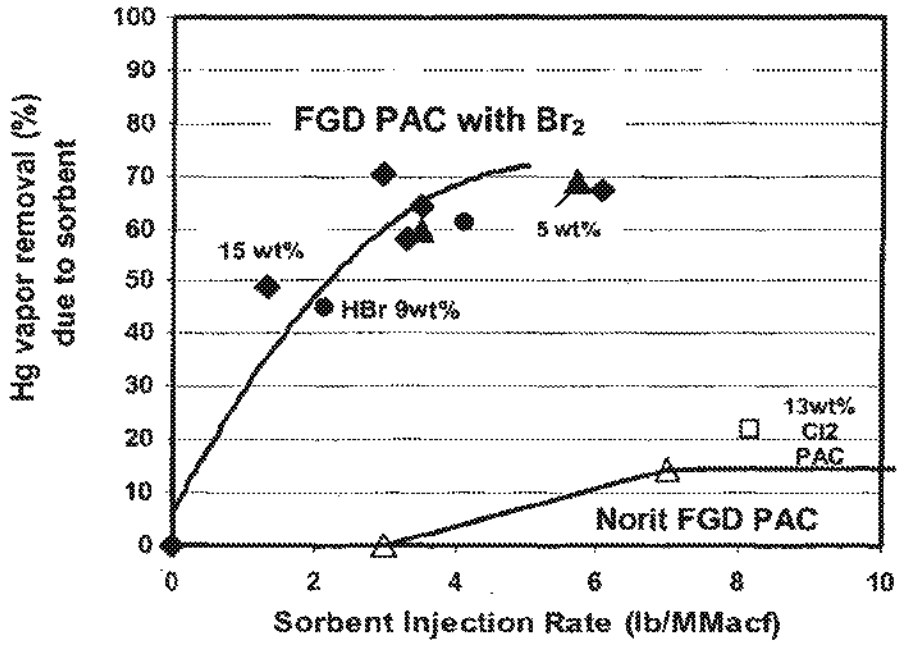


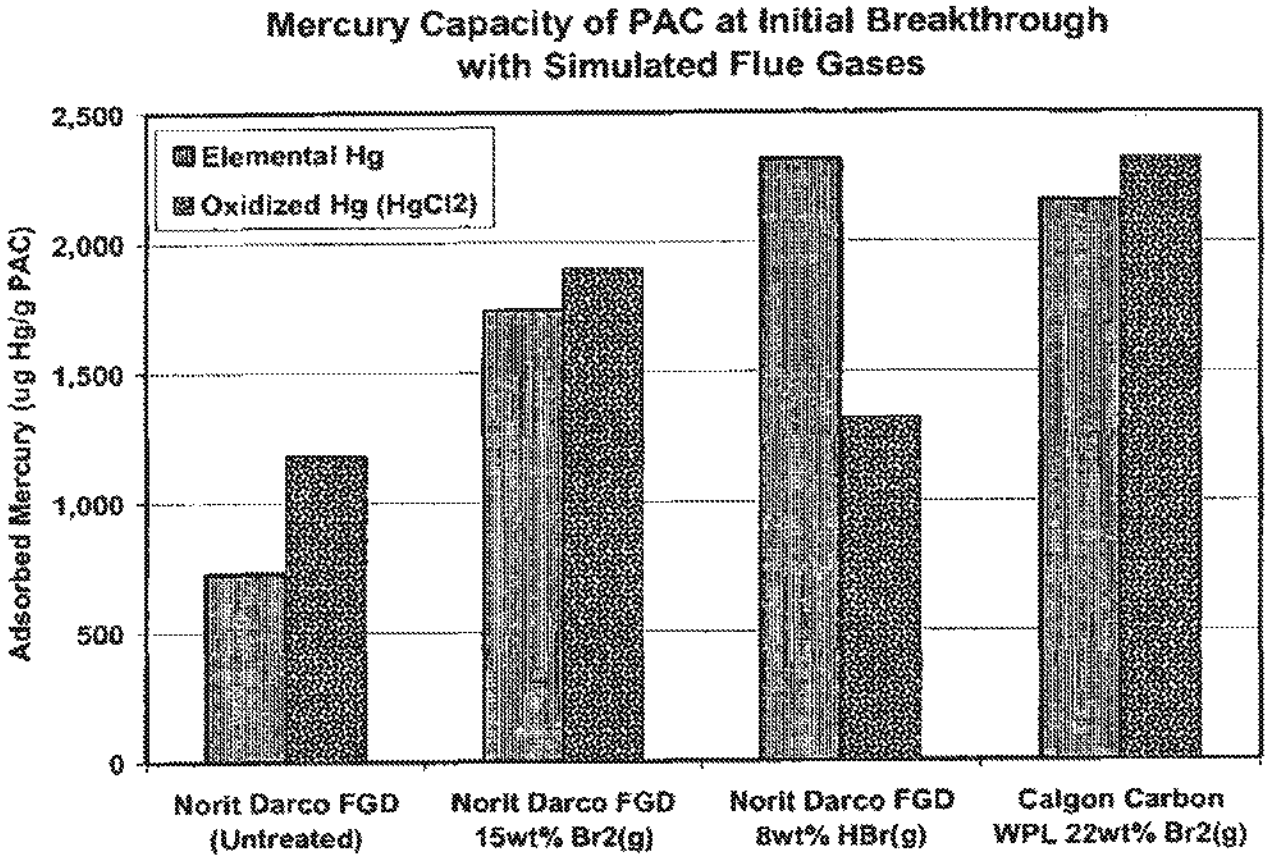
Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). For all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br_2-treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br_2 data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br_2-treated activated carbons.

At paragraph [0092], Nelson states:

> **[0092]** The brominated sorbents of this invention, on the other hand, performed very well with this difficult flue gas, achieving about 50% mercury removal with only 2 lb/MMacf of sorbent consumption and almost 70% removal at an injection rate of 4 lb/MMacf. PACs brominated with Br_2 to 5 wt % and 15 wt %, and with HBr to 9 wt % all performed similarly.

Paragraph [0092] refers to the data shown in Figure 15. However, Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

Taken in the context of the entire document, figures 14-15 and paragraph [0092] fails to describe or suggest equivalent mercury-removal performance of HBr-treated activated carbon and Br_2-treated activated carbon. With regard to figure 14, Nelson states at paragraph [0084] that "[t]here was not much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity." Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized. In figure 15, for all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br_2-treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br_2 data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br_2-treated activated carbons. In figure 12, reproduced below, Nelson compares the mercury capacity of untreated activated carbon, 15 wt% Br_2-treated activated carbon, 8 wt% HBr-treated activated carbon, and 22 wt%Br_2-treated activated carbon.



Paragraph [0080], discussing figure 12, states that:

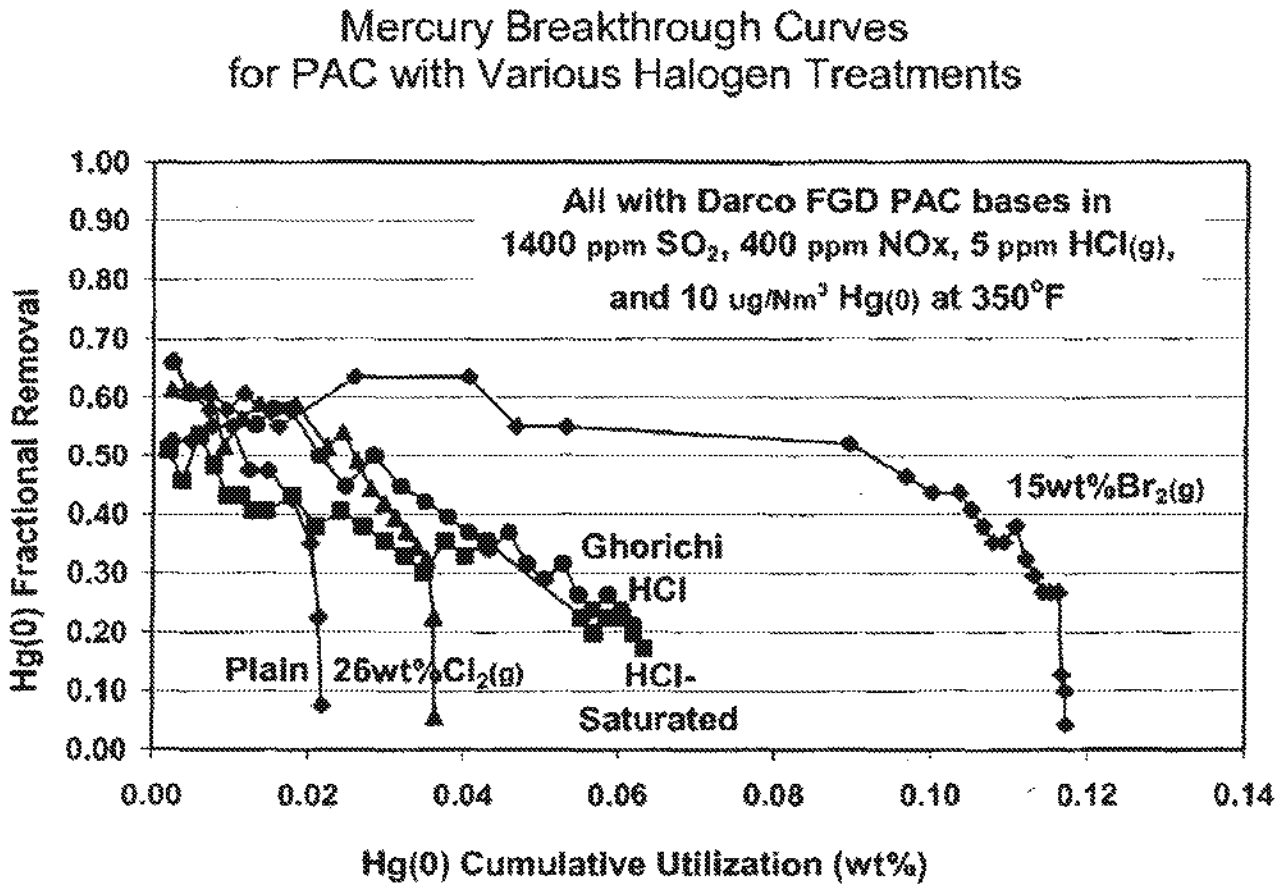
> ...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

Both of the Br_2-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is "important."

Nelson does not portray the mercury removal abilities of activated carbon treated with Cl_2 outside the flue gas as equivalent to that of activated carbon treated with HCl outside the flue gas.

At figure 11, reproduced below, Nelson shows mercury breakthrough curves for elemental mercury removal from a non-flue gas "mercury-challenge gas" for powdered activated carbon with various halogen treatments performed outside the flue gas.

Figure 11.



At paragraph [0077], reproduced below, Nelson discusses figure 11.

> **[0077]** The sample that had been exposed to gaseous chlorine, $Cl_2(g)$, exhibited some improvement in mercury removal performance relative to the plain, untreated PAC. Two samples of HCl-treated PACs showed even higher ultimate mercury capacities, but poorer kinetics. One of these samples had been pretreated by flowing gas-phase HCl through the PAC sample until it no longer added mass. The other, acquired from Ghorishi et al., was produced by a dilute liquid-phase HCl treatment described in their publications. The elemental mercury breakthrough curves of the two HCl-treated PACs were very similar, exhibiting a slow and steady drop-off in performance, indicative of poor mercury adsorption kinetics. In contrast, the brominated sample of this invention broke through very sharply and captured more than five times the elemental mercury of the untreated PAC.

At paragraph [0077], Nelson states that the HCl-treated powdered activated carbons had higher capacities for elemental mercury, but showed poorer kinetics. Although some information about how the Cl_2- and HCl-treated activated carbons would behave in a flue gas can be learned from figure 11, a flue gas contains additional species that were not present in the "mercury challenge gas", and, further, can include other forms of mercury other than the elemental mercury measured by the breakthrough test of figure 11, such as oxidized mercury. Nelson does not perform mercury-removal testing of HCl-treated activated carbons in a flue gas. However, Nelson in figure 11, paragraph [0077], and paragraph [0012] refers to HCl-treated activated carbon from Ghorishi et al., which had about the same performance in figure 11 as the HCl-saturated activated carbon prepared by Nelson. At paragraph [0012] Nelson describes a publication by this author, Ghorishi, S.B., Keeney, R.M., Jozewicz, W.S., Serre, S.D. and Gullett, B.K., 2001, In-flight capture of elemental mercury by a chlorine-impregnated activated carbon, Annual Air and Waste Management Association(AWMA) Conference, Orlando, FL, Vol. 24, No. 28 ("Ghorishi").

Ghorishi's conclusion at page 11 states that over 80% mercury removal was accomplished from a flue gas using activated carbon treated outside the flue gas with HCl. Comparing these results to Nelson's results shown in figures 14 and 15, 80% mercury removal is better than the about 58% removal by Cl_2-treated activated carbon in figure 14, is better than the about 22% removal by Cl_2-treated activated carbon in figure 15, and is better than the maximum mercury removal of HBr-

or Br_2-treated activated carbons in figure 15. Therefore, one of ordinary skill in the art hypothetically reviewing Nelson would not only conclude that activated carbon treated outside the flue gas with HCl not only has higher capacity for elemental mercury than Cl_2-treated activated carbon as shown in Nelson's figure 11, but also from comparing Ghorishi to Nelson that activated carbon treated outside the flue gas with HCl has better mercury removal performance in flue gas than Cl_2-treated activated carbon. Accordingly, even if, merely for the sake of argument, one of ordinary skill in the art were to conclude from Nelson's statements at paragraph [0092] that activated carbon treated with HBr or Br_2 outside the flue gas have similar mercury removal abilities, this would not lead to the conclusion that activated carbon treated with HBr outside the flue gas has better mercury removal abilities than activated carbon treated with HCl outside the flue gas.

Nelson never directly compares the mercury-removal ability of HBr-treated activated carbon with HCl-treated activated carbon. With Nelson clearly indicating that HBr-treated activated carbon has inferior mercury-removal ability as compared to Br_2-treated activated carbon, and that HCl-treated activated carbon has superior mercury-removal ability as compared to Cl_2-treated activated carbon, there is no way that one of ordinary skill in the art hypothetically considering Nelson could conclude that HBr-treated activated carbon has equivalent or superior mercury-removal ability compared to HCl-treated activated carbon.

No part of Nelson describes or suggests that HBr or Br^- even have the same effectiveness for mercury sequestration when used to treat activated carbons as HCl or Cl^-, let alone that HBr or Br^- are more effective for mercury sequestration when used to treat activated carbons than HCl or Cl^-. A person of ordinary skill in the art would have no reason to modify Felsvang's HCl or Cl^- process with a different promoter to form an effective carbon sorbent for mercury removal if the resulting mercury-removal efficiency could not be reasonably predicted to be the same or greater as that of Felsvang's original process. Therefore, a person of ordinary skill in the art would not be motivated to replace Felsvang's HCl or Cl^- treatment of activated carbon with Nelson's HBr treatment. Independent claim 1 is patentable for at least this reason.

I(A)(3). Reply to Examiner's response to arguments.

The Office Action states:

> The applicant traverses the combination of Felsvang and Nelson combination stating that there is no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process. The applicant contends that one having ordinary skill in the art would not be motivated to replace Felsvang's chloride treatment with treatment by another material as the prior art does not disclose the bromide additives performing the same or better mercury-removal efficiency.
>
> The examiner disagrees. See Fig. 14 of Nelson which shows that about 3 times the amount of chlorine treated PAC was required to achieve the same degree of mercury removal as with bromine. (paragraph [0085]). Also see the absorption rate in the table on page 8. Further as the rejection above states. Both chlorine and bromine are known within the art to treat activated carbon and therefore it would be well within the capability of one having ordinary skill in the art to *either replace the Cl with or include in addition to* the halogen or halide promoter comprising HBr, Br^-, or a combination thereof to promote activated carbon (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury.

The Office Action states that Fig. 14 of Nelson shows that about 3 times the amount of chlorine treated PAC was required to achieve the same degree of mercury removal as with bromine, citing to paragraph [0085]. The Office Action also cites to the absorption rate in the table on page 8.

Although figures 14 and 15 illustrate HBr-treated activated carbon and Cl_2-treated activated carbon, Cl_2-treated activated carbon is not HCl- or Cl^--treated carbon and these figures fail to show any comparison to HCl- or Cl^--treated activated carbon.

At paragraph [0085], Nelson states:

> sorbents of this invention. See **FIG. 14.** About three times as much chlorine-gas treated PAC was required to achieve the same degree of mercury removal as with bromine. The

Figure 14 of Nelson is reproduced below:

Figure 14.

Duct-Injection Pilot Plant with ESP

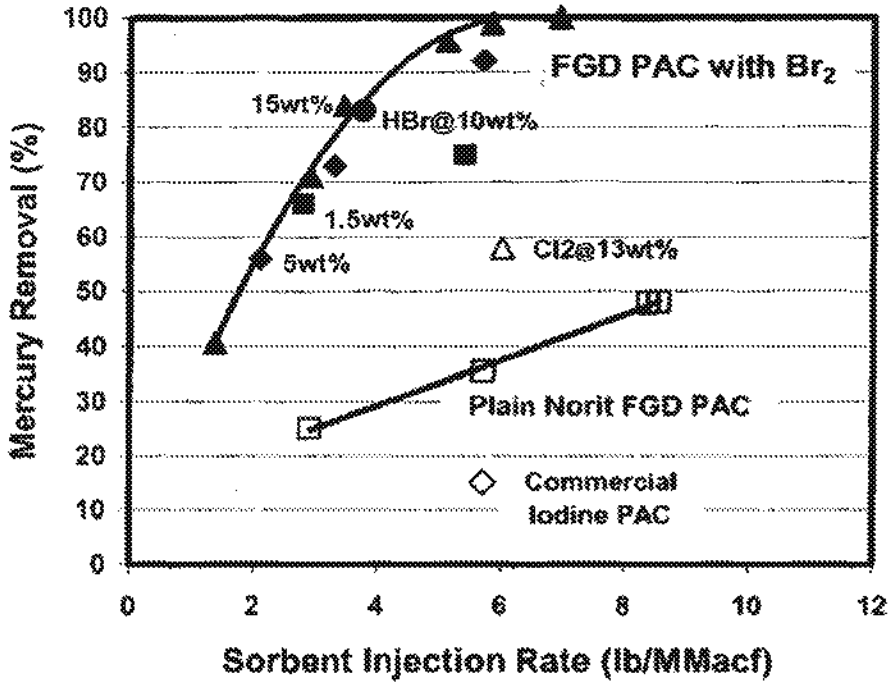


Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br_2-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl_2-treated activated carbon and the 5 wt% Br_2-treated activated carbon which had a percent mercury removal that was about the same.

At paragraph [0017], Nelson states:

> **[0017]** The particular advantages of using bromine, rather than iodine or iodides, or chlorine or chlorides, with activated carbons for mercury control have not been previously appreciated. Gaseous bromine and hydrogen bromide have been combined with carbon substrates before, but not to sequester mercury from hot combustion-gas streams. For example, Greinke U.S. Pat. No. 5,372,619 found that bromine-treated carbon can make a superior natural-gas storage medium. In another example, SKC Inc. sells a small tube with hydrobromic acid-treated charcoal to sample air for ethylene oxide. However, with both of these uses it is important that the adsorption targets, natural gas and ethylene oxide, be easily desorbable from the carbon, the exact opposite of what is required in a mercury vapor sequestration application. In a similar vein, in U.S. Pat. No. 6,475,461 Ohsaki describes a process for treating carbon substrates with gaseous bromine or chlorine, but then explicitly desorbs them to achieve his desired product. Seki U.S. Pat. No. 3,961,020; Yoshida and Seki et al. U.S. Pat. No. 4,174,373; and Knoblauch et al. U.S. Pat. No. 5,179,058 impregnate activated carbon with bromine to produce a catalyst for reacting nitrogen oxide with ammonia to form nitrogen and water. In this application too, the bromine of the carbon does not act as a sequestration agent, permanently tying up its target. Rather, it serves as a catalyst, taking part in a repeated series of desired chemical reactions, but not becoming permanently consumed by any of them. Perhaps it is understandable that the tenacity of carbon-bromine-mercury complexes could be overlooked.

The first sentence of paragraph [0017] refers to the "…particular advantages of using bromine…" for treatment of activated carbons for mercury control, which must mean either elemental bromine (Br_2) or the element bromine generally, and is not a specific reference to bromides (Br^-). The "…particular advantages of using bromine…" is compared to iodine (I_2), iodides (I^-), chlorine (Cl_2), and chlorides (Cl^-), but no specific comparison is made between bromides (Br^-) and chlorides (Cl^-). However, it does not make sense for Nelson to refer to the element bromine generally while specifically distinguishing between chlorine (Cl_2) and chlorides (Cl^-), and iodine (I_2) and iodides (I^-) in the same sentence. If Nelson wanted to compare both

elemental bromine (Br_2) and hydrogen bromide (HBr) to the other halides specifically disclosed in the first sentence, Nelson would have specifically distinguished between bromine (Br_2) and bromides (Br^-); therefore, "…bromine…" in the first sentence of paragraph [0017] would be interpreted as elemental bromine (Br_2), and not as the element bromine generally.

No "…particular advantages of using bromine…" are explicitly described in paragraph [0017], with the remainder of the paragraph focusing on the failure of the prior art to use bromine with activated carbon for mercury control, describing various disadvantages of other processes, such as the desorbability of Br_2, HBr, or Cl_2 from the activated carbon, or the failure of the Br_2 or HBr to act as a mercury sequestration agent. The paragraph concludes with a statement that it is understandable that "…the tenacity of carbon-bromine-mercury complexes…" could be overlooked, which must refer to complexes including either elemental bromine (Br_2) or the element bromine generally, with no specific reference to bromide (Br^-) or complexes formed therefrom. The concluding statement of paragraph [0017] is directed toward the discussion in the bulk of paragraph [0017]—the prior art fails to use bromine with activated carbon for mercury control and therefore fails to generate carbon-bromine-mercury complexes—rather than as a statement of any relative advantage of bromine over other halogens or halides. The "…tenacity of carbon-bromine-mercury complexes…" is not specifically compared to the strength of any other complexes, such as carbon-chlorine-mercury complexes, carbon-chloride-mercury complexes, carbon-iodine-mercury complexes, or carbon-iodide-mercury complexes; therefore, at best, the "…tenacity…" of the complexes described in the last sentence of paragraph [0017] can be regarded as a general statement, rather than as a comparative one. Paragraph [0017] fails to attribute any advantage of Nelson's invention specifically to HBr or Br^-, and, moreover, fails to describe or suggest that HBr or Br^- treatment of activated carbon could provide equal, let alone better, mercury removal than HCl or Cl^- treatment of the activated carbon.

At paragraph [0044], Nelson states:

> **[0044]** Production of the new mercury sorbent materials is simple and inexpensive. The carbon material and the bromine gas need simply be contacted with each other for the advantageous mercury-reactive surface compounds to quickly form. Elemental bromine is a liquid at ambient temperature, but turns to a gas at only a modestly elevated temperature. Hydrogen bromide is a gas at even ambient temperature. Using a gas-phase carbon reactant considerably simplifies the production of the sorbent and leads to the low costs which are a requirement for a sorbent to be used as a once-through duct injectant. Any common mixing method and equipment can be use to contact the gaseous bromine species with the carbon-based substrates, although it is preferably lined with corrosion-resistant material, because the bromine species can be quite corrosive. It is also preferable that the mixing of bromine gas and carbon be done at an elevated temperature. This keeps the bromine gas in the gaseous form, but also minimizes the amount of any bromine physically-adsorbed into the pores of the carbon. Such physically adsorbed bromine is not chemically bound to the carbon lattice and can be emitted in handling, in storage, and especially, when the sorbent is injected into a hot flue gas.

Paragraph [0044] expands on the general advantage described in paragraph [0021] of simple and inexpensive generation and use of the treated activated carbon sorbent. Paragraph [0044] also describes that elevated temperature during treatment can provide an advantage of reduced physical-adsorption of the elemental bromine or the hydrogen bromide, which helps to avoid emission during handling, storage, and during injection into a hot flue gas. The advantages are not described or suggested to include equal or greater mercury-removal ability of HBr- or Br^--treated activated carbon as compared to HCl- or Cl^--treated activated carbon.

The Office Action states:

> The applicant contends that the Nelson reference does not disclose HBR and Br2 being more effect with activated carbons than chlorides.
>
> The examiner disagrees. The Nelson reference discloses that HBr is used to provide bromide to the system. Example 5, paragraph [0083] states that the brominated PACs were treated with HBr or Br_2. Figures 14 and 15 disclose that HBr treated PAC performs better than chlorine treated PAC. Further one having ordinary skill in the art would expect PAC treated with HBr or Br_2 would result in a very similar modified PAC as they both include bromide (see paragraph [0092] which discloses that each of the brominated PACs performed similarly). The examiner also points to paragraph [0057] of Nelson which discloses that PAC adsorption of gaseous hydrogen bromide being ten times faster than it was for chlorine.

The Office Action states that the Nelson reference discloses that HBr is used to provide bromide to the system, and that Example 5, paragraph [0083] states that brominated PACs were treated with HBr or Br_2. Applicant cannot find the language of providing HBr "to the system" in Nelson; paragraph [0083] in Example 5 describes treating powdered activated carbons with different amounts of gaseous $Br_2(g)$ or HBr prior to injecting the activated carbons into the flue gas. However, Nelson fails to describe or suggest that treatment of activated carbon with HBr provides the same, let alone better, mercury removal efficiency as activated carbon treated with HCl or Cl^-.

With regard to figures 14 and 15, as explained above, although figures 14 and 15 illustrate HBr-treated activated carbon and Cl_2-treated activated carbon, Cl_2-treated activated carbon is not HCl- or Cl^--treated carbon and these figures fail to show any comparison to HCl- or Cl^--treated activated carbon. Figure 14 shows mercury removal percent from seven different types of activated carbons: commercial iodine activated carbon, plain Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 10 wt% HBr-treated activated carbon, 1.5 wt% Br_2-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 14 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon). Paragraph [0085] states that about three times as much chlorine-gas treated activated carbon was required to achieve the same degree of mercury removal as with bromine, which can only be a comparison between the 13 wt% Cl_2-treated activated carbon and the 5 wt% Br_2-treated activated carbon which had a percent mercury removal that was about the same. Figure 15 shows mercury removal percent from five different types of

activated carbons: Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

The Office Action states that paragraph [0087] of Nelson discloses that PAC adsorption of gaseous hydrogen bromide was ten times faster than it was for chlorine. At paragraph [0087], and the following table, Nelson states:

> **[0087]** Manufacture of the elemental bromine sorbents was much faster than for the others. The elemental bromine was adsorbed and reacted with the PACs much faster than was the elemental chlorine, for example—one-hundred-times faster. This allowed for quick and inexpensive manufacture of these sorbents. See the table below with rate data in terms of grams of gas adsorbed per kilogram of PAC per minute. The PAC adsorption of gaseous hydrogen bromide, HBr(g), was ten times faster than it was for chlorine.

Gaseous Halogen	Final Loading on FGD PAC (wt %)	Adsorption Rate (gm of gas) (kg PAC = min)	Concentration in Storage Vessel (ppm)
Br_2 (g)	5%	10	0
Br_2 (g)	15%	10	0.5
HBr (g)	9%	1	N.A.
Cl_2 (g)	13%	0.1	>40

Paragraph [0087] states that the activated carbon adsorbed elemental bromine (Br_2) and hydrogen bromide (HBr) faster than chlorine (explicitly shown as Cl_2 in the Table). The table shows the amount of treatment material (Br_2, HBr, or Cl_2) absorbed on the activated carbon and the rate of adsorption of the treatment material on the activated carbon. Paragraph [0087] and the table that follows make no statements describing or suggesting mercury removal rates of the treated activated carbon.

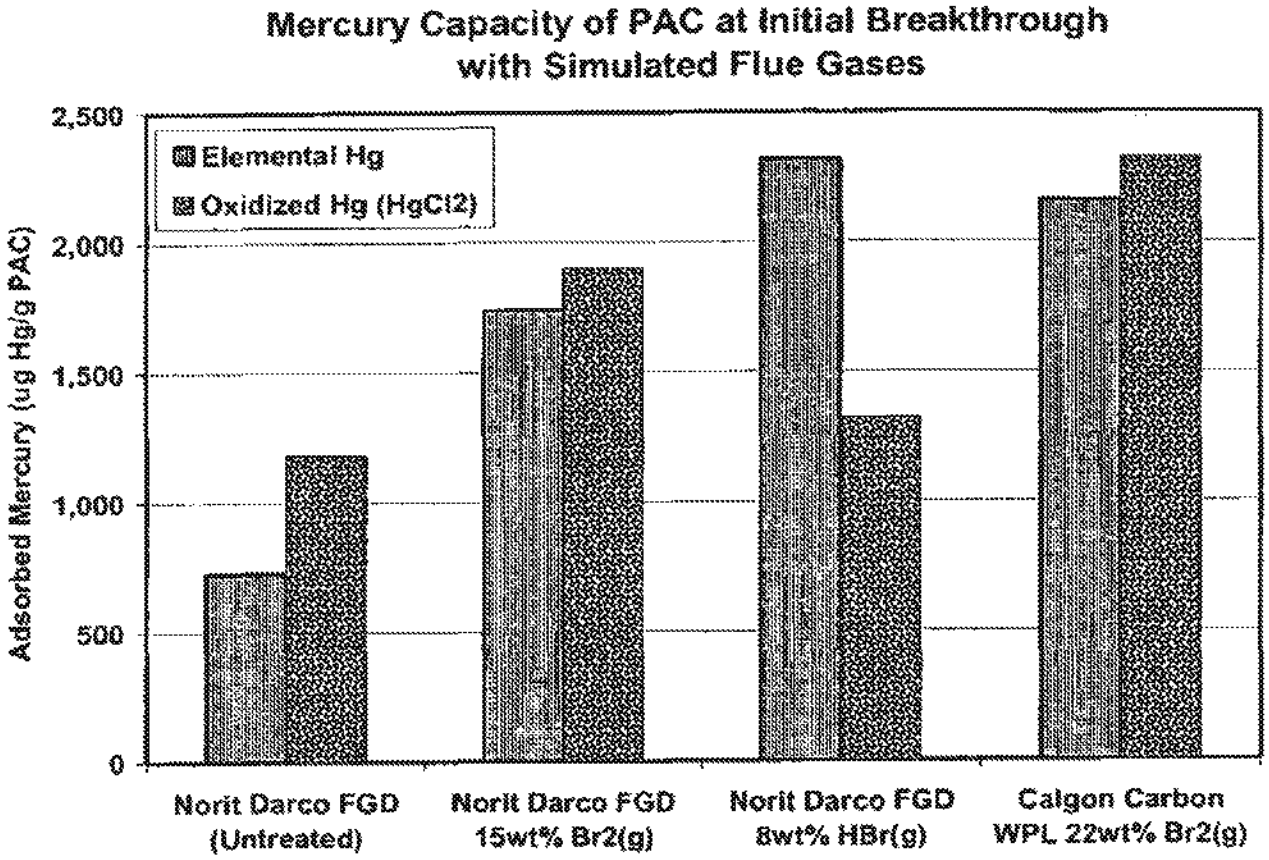
The Office Action states that one having ordinary skill in the art would expect activated carbon treated with HBr or Br_2 would result in a very similar modified PAC as they both include bromide, citing to paragraph [0092] as allegedly disclosing that each of the brominated PACs

performed similarly. Applicant notes Declaration C at item 18 which explains that Br_2 is not and does not include Br^-. At paragraph [0092], Nelson states:

> **[0092]** The brominated sorbents of this invention, on the other hand, performed very well with this difficult flue gas, achieving about 50% mercury removal with only 2 lb/MMacf of sorbent consumption and almost 70% removal at an injection rate of 4 lb/MMacf. PACs brominated with Br_2 to 5 wt % and 15 wt %, and with HBr to 9 wt % all performed similarly.

Paragraph [0092] refers to the data shown in Figure 15. However, Figure 15 shows mercury removal percent from five different types of activated carbons: Norit activated carbon, 13 wt% Cl_2-treated activated carbon, 9 wt% HBr-treated activated carbon, 5 wt% Br_2-treated activated carbon, and 15 wt% Br_2-treated activated carbon. No HCl- or Cl^--treated activated carbon is shown in Figure 15 or described in any of Examples 5-7 (the only Examples demonstrating the use of HBr-treated activated carbon).

Taken in the context of the entire document, figures 14-15 and paragraph [0092] fails to describe or suggest equivalent mercury-removal performance of HBr-treated activated carbon and Br_2-treated activated carbon. With regard to figure 14, Nelson states at paragraph [0084] that "[t]here was no much difference in performance between the various brominated samples, probably because in the duct-injection mode they only used a small fraction of their available mercury-adsorption capacity." Therefore, Nelson states that figure 14 does not provide an accurate comparison between the brominated samples, because the full mercury-adsorption capacity was not utilized. In figure 15, for all data points showing HBr-treated activated carbon, a higher sorbent injection rate was needed to achieve equivalent mercury-removal performance as the Br_2-treated activated carbons (i.e., the HBr data points for a given mercury-removal percentage are always to the right of the Br_2 data points for that mercury-removal percentage), indicating HBr-treated activated carbon to have less mercury-removal ability than Br_2-treated activated carbons. In figure 12, reproduced below, Nelson compares the mercury capacity of untreated activated carbon, 15 wt% Br_2-treated activated carbon, 8 wt% HBr-treated activated carbon, and 22 wt%Br_2-treated activated carbon.



Paragraph [0080], discussing figure 12, states that:

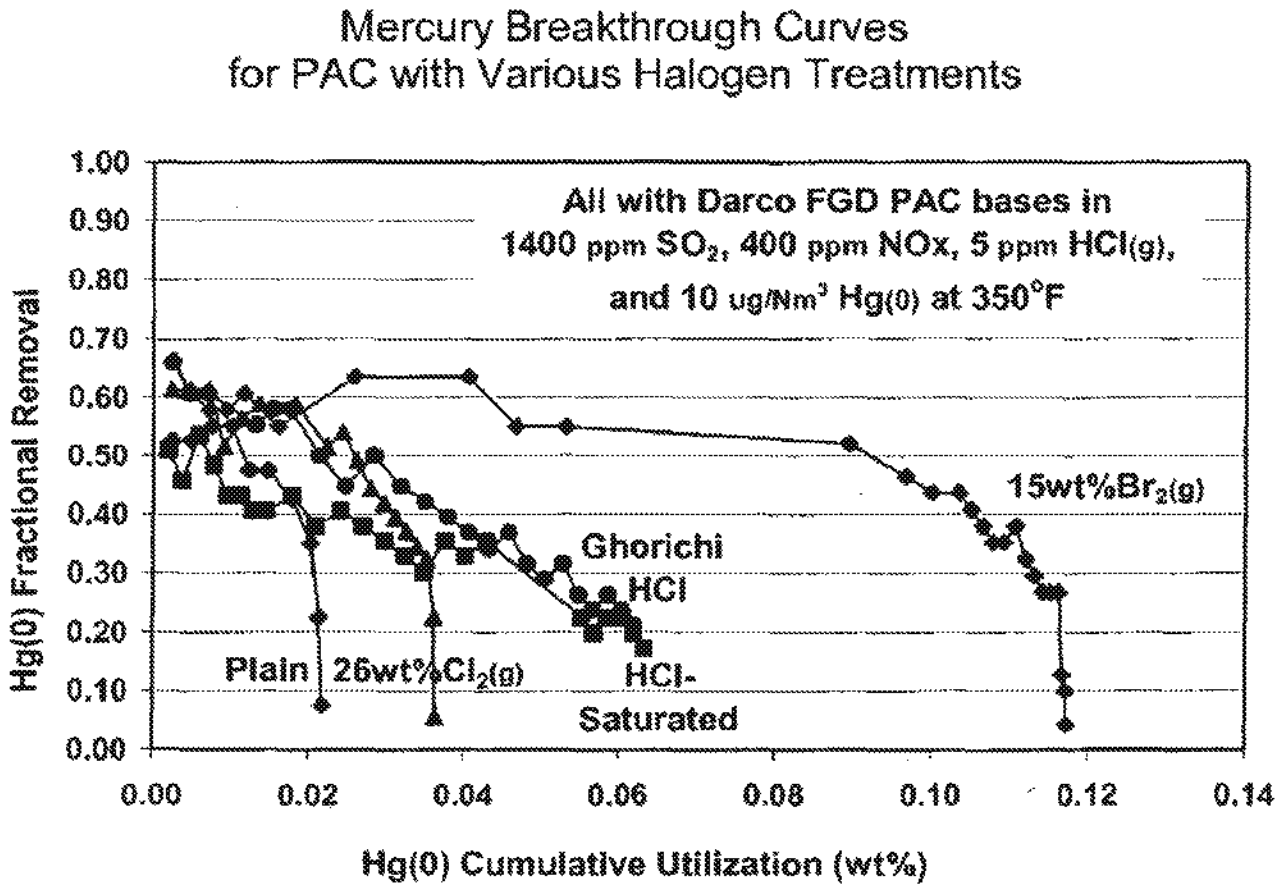
> ...the brominated carbons adsorbed considerably more mercury species than the untreated version, with the improvements averaging about 100%. Importantly, the bromine-gas-treated sorbents removed about as much oxidized mercury-chloride from the test gases as elemental mercury, indicating performance improvements with both kinds of common flue-gas mercury species.

Both of the Br_2-treated activated carbons in figure 12 showed increased removal of both elemental mercury and oxidized mercury as compared to the untreated activated carbon. However, the HBr-treated activated carbon in figure 12 had hardly any improvement in removal of oxidized Hg compared to the untreated activated carbon, which paragraph [0080] describes as one of two common flue-gas mercury species, and that the removal of both of these species is "important."

Nelson does not portray the mercury removal abilities of activated carbon treated with Cl_2 outside the flue gas as equivalent to that of activated carbon treated with HCl outside the flue gas.

At figure 11, reproduced below, Nelson shows mercury breakthrough curves for elemental mercury removal from a non-flue gas "mercury-challenge gas" for powdered activated carbon with various halogen treatments performed outside the flue gas.

Figure 11.



At paragraph [0077], reproduced below, Nelson discusses figure 11.

> **[0077]** The sample that had been exposed to gaseous chlorine, $Cl_2(g)$, exhibited some improvement in mercury removal performance relative to the plain, untreated PAC. Two samples of HCl-treated PACs showed even higher ultimate mercury capacities, but poorer kinetics. One of these samples had been pretreated by flowing gas-phase HCl through the PAC sample until it no longer added mass. The other, acquired from Ghorishi et al., was produced by a dilute liquid-phase HCl treatment described in their publications. The elemental mercury breakthrough curves of the two HCl-treated PACs were very similar, exhibiting a slow and steady drop-off in performance, indicative of poor mercury adsorption kinetics. In contrast, the brominated sample of this invention broke through very sharply and captured more than five times the elemental mercury of the untreated PAC.

At paragraph [0077], Nelson states that the HCl-treated powdered activated carbons had higher capacities for elemental mercury, but showed poorer kinetics. Although some information about how the Cl_2- and HCl-treated activated carbons would behave in a flue gas can be learned from figure 11, a flue gas contains additional species that were not present in the "mercury challenge gas", and, further, can include other forms of mercury other than the elemental mercury measured by the breakthrough test of figure 11, such as oxidized mercury. Nelson does not perform mercury-removal testing of HCl-treated activated carbons in a flue gas. However, Nelson in figure 11, paragraph [0077], and paragraph [0012] refers to HCl-treated activated carbon from Ghorishi et al., which had about the same performance in figure 11 as the HCl-saturated activated carbon prepared by Nelson. At paragraph [0012] Nelson describes a publication by this author, Ghorishi, S.B., Keeney, R.M., Jozewicz, W.S., Serre, S.D. and Gullett, B.K., 2001, In-flight capture of elemental mercury by a chlorine-impregnated activated carbon, Annual Air and Waste Management Association(AWMA) Conference, Orlando, FL, Vol. 24, No. 28 ("Ghorishi").

Ghorishi's conclusion at page 11 states that over 80% mercury removal was accomplished from a flue gas using activated carbon treated outside the flue gas with HCl. Comparing these results to Nelson's results shown in figures 14 and 15, 80% mercury removal is better than the about 58% removal by Cl_2-treated activated carbon in figure 14, is better than the about 22% removal by Cl_2-treated activated carbon in figure 15, and is better than the maximum mercury removal of HBr-

or Br_2-treated activated carbons in figure 15. Therefore, one of ordinary skill in the art hypothetically reviewing Nelson would not only conclude that activated carbon treated outside the flue gas with HCl not only has higher capacity for elemental mercury than Cl_2-treated activated carbon as shown in Nelson's figure 11, but also from comparing Ghorishi to Nelson that activated carbon treated outside the flue gas with HCl has better mercury removal performance in flue gas than Cl_2-treated activated carbon. Accordingly, even if, merely for the sake of argument, one of ordinary skill in the art were to conclude from Nelson's statements at paragraph [0092] that activated carbon treated with HBr or Br_2 outside the flue gas have similar mercury removal abilities, this would not lead to the conclusion that activated carbon treated with HBr outside the flue gas has better mercury removal abilities than activated carbon treated with HCl outside the flue gas.

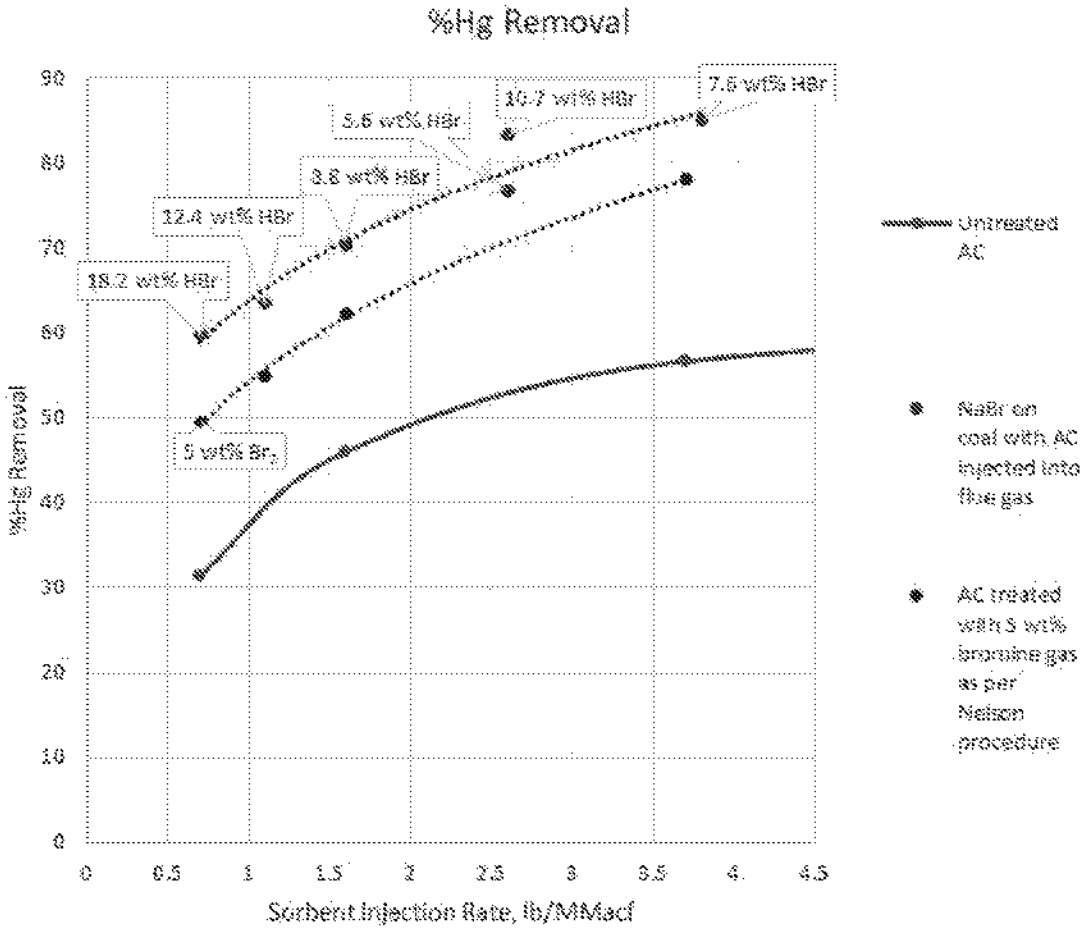
Nelson never directly compares the mercury-removal ability of HBr-treated activated carbon with HCl-treated activated carbon. With Nelson clearly indicating that HBr-treated activated carbon has inferior mercury-removal ability as compared to Br_2-treated activated carbon, and that HCl-treated activated carbon has superior mercury-removal ability as compared to Cl_2-treated activated carbon, there is no way that one of ordinary skill in the art hypothetically considering Nelson could conclude that HBr-treated activated carbon has equivalent or superior mercury-removal ability compared to HCl-treated activated carbon.

I(B). In-flight promotion versus treatment outside the flue gas.

I(B)(1). In-flight promotion with HBr or Br^- promoters is more effective for mercury removal than treating the sorbent with HBr, Br^-, or Br_2 outside the mercury-containing gas.

The inventors of the present application have discovered that by combusting coal in the presence of a HBr or Br^- promoter, and by placing an activated carbon sorbent in the mercury-containing gas, as presently claimed, the activated carbon can be promoted by the promoter in-flight in the mercury-containing gas, and further, that in-flight HBr or Br^- promotion of the activated carbon is more effective for mercury removal than use of an activated carbon that is treated with HBr, Br^-, or Br_2 outside the flue gas.

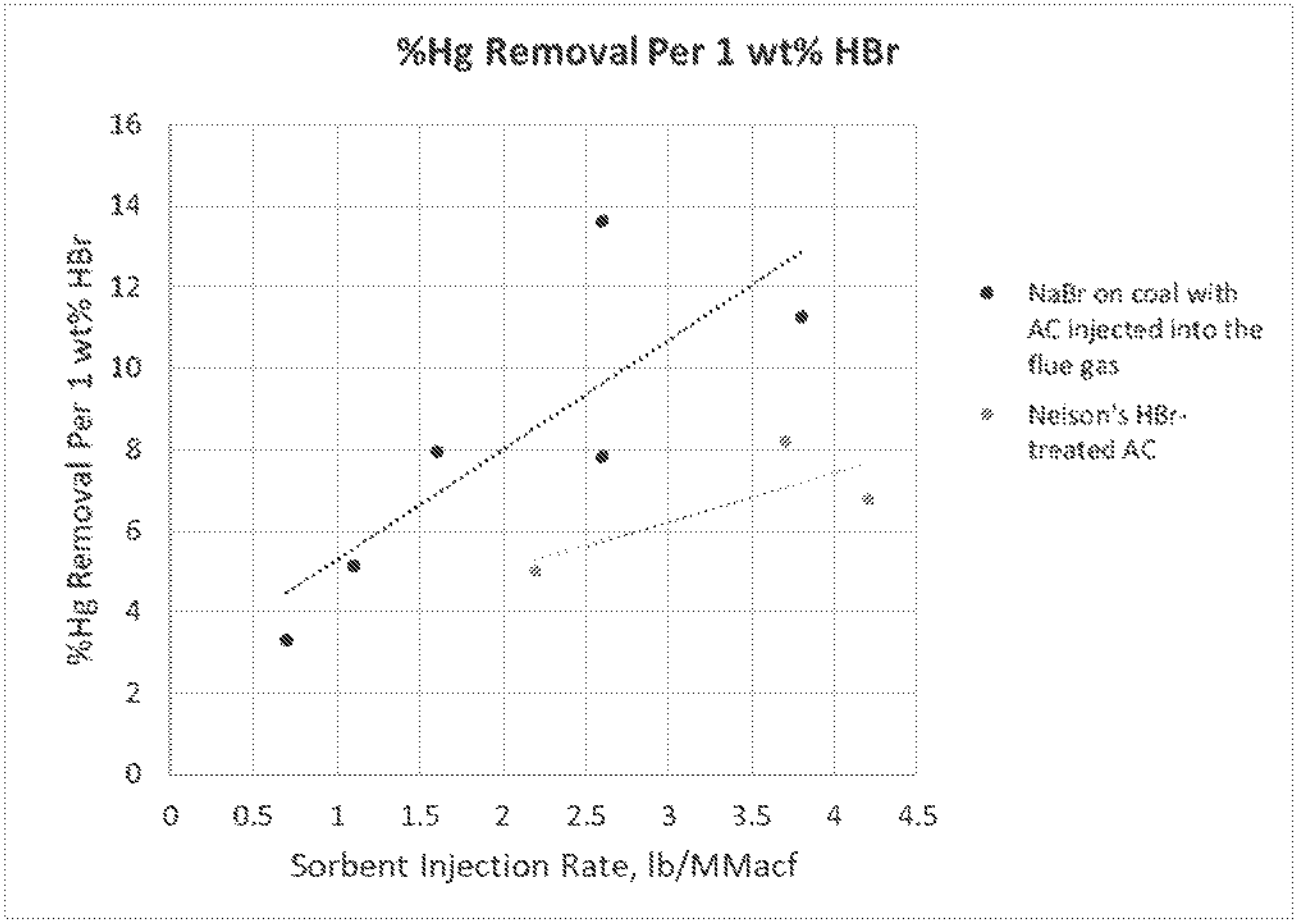
As explained in Declaration B, pilot-scale testing was performed with activated carbon alone (untreated) injected into the flue gas, the activated carbon treated with Br_2 outside the flue gas as per the Nelson procedure (see, Declaration B at item 7), and with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-11. The plot given in Declaration B at item 11 is reproduced below.



The data in the plot above from item 11 of Declaration B show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas (in-flight promotion with Br^*) provided a higher percent of mercury removal at all tested sorbent injection rates as compared to the activated carbon alone (untreated) and compared to the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure.

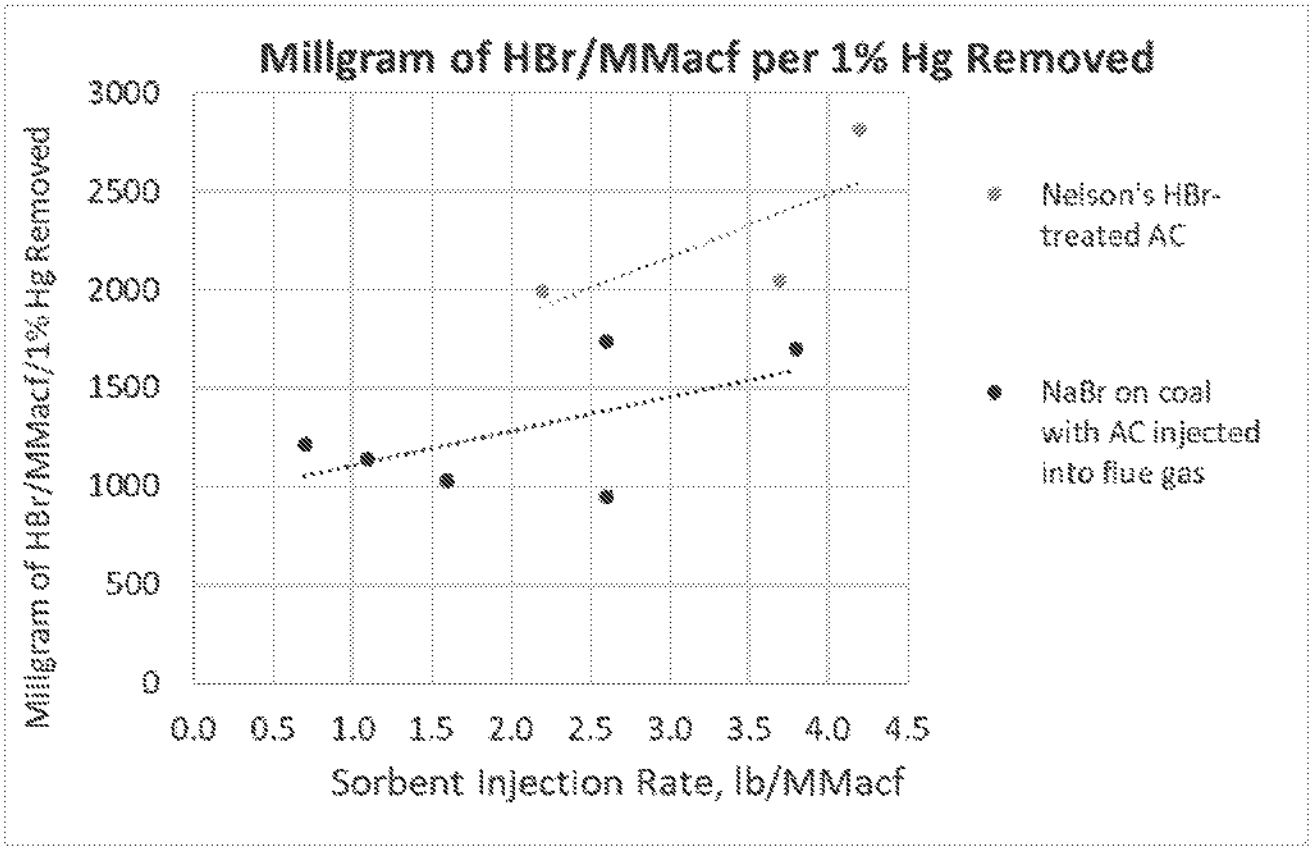
With NaBr added to the coal and activated carbon injected into the flue gas, there was a significant reduction in the amount of sorbent required to acheive similar mercury removal compared to the activated carbon treated with Br_2 outside the flue gas. For example, to acheive 70% mercury removal, 2.5 lb/MMacf of Br_2-treated carbon was required, as compared to 1.6 lb/MMacf with NaBr added to the coal and activated carbon injected into the flue gas; an additional (2.5-1.6/1.6)*100% or 56% treated sorbent was required to achieve the same leval of mercury removal. See, Declaration B at items 2-5 and 12.

The percent mercury removal per 1 wt% HBr versus the sorbent injection rate was compared with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas using the pilot-scale plant, and with Nelson's activated carbon treated with HBr outside the flue gas. The data for Nelson's activated carbon treated with HBr outside the flue gas was taken directly from Nelson. The first plot given in Declaration B at item 13 is reproduced below, but only showing the HBr data.



The data in the plot above, derived from the first plot at item 13 of Declaration B, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 2x) percent mercury removal per 1 wt% HBr at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas. See, Declaration B at item 14.

The data from the pilot-scale plant was also plotted to show the milligrams of HBr/MMacf per 1% mercury removal versus the sorbent injection rate with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for Nelson's activated carbon treated with HBr outside the flue gas. The second plot given in Declaration B at item 13 is reproduced below.



The data in the plot above, derived from the second plot at item 13 of Declaration B, show that NaBr added to coal prior to introduction to the furnace with injection of untreated activated

carbon into the flue gas provided a significantly lower milligrams of HBr/MMacf per 1% mercury removal at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas, indicating more efficient (approximately 2x) use of HBr for mercury removal during in-flight promotion of activated carbon than treatment of activated carbon outside the flue gas. See, Declaration B at item 14.

As explained at item 9 of Declaration D, Nelson's experimental setup in Examples 5 and 7 and the experimental setup described at item 8 of Declaration B inject activated carbon sorbent into a flue gas upstream of an ESP and use no scrubber, making the procedures comparable. However, the higher HCl concentration in Nelson's Example 7 flue gas allows for easier mercury removal, due to HCl acting as a promotor of the activated carbon, as compared to the pilot-scale setup described at item 8 of Declaration B. Further, the higher mercury concentration in Nelson's Example 5 makes it easier for Nelson's sorbents to remove the same overall percentage of mercury from the flue gas, as compared to the pilot-scale setup described at item 8 of Declaration B. Therefore, if Nelson's Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson's sorbents would remove a lower percentage of mercury than found in Nelson's Examples 5 and 7, meaning that Nelson's sorbents would exhibit an even lower (and less efficient) percent mercury removal per 1 wt% HBr at any sorbent injection rate than shown in the second plot above (derived from the first plot at item 13 of Declaration B), and would exhibit an even higher (and less efficient) milligrams of HBr/MMacf per 1% mercury removal at any sorbent injection rate than shown in the third plot above (derived from the second plot at item 13 of Declaration B).

I(B)(2). There is no way a person of ordinary skill in the art could predict that in-flight promotion of a sorbent with HBr or Br^- promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas.

The M.P.E.P. at the beginning of § 2143.02 states (emphasis added) "[a] rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, *and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.*"

As admitted by the Office Action, Felsvang fails to describe or suggest HBr or Br^- promoters. Felsvang also fails to describe or suggest that treatment of an activated carbon with a HCl or Cl^- additive outside of flue gas has any advantages over in-flight promotion of an activated carbon with an HCl or Cl^- promoter. Further, as shown herein at **I(D)**, treatment of activated carbon outside the flue gas with HCl provides better mercury removal than in-flight promotion of activated carbon with HCl or Cl^-. Therefore, a person of ordinary skill in the art hypothetically having Felsvang in-hand would have no clue that in-flight promotion of activated carbon with a halide could give the same or better percent mercury removal over halide treatment outside of the flue gas, and would be led away from Felsvang's process if they investigated the relative mercury removal of treatment of the activated carbon with HCl or Cl^- outside the flue gas versus in-flight treatment with HCl or Cl^- in the flue gas.

Nelson mentions treating activated carbon outside of flue gas, and then adding the activated carbon to flue gas. Nelson fails to describe or suggest in-flight promotion of an activated carbon with a halide in the flue gas. Therefore, a person of ordinary skill in the art hypothetically having Nelson in-hand would *also* have no idea that in-flight promotion of activated carbon with a halide could have any advantages over halide treatment outside of the flue gas.

There is no way to predict from the presently cited references the superior mercury capture discovered by the present inventors that occurs when activated carbon is promoted with HBr or Br^- promoters in-flight in the mercury-containing gas, as occurs when following the present claims. The Office Action states at the end of the second full paragraph on page 4 that Nelson's additives would be combined with Felsvang's process "...so as to provide an effective carbon sorbent for mercury." However, a person of ordinary skill in the art would have no idea that in-flight promotion with HBr or Br^- promoters could work better than Nelson's HBr-treatment outside the flue gas. Felsvang fails to describe or suggest that in-flight promotion provides a sorbent with even the same (let alone superior) properties as a sorbent treated outside the flue gas, and, as explained herein at **I(D)**, treatment of activated carbon outside the flue gas with HCl actually provides better mercury removal than in-flight promotion of activated carbon with HCl or Cl^-; similarly, Nelson fails to describe in-flight promotion, let alone that in-flight promotion provides the same or superior mercury removal ability as compared to treatment outside the flue gas.

The only way that a person of ordinary skill in the art could discover that in-flight promotion of activated carbon with HBr or Br^- promoters is more effective for mercury removal than HBr treatment outside the flue gas would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then compare the mercury removal of Felsvang's modified process to Nelson's sorbent treated outside the flue gas.[8] However, the person of ordinary skill carrying out such a combination would be surprised to find that in-flight promotion with HBr or Br^- is more effective for mercury removal than HBr treatment of the sorbent outside the flue gas. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claim 1 is patentable over Felsvang in view of Nelson for at least this additional reason.

I(B)(3). Reply to Examiner's response to arguments.

The Office Action states:

> The applicant contends that the bromide promoters are more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas. The applicant further provides a graph to demonstrate these unexpected results.

[8] In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

These unexpected results are not commensurate with the scope of the claims. The applicant is claiming HBr and Br- while the graph only demonstrates HBr. Further the comparisons between the prior art and that of the current invention do no demonstrate unexpected results. The applicants data is unclear as it is either HBr (as specified in the actual graph) or NaBr (as specified in the legend). Further the 18.2 data point has no labeling on what the promoter is. None of the data point include what amount is being specified, wt%, vol% etc. The results would be expected by one having ordinary skill in the art as the wt% (if we are to assume the amount specified is wt) of the amount supported on the upper most line is greater than that of the wt% on the middle trending line. Further claim 1 does not include NaBr on coal. Lastly is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods.

As explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na^+ and Br^-. Therefore, placing NaBr on the coal (as specified in the legend of the plot given at item 11 of Declaration B) results in formation of HBr and Br^- in the flue gas (as specified in the graph), and the results shown are commensurate with the scope of the claims. In the graphs in Declaration B all halides in the flue gas formed from halide salts placed on the coal are assumed to be in the form of the respective hydrogen halide for comparative purposes, although these could be in the form of the gaseous halide salt or the hydrogen halide—this assumption is made for consistency across all the graphs in Declaration B. As the graphs show trends between %Hg removal and halide content of the flue gas, so long as the amounts of the different halides present in the flue gas are compared in a consistent way it does not matter whether they are in the form of the hydrogen halide or the halide ion in the flue gas for purposes of comparing relative %Hg removal.

The data table at item 10 of Declaration B shows that the 18.2 data point of the plot shown at item 11 corresponds to 18.2 wt% HBr, and that all of the labels on the data set "NaBr on coal with AC injected into flue gas" indicate wt% HBr. Additionally, for increased clarity, Declaration B is revised to indicate wt% and properly labels the 18.2 data point in the plot shown at item 11.

The Office Action states that the results would be expected by one having ordinary skill in the art because the amount of HBr on the upper line, representing NaBr on coal with AC injected into the flue gas, are greater than the wt% of the middle trending line, representing AC treated with

5 wt% bromine outside the flue gas as per the Nelson procedure. Applicant does not agree that the results are not unexpected. The unexpected results described in the Response are that in-flight promotion of a sorbent with HBr or Br^- promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas (as explained herein at **I(B)**, using the first and second plots from item 13 of Declaration B), and that in-flight promotion with HBr or Br^- promoters is more effective for mercury removal than in-flight promotion with HCl or Cl^- promoters (as explained herein at **I(C)**). Applicant included the plot at item 11 primarily to show that adding NaBr to coal and injecting untreated AC into the flue gas is an effective way to remove mercury.

The Office Action states that it is not clear whether the results are because of different components being reacted or because of the different method being used. However, all of the data shown in the plot at item 11 of Declaration B is shown in the tables at items 9 and 10 of Declaration B, which is all derived from the same pilot-scale test unit described at item 8 of Declaration B, using the same components, the same type of AC, and the same method, with the only variations between the data sets being the type of treatment of the AC (i.e., no treatment, treatment with Br_2 outside the flue gas prior to injection, and adding NaBr to coal while injecting untreated AC into the flue gas); item 11 of Declaration B has been revised to clarify this point.

The Office Action states:

> The second graph on page 12 comparing NaBr on coal to HBr treated AC and it is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. To do that the graph would have to be comparing HBr in the present method to HBr in the prior art method. Further the applicant has not shown the amount of promoter supported by each (wt%) data point. Lastly claim 1 does not include NaBr on coal.

The second graph on page 12 of the last Response was the first graph from item 13 of Declaration B. The Office Action states that the components used must be the same for both methods, such that the graph compares HBr in the present method to HBr in the prior art method. However, as explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na^+ and Br^-. Therefore, placing NaBr on the coal results in formation of

HBr and Br^- in the flue gas. All of the NaBr is assumed to be converted to HBr in the graph, such that the components being compared are the same for both methods.

Although the data set "NaBr on coal with AC injected into flue gas" is shown in the table in item 10 and is derived from the pilot-scale test unit described at item 8 of Declaration B, while the data set "Nelson's HBr-treated AC" is from Nelson, as explained at item 9 of Declaration D and at **I(B)(1)** herein, data from Nelson's experimental setup and from the pilot-scale unit of item 8 of Declaration B are validly comparable----further, Nelson's conditions used in Examples 5 and 7 allow for easier mercury removal than in the pilot-scale unit of item 8 of Declaration B, such that if Nelson's Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson's sorbents would remove a lower percentage of mercury than found in Nelson's Examples 5 and 7.

The Office Action states that "the application has not shown the amount of promoter supported by each (wt%) data point." However, the y-axis indicates the percent mercury removal per 1 wt% HBr; therefore, the wt% promoter data is part of what is shown on the graph. Further, the table at item 10 indicates the specific amount of HBr for each data point.

The Office Action states:

> The third graph on page 13 compares HBr treated AC and NaBr on coal with AC injected into flue gas. The graph states Milligram of HBr/MMacf/1%Hg Removed. As HBr is not a part of the current application data points it is unclear how to interpret this graph. Claim 1 does not include NaBr on coal. Further is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods

The third graph on page 13 of the last Response was the second graph from item 13 of Declaration B. The Office Action states that HBr is not a part of the current application data points, and that claim 1 does not include NaBr on coal. However, as explained in Declaration C at item 28, when NaBr is added to coal, gaseous NaBr is formed in the flue gas, and HBr is formed in the flue gas. As explained in Declaration C at item 33, NaBr is a salt that includes Na^+ and Br^-. Therefore, placing NaBr on the coal results in formation of HBr and Br^- in the flue gas. All of the NaBr is assumed to be converted to HBr in the graph, such that the components being compared are the same for both methods.

Although the data set "NaBr on coal with AC injected into flue gas" is shown in the table in item 10 and is derived from the pilot-scale test unit described at item 8 of Declaration B, while the data set "Nelson's HBr-treated AC" is from Nelson, as explained at item 9 of Declaration D and at **I(B)(1)** herein, data from Nelson's experimental setup and from the pilot-scale unit of item 8 of Declaration B are validly comparable—further, Nelson's conditions used in Examples 5 and 7 allow for easier mercury removal than in the pilot-scale unit of item 8 of Declaration B, such that if Nelson's Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson's sorbents would remove a lower percentage of mercury than found in Nelson's Examples 5 and 7.

The Office Action states:

> The applicant contends that there is no way a person of ordinary skill in the art could predict from the cited references that in-flight promotion of a sorbent with bromide promoters is more effective for mercury removal.
>
> The examiner contends that the applicant has not established that it is more effective.

Applicant respectfully disagrees. As explained above, the data does provide evidence that in-flight promotion of a sorbent with HBr or Br^- promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas.

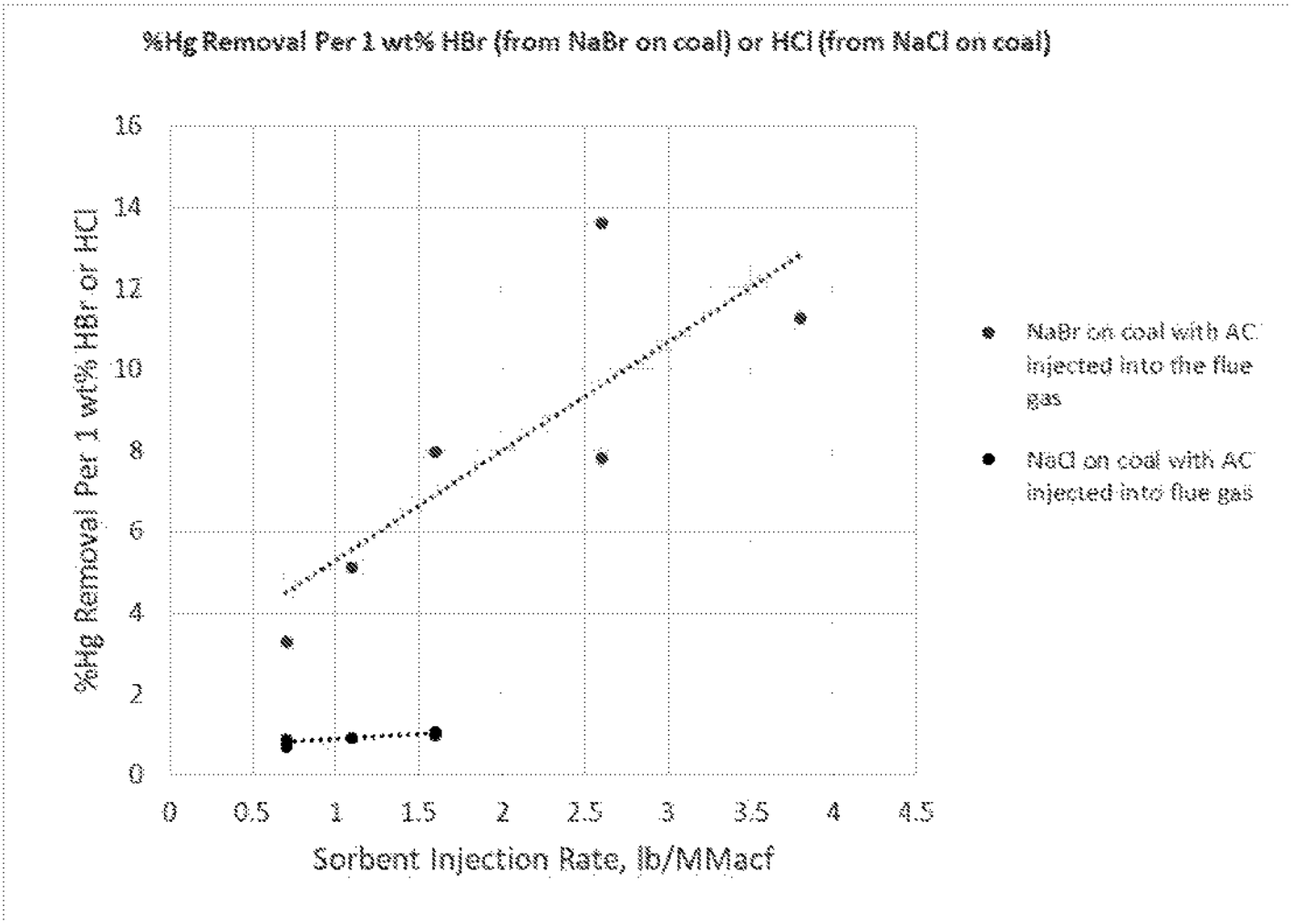
I(C). In-flight promotion with HBr or Br^- versus HCl or Cl^-.

I(C)(1). In-flight promotion with HBr or Br^- promoters is more effective for mercury removal than in-flight promotion with HCl or Cl^- promoters.

The inventors of the present application have discovered that that in-flight HBr or Br^- promotion of an activated carbon in a mercury-containing flue gas is significantly more effective for mercury removal than in-flight HCl or Cl^- promotion of an activated carbon.

As explained in Declaration B, pilot-scale testing was performed with NaBr or NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-10. The

first plot given in Declaration B at item 13 is reproduced below, but not showing the data from Nelson's HBr-treated AC.



The data in the plot above, derived from the first plot at item 13 of Declaration B, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 6-8x) percent mercury removal per 1 wt% HBr or HCl at all tested sorbent injection rates compared to the NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, Declaration B at item 14.

I(C)(2). There would be no way for a person of ordinary skill in the art to predict this advantage from the from the cited references.

As explained herein at **I(A)(2)(d)**, Nelson fails to describe or suggest that treatment of activated carbon with HBr or Br^- could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang.

The only way that a person of ordinary skill in the art could discover that in-flight promotion with HBr or Br^- promoters is more effective for mercury removal than in-flight promotion with HCl or Cl^- promoters would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then to compare the mercury removal of Felsvang's modified process to Felsvang's original process.[9] However, the person of ordinary skill carrying out such a combination would be surprised to find that promotion of activated carbon with HBr or Br^- could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claim 1 is patentable over Felsvang in view of Nelson for at least this additional reason.

I(C)(3). Reply to Examiner's response to arguments.

The Office Action states:

[9] In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

The applicant contends that one having ordinary skill in the art would not have predicted in-flight chloride promotion of activated carbon to be more effective for mercury removal that in-fligh chloride promotion.

The examiner disagrees. Nelson discloses that bromide is a better promoter of AC for the

II(C)(1). The applicant contends that one having ordinary skill in the art would not have predicted in-flight chloride promotion of activated carbon to be more effective for mercury removal that in-fligh chloride promotion.

The examiner disagrees. Nelson discloses that bromide is a better promoter of AC for the purpose of mercury removal as shown above. Therefore one having ordinary skill in the art would expect an inflight bromide promoted sorbent to superior to and inflight chloride promoted sorbent.

The applicant argues that one having ordinary skill in the art would not predict this advantage from the cited references.

The examiner disagrees for the reasons stated above.

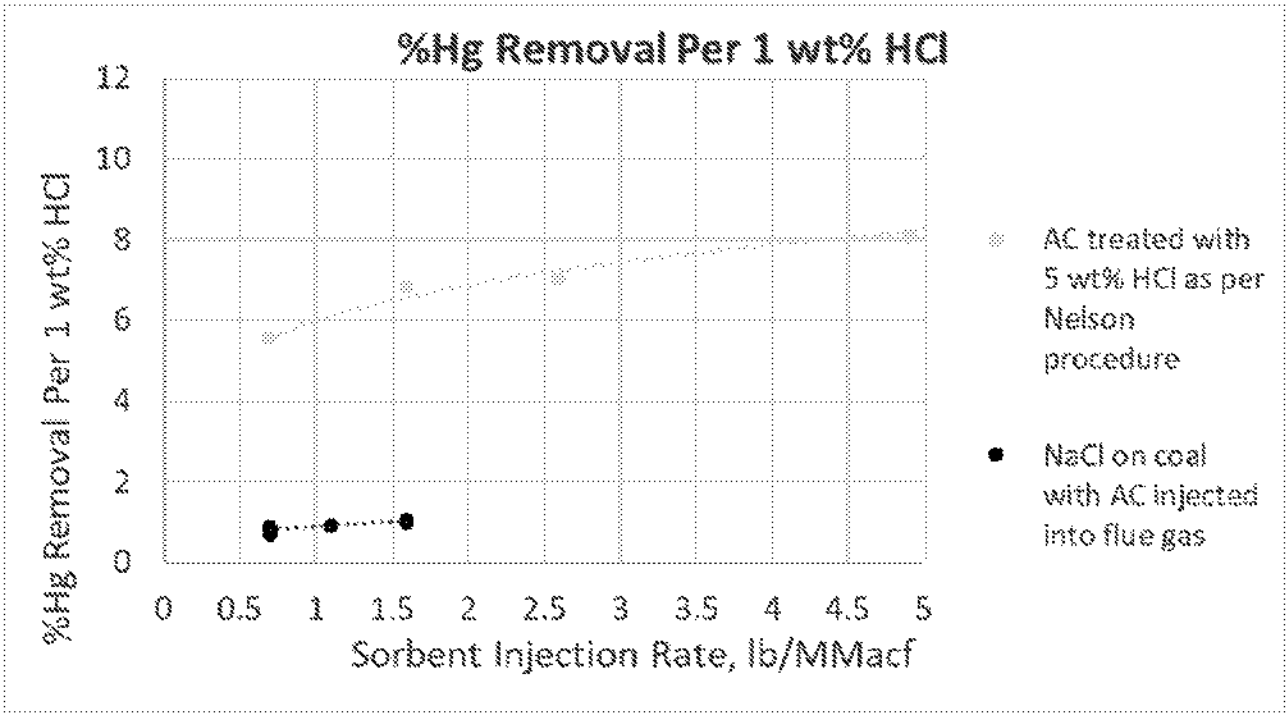
However, as explained herein at **I(A)(2)(d)** and **I(A)(3)**, Nelson fails to describe or suggest that HBr-treatment of activated carbon provides better mercury removal ability than HCl-treated activated carbon; therefore, there is no way one of ordinary skill in the art could reasonably predict from Felsvang and Nelson that treatment of activated carbon with HBr or Br^- could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang.

I(D). A person of ordinary skill in the art would find that treatment of activated carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl^- in the flue gas.

I(D)(1). Even if a person of ordinary skill in the art compared the mercury removal of Felsvang to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties per wt% HCl.

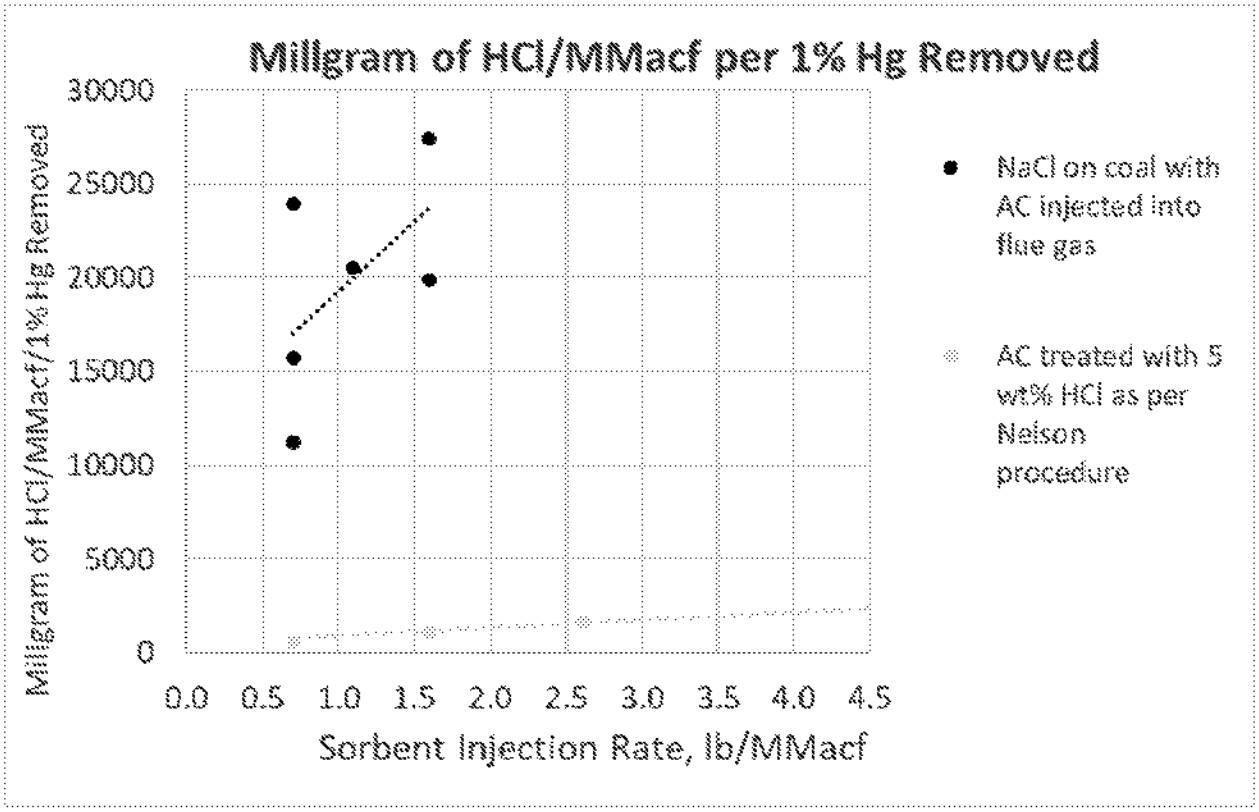
As explained herein at **I(A)(2)(c)**, Felsvang fails to describe or suggest that in-flight promotion of activated carbon with HCl or Cl^- in the flue gas provides better mercury removal than treatment of activated carbon outside the flue gas with HCl. A person of ordinary skill would notice the extremely poor improvement (if any improvement actually occurred) caused by addition of activated carbon in Felsvang's sole Example showing the use of activated carbon (Example 4) (see **I(A)(2)(c)** herein) and would question whether Felsvang's process is an efficient way to use activated carbon for mercury removal as compared to Nelson's process. Merely for the sake of argument, if one of ordinary skill in the art were to investigate Felsvang's embodiments including activated carbon and compare the relative mercury-removal ability to that of activated carbon treated with HCl outside the flue gas, as explained below, they would find that treatment of activated carbon outside the flue gas with HCl as per Nelson's process actually provides more effective mercury removal per wt% HCl than treatment of activated carbon with HCl or Cl^- in the flue gas, which would lead one of ordinary skill in the art away from using Felsvang's process.

As explained in Declaration B, pilot-scale testing was performed with activated carbon treated with HCl outside the flue gas as per the Nelson procedure (see, Declaration B at item 7), and with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, Declaration B at items 8-10. The first plot given in Declaration B at item 15 is reproduced below.



The data in the plot above from the item 15 of the Declaration B show that activated carbon treated with HCl outside the flue gas as per the Nelson procedure provided a much higher percent of mercury removal per 1 wt% HCl at all tested sorbent injection rates as compared to NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, Declaration B at item 16.

The pilot-scale data was also plotted to show the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure. The second plot given in Declaration B at item 15 is reproduced below.



The data in the second plot above from item 15 of Declaration B show that the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas was significantly higher as compared to the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure, indicating more efficient use of HCl for mercury removal by treatment of activated carbon outside the flue gas than by promotion in-flight.

I(D)(2). Reply to response to arguments.

The Office Action states:

> *The applicant contends that "Even if a person of ordinary skill in the art compared the mercury removal of Feiyang's activated carbons promoted with Chloride in the flue gas to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties".*

> This appears to be merely conjecture by the applicant as no factual evidence has been presented.
>
> The graphs on pages 18 and 19, has NaCl compared to HCl, it is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. Further the examiner points to the y-axis which has HCl which is not included in one set (NaCl) of the data points so it is unclear how the data points are being obtained.

The Office Action states that Applicant's contention that a person of ordinary skill in the art comparing Felsvang's process to treatment of activated carbon with HCl outside the flue gas would find that in-flight promotion provides less mercury removal is conjecture and is unsupported by factual evidence. However, Applicant's contention is not conjecture and is supported by data provided in Declaration B, as described herein at **I(D)(1)**; therefore, Applicant does not understand this statement of the Office Action.

The Office Action states that the graphs have NaCl compared to HCl, and that the y-axis has HCl which is not included in one set (NaCl) of the data points so it is unclear how the data points are being obtained. However, as explained in Declaration C at item 28, when NaCl is added to coal, gaseous NaCl is formed in the flue gas, and HCl is formed in the flue gas. NaCl is a salt that includes Na^+ and Cl^-. Therefore, placing NaCl on the coal results in formation of HCl and Cl^- in the flue gas. In the graphs in Declaration B all halides in the flue gas formed from halide salts placed on the coal are assumed to be in the form of the respective hydrogen halide for comparative purposes, although these could be in the form of the gaseous halide salt or the hydrogen halide—this assumption is made for consistency across all the graphs in Declaration B. As the graphs show trends between %Hg removal and halide content of the flue gas, so long as the amounts of the different halides present in the flue gas are compared in a consistent way it does not matter whether they are in the form of the hydrogen halide or the halide ion in the flue gas for purposes of comparing relative %Hg removal.

The Office Action states that in order to establish that the method being used has unexpected results the components used must be the same for both methods. However, the data sets in the first and second plots at item 15 of Declaration B were taken from the table at item 10, which was produced using the same pilot-scale setup described at item 8, using the same components, the same

type of AC, and the same method, with the only variations between the data sets being the type of treatment of the AC (i.e., AC treated with 5 wt% HCl outside the flue gas prior to injection into the flue gas, or placing NaCl on the coal and injection of untreated AC into the flue gas); item 15 of Declaration B has been revised to clarify this point.

I(E). Objective evidence of non-obviousness of the claimed invention.

Applicant herein discusses objective evidence of nonobviousnesss presented in Declaration A. The M.P.E.P. at §716.01(a) states that:

> Affidavits or declarations, when timely presented, containing evidence of criticality or unexpected results, commercial success, long-felt but unsolved needs, failure of others, skepticism of experts, etc., must be considered by the examiner in determining the issue of obviousness of claims for patentability under 35 U.S.C. 103.

The M.P.E.P. at §716.01(d) states that:

> When an applicant timely submits evidence traversing a rejection, the examiner must reconsider the patentability of the claimed invention. The ultimate determination of patentability must be based on consideration of the entire record, by a preponderance of evidence, with due consideration to the persuasiveness of any arguments and any secondary evidence.

As explained in Declaration A at items 1-6, before the priority date of the presently claimed invention, the EPA called for new mercury removal technology in the 1990s, evidencing recognition of a problem and long-felt but unsolved needs that the presently claimed invention provides a solution for.

As explained in Declaration A at items 7-8, before the priority date of the presently claimed invention, the EPA espoused the conventional wisdom in favor of pre-treated sorbents, not in-flight sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others.

As explained in Declaration A at items 9-11, before the priority date of the presently claimed invention, Sidney Nelson touted brominated sorbent, not in-flight sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others.

As explained in Declaration A at items 12-13, after the priority date of the presently claimed invention, the EPA continued to teach away from in-flight sorbent enhancement in the flue gas, evidencing a teaching away from the presently claimed invention by others and skepticism by experts that the presently claimed invention could provide effective and efficient mercury control.

As explained in Declaration A at items 14-15, before the priority date of the presently claimed invention, the Department of Energy funded research into in-flight sorbent enhancement in the flue gas, evidencing recognition of a problem and long-felt but unsolved needs that the presently claimed invention provides a solution for.

As explained in Declaration A at item 16, after the priority date of the presently claimed invention, in-flight sorbent enhancement in the flue gas was finally recognized as a critical advancement, evidencing praise by others for the presently claimed invention.

As explained in Declaration A at items 17-19, after the priority date of the presently claimed invention, in-flight sorbent enhancement in the flue gas experienced commercial success and was copied by Sidney Nelson and other competitors, evidencing copying of the presently claimed invention by others.

Dependent claims 4 and 6-20 are directly or indirectly dependent on independent claim 1. As such, these claims incorporate all the features of claim 1. Accordingly, dependent claims 4 and 6-20 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 1, 4, and 6-20 under 35 U.S.C. § 103(a) over Nelson in view of Felsvang.

Double Patenting Rejections

II. Double patenting rejections.

II(A). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 7,435,286 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-30 of U.S. patent no. 7,435,286 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(B). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-25 of patent no. 8,168,147 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-25 of U.S. patent no. 8,168,147 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(C). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,512,655 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-60 of U.S. patent no. 8,512,655 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(D). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,821,819 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-60 of U.S. patent no. 8,821,819 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(E). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-33 of U.S. patent no. 9,757,689 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-33 of U.S. patent no. 9,757,689 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(F). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of U.S. patent no. 9,468,886 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-20 of U.S. patent no. 9,468,886 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(G). The Office Action rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,652,235 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-30 of U.S. patent no. 8,652,235 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(H). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/295,594 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-16 of copending application no. 15/295,594 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(I). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 8-20 of copending application no. 15/589,359 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 8-20 of copending application no. 15/589,359 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(J). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(K). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 14/712,558 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-20 of copending application no. 14/712,558 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(L). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/951,970 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-20 of copending application no. 15/951,970 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(M). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/382,114 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-20 of copending application no. 15/382,114 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(N). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang. This rejection appears to be a duplicate of the rejection listed herein at **II(J)**.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(O). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/978,760 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-20 of copending application no. 15/978,760 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

II(P). The Office Action provisionally rejected claims 1, 4, and 6-20 on the ground of nonstatutory double patenting over claims 1-10, 14, and 21-25 of copending application no. 15/974,343 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1, 4, and 6-20 are obvious over claims 1-10, 14, and 21-25 of copending application no. 15/974,343 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

CONCLUSION

It is respectfully submitted that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 349-9580 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402-0938
(612) 373-6900

Date July 10, 2019

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A method for reducing mercury in a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, the coal[[that]] compris[[es]]ing an additive comprising Br_2, HBr, [[Br^-]]a bromide compound, or a combination thereof, to form the mercury-containing gas; ~~wherein the combusting of the coal is performed at a coal-combustion facility site~~;

collecting mercury in the mercury-containing gas [[on]]with a sorbent comprising~~to produce a cleaned gas, wherein the sorbent comprises a promoted~~ activated carbon~~that is promoted in flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter comprising HBr, Br^-, or a combination thereof~~.

2.-3. (Canceled)

4. (Canceled)

5. (Canceled)

6. (Canceled)

7. (Canceled)

8. (Canceled)

9. (Original) The method of claim 1, further comprising injecting an alkaline sorbent into the mercury-containing gas stream.

10. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

11. (Canceled)

12. (Original) The method of claim 1, wherein the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof.

13. (Canceled)

14. (Canceled)

15. (Canceled)

16. (Currently Amended) The method of claim 1, wherein the sorbent has a composition comprising from about 1 to about 30 grams of ~~promoter~~the element bromine per 100 grams of activated carbon.

17. (Canceled)

18. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas.

19. (Currently Amended) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas [[on]]with the sorbent.

20. (Currently Amended) The method of claim 1, ~~wherein the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method~~ further comprising:

~~monitoring~~measuring mercury content of ~~the cleaned gas~~the mercury-containing gas; and

~~controlling~~modifying, in response to the ~~monitored~~measured mercury content ~~of the cleaned gas~~.

an injection rate of injecting [[a]]the sorbent comprising activated carbon into the mercury-containing gas,

~~a rate at which the~~an amount of the additive comprising the Br_2, HBr, bromide compound, or a combination thereof ~~promoter is~~ added to the coal~~sorbent comprising activated carbon~~, or

a combination thereof~~,~~

~~so that the mercury content of the cleaned gas is maintained at or below the desired level~~.

21. (New) The method of claim 20, wherein the measuring of the mercury content of the mercury-containing gas is performed substantially continuously.

22. (New) The method of claim 1, further comprising:

modifying, in response to a measured mercury content,

an injection rate of injecting the sorbent comprising activated carbon into the mercury-containing gas,

an amount of the Br_2, HBr, bromide compound, or a combination thereof, added to the coal, or

a combination thereof.

23. (New) The method of claim 1, wherein the coal comprises a subbituminous coal.

24. (New) The method of claim 1, wherein the coal comprises a lignite coal.

25. (New) The method of claim 1, wherein the coal comprises the added Br_2, HBr, the bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber.

26. (New) The method of claim 1, wherein the combustion chamber comprises the added Br_2, HBr, the bromide compound, or a combination thereof.

27. (New) The method of claim 1, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br_2, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br_2, HBr, bromide compound, or combination thereof, to the coal is performed at the coal-combustion facility.

28. (New) The method of claim 1, wherein the coal is combusted in the combustion chamber at a coal-combustion facility, wherein the Br_2, HBr, bromide compound, or combination thereof, is added to the coal before the coal enters the combustion chamber, wherein the addition of the Br_2, HBr, bromide compound, or combination thereof, to the coal is performed at a site other than the coal-combustion facility.

29. (New) The method of claim 1, wherein the combustion chamber is an electric utility coal combustion chamber.

30. (New) The method of claim 1, wherein the combustion chamber is a coal combustion furnace.

31. (New) The method of claim 1, wherein the mercury-containing gas comprises about 1 g to about 30 g of the element bromine per 100 g of the sorbent.

32. (New) The method of claim 1, wherein the sorbent that collects the mercury comprises the element bromine and mercury.

33. (New) The method of claim 1, wherein the sorbent in the mercury-containing gas comprises about 1 g to about 30 g of the added Br_2, HBr, the bromide compound, or a combination thereof, per 100 g of the sorbent.

34. (New) The method of claim 1, wherein the Br_2, HBr, or the bromide compound is contacted with the sorbent in vapor form, gaseous form, liquid form, or in an organic solvent.

35. (New) The method of claim 1, wherein the sorbent injected into the mercury-containing gas is a sorbent obtained by contacting a base sorbent with a halogen or halide promoter prior to injection of the sorbent to the mercury-containing gas.

36. (New) The method of claim 1, wherein the sorbent injected into the mercury-containing gas is free of contact with a halogen or halide promoter prior to injection of the sorbent into the mercury-containing gas.

37. (New) The method of claim 1, wherein the injection of the sorbent into the mercury-containing gas occurs upstream of a particulate separator or a scrubber.

38. (New) The method of claim 37, wherein the particulate separator comprises an electrostatic precipitator, a baghouse, a fabric filter, or a combination thereof.

39. (New) The method of claim 1, wherein the coal comprises added halide sorbent enhancement additive that comprises the added Br_2, HBr, the bromide compound, or combination thereof.

40. (New) The method of claim 1, wherein the sorbent enhancement additive comprises the bromide compound.

41. (New) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, wherein

the coal comprises added Br_2, HBr, bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br_2, HBr, bromide compound, or a combination thereof, or

a combination thereof;

collecting mercury in the mercury-containing gas with a sorbent comprising activated carbon.

42. (New) A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein the mercury-containing gas comprises a halogen or halide promoter comprising HBr, Br^-, or a combination thereof, wherein

the coal comprises added Br_2, HBr, bromide compound, or a combination thereof, added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises added Br_2, HBr, bromide compound, or a combination thereof, or

a combination thereof;

collecting mercury in the mercury-containing gas with a sorbent comprising activated carbon;

separating the sorbent contacted with the mercury from the mercury-containing gas;

measuring the mercury content of the mercury-containing gas; and

modifying, in response to the measured mercury content of the mercury-containing gas,

an injection rate of injecting the sorbent into the mercury-containing gas,

an amount of the Br_2, HBr, bromide compound, or a combination thereof, added to the coal or the combustion chamber, or

a combination thereof.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/997,091 Group Art Unit: 1776
Filed: June 4, 2018 Docket No.: 4820.001U10
Confirmation No.: 5161
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.116

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant has received the Final Office Action dated January 11, 2019. Please enter the following.

This response is accompanied by a Petition, as well as the appropriate fee, to obtain a three-month extension of the period for responding to the Office Action, thereby moving the deadline for response from April 11, 2019 to July 11, 2019.

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-10,343,114	7/9/2019	Olson, Edwin S, et al.
	US-20120100053A1	4/26/2012	Durham, Michael D, et al.
	US-20130157845A1	6/20/2013	Nalepa, Christopher J, et al.

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Foreign Document Number	Publication Date	Name of Patentee or Applicant of cited Document	T1
	WO-2012030560A1	3/8/2012	Nalepa, Christopher J, et al.	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T1
	"Application Serial No. 15/382,114, Final Office Action mailed 06-21-19", 31 pgs	
	"Application Serial No. 15/589,359, Advisory Action mailed 05-22-19", 3 pgs	
	"Application Serial No. 15/589,359, Non Final Office Action mailed 06-21-19", 7 pgs	
	"Application Serial No. 15/978,760, Notice of Allowability mailed 05-30-19", 3 pgs	
	"Application Serial No. 15/978,760, Notice of Allowance mailed 05-08-19", 7 pgs	

EXAMINER **DATE CONSIDERED**

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.	Examiner: Amber Orlando
Serial No.: 15/997,091	Group Art Unit: 1776
Filed: June 4, 2018	Docket: 4820.001U10
Customer No.: 21186	Confirmation No.: 5161

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

INFORMATION DISCLOSURE STATEMENT

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. Applicant respectfully requests that this Information Disclosure Statement be entered and the documents listed on the attached PTO 1449 Form be considered by the Examiner and made of record. Pursuant to the provisions of MPEP 609, Applicant requests that a copy of the PTO 1449 Form, initialed as being considered by the Examiner, be returned to the Applicant with the next official communication.

Pursuant to 37 C.F.R. § 1.97(b), it is believed that no fee or statement is required with the Information Disclosure Statement. However, if an Office Action on the merits has been mailed after filing of the application or after the filing of the most recent RCE, the Commissioner is hereby authorized to charge the required fees to Deposit Account No. 19-0743 in order to have this Information Disclosure Statement considered.

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicant acknowledges the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date July 10, 2019 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:mlr1

REQUEST FOR CONTINUED EXAMINATION (RCE) TRANSMITTAL		
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Confirmation Number	5161
	Group Art Unit	1776
	Examiner Name	Amber Orlando
	Attorney Docket Number	4820.001U10
	Customer No.	21186

This is a Request for Continued Examination (RCE) under 37 C.F.R § 1.114 of the above-identified application entitled SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

1. Submission required under 37 C.F.R. § 1.114:

   X Amendment and Response Under 37 C.F.R § 1.116 (80 pages) is enclosed.

   X Certification and Request for Prioritized Examination (Track 1) (1 pg)

   X Information Disclosure Statement (2 pages). Form 1449 (1 page), and copies of cited documents (6).

   X Petition for Extension of Time (1 pg).

   X DECLARATION UNDER 37 C.F.R. § 1.132 (A) (11 pgs), (B) (12 pgs), (C) (16 pgs), and (D) (6 pgs)

2. Fees

   X Authorization to charge deposit account 19-0743 in the amount of $1300.00 to pay the RCE filing fee required under 37 C.F.R. § 1.17(e).

   X Authorization to charge Deposit Account 19-0743 in the amount of $4000.00 for the Prioritized Examination (Track 1) filing fee as set forth in 37 C.F.R. § 1.17(c); and Authorization to charge Deposit Account 19-0743 for the Processing Fee (Track 1) set forth in 37 C.F.R. § 1.17(i) in the amount of $140.00.

   X Authorization to charge deposit account 19-0743 in the amount of $1400.00 to pay the extension of time fee.

   X Authorization to charge deposit account 19-0743 in the amount of $1000.00 to cover the fee for additional claims.

The fee for additional claims has been calculated as follows:

CLAIMS AS AMENDED						
	Claims Remaining After Amendment		**Highest Number Previously Paid For**	**Present Extra**	Rate	**Fee**
TOTAL CLAIMS	**30**	-	**20**	**10**	**x 100.00 =**	**1000.00**
INDEPENDENT CLAIMS	**3**	-	**3**	**0**	**x 460.00 =**	**0.00**
[] MULTIPLE DEPENDENT CLAIMS PRESENTED						**0.00**
TOTAL						**1000.00**

The Commissioner is hereby authorized to charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.

/ Nicholas P. Lanzatella /

By: Nicholas P. Lanzatella
Reg. No. 63,803

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(71) Applicant *(for all designated States except US)*: **ALBEMARLE CORPORATION** [US/US]; 451 Florida Street, Baton Rouge, LA 70801-1765 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **NALEPA, Christopher, J.** [US/US]; 3587 Jim East Avenue, Zachary, LA 70791 (US). **PICKRELL, William, S.** [US/US]; 16414 Round Rock Court, Baton Rouge, LA 70817 (US). **LAMBETH, Gregory, H.** [US/US]; 18226 Creek Hollow Road, Baton Rouge, LA 70817 (US). **ZHOU, Qunhui** [US/US]; c/o Albemarle Corporation, 451 Florida Street, Baton Rouge, LA 70801 (US).

(74) Agents: **HOEFLING, Marcy, M.** et al.; Albemarle Corporation, 451 Florida Street, Baton Rouge, LA 70801-1765 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

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WO 2012/030560 A1

(54) Title: IMPROVED SORBENTS FOR REMOVING MERCURY FROM EMISSIONS PRODUCED DURING FUEL COMBUSTION

(57) Abstract: Activated carbon is rendered more thermally stable by exposure to a non- halogenated additive, and optionally to a halogen and/or a halogen-containing compound. Such treated carbon is suitable for use in mitigating the content of hazardous substances in flue gases, especially flue gases having a temperature within the range of from about 100 °C to about 420 °C.

IMPROVED SORBENTS FOR REMOVING MERCURY FROM EMISSIONS PRODUCED DURING FUEL COMBUSTION

BACKGROUND

[0001] It has become both desirable and necessary to reduce the hazardous substance content of industrial flue gasses. The hazardous substances can have a deleterious affect on the public health and the environment. Industry and government have been working to reduce the emissions of such substances with good progress being made. Special focus has been on flue gas from coal-fired boilers, such as that found in electric generation plants. Recent focus has also been on emissions from cement kilns. But there is more to do. Hazardous substances include particulates, e.g. fly ash, acid gases, e.g. SOx, NOx, as well as dioxins, furans, heavy metals and the like.

[0002] The methods used to mitigate the emission of hazardous substances depend on the nature of the hazardous substance, the minimum emission level sought, the volume of emitted gas to be treated per unit time and the cost of the mitigating method. Some hazardous substances lend themselves to removal from gaseous effluent by mechanical means, e.g. capture and removal with electrostatic precipitators (ESP), fabric filters (FF) or wet scrubbers. Other substances do not lend themselves to direct mechanical removal.

[0003] Hazardous gaseous substances that are present in a gaseous effluent present interesting challenges, given that direct mechanical removal of any specific gaseous component from a gas stream is problematic. However, it is known, and an industrial practice, to remove hazardous gaseous components from a gaseous effluent by dispersing a fine particulate adsorbent evenly in the effluent to contact and capture, in flight, the targeted gaseous component. This is followed by mechanical removal of the adsorbent with its adsorbate from the effluent vapor by ESP, FF or wet scrubbers. A highly efficacious adsorbent is carbon, e.g., cellulosic-based carbons and coal-based carbons in a form such as powdered activated carbon (PAC). Such PACs, for example, can be used with or without modification. Modified PACs may enhance capture of the target hazardous substance by enhancing adsorption efficiency. PAC modification is exemplified by US 4,427,630; US 5,179,058; US 6,514,907; US 6,953,494; US 2001/0002387; US 2006/0051270; and US 2007/0234902. Cellulosic-

based carbons include, without limitation, carbons derived from woody materials, coconut shell materials, or other vegetative materials. Coal-based PACs include, without limitation, carbons derived from peat, lignite, bituminous, anthracite, or other similar sources.

[0004] A problem with the use of carbons in industrial applications, is their unreliable thermal stability, that is, the lack of assurance that they are resistant to self-ignition. Self-ignition is especially problematic when the carbon is used in the treatment of warm or hot gaseous effluents or when packaged or collected in bulk amounts. For example, bulk PAC is encountered (i) when the PAC is packaged, such as in super-sacks or (ii) when formed as a filter cake in an FF unit or is collected in silos or hoppers associated with an ESP, TOXECON unit, and baghouse. Self-ignition results from unmitigated oxidation of the carbon and can lead to its smoldering or burning. Self-ignition is exacerbated by the carbon being warm or hot, as could be the case when used in treating coal-fired boiler effluents. If oxygen (air) is not denied to the oxidation site or if the site is not cooled, the heat from the initial oxidation will propagate until the carbon smolders or ignites. Such an ignition can be catastrophic. Utility plants are especially sensitive about self-ignition as smoldering or fire within the effluent line can cause a plant shut-down with widespread consequences to served customers.

[0005] Further information on PAC thermal stability can be found in US 6,843,831, "Process for the Purification of Flue Gas." Some carbons are more resistant to self-ignition than others. For example, in the US, the use of coal-derived PACs is often employed for utility flue gas treatment, in part because of the generally recognized good thermal stability of coal-derived PACs.

[0006] It would be advantageous if PACs of lesser thermal stability, such as those derived from certain cellulosic-based carbons could be modified to be more thermally stable so that the practitioner could enjoy the benefit of the excellent adsorption qualities of cellulosic-based carbons. It would also be advantageous to improve the thermal stability of certain coal-based PACs, such as, those that are lignite-based, since even these carbons have been associated with self-ignition and smoldering events.

THE INVENTION

[0007] This invention meets the above-described needs by providing an activated carbon that has been exposed to a non-halogenated additive comprising sulfur, sulfuric acid, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally to a halogen and/or a halogen-containing compound, and that has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon without the exposure to the non-halogenated additive and, optionally, to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon without the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon without the exposure. It is believed that any one or more of the qualities recited in (i), (ii) and (iii) is indicative of an enhancement of the thermal stability of an activated carbon exposed to one or more non-halogenated additives, and optionally to a halogen and/or a halogen-containing compound, according to this invention as compared to the same activated carbon without the exposure. This invention also relates to a process for enhancing the thermal stability of activated carbon. The process comprises exposing the activated carbon to a non-halogenated additive comprising sulfur, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally, to a halogen and/or a halogen-containing compound, at a temperature and for a time sufficient so that the exposed activated carbon has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon without the exposure to the non-halogenated additive and, optionally to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon without the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon without the exposure. This invention also relates

to a process for mitigating the atmospheric release of gaseous hazardous substances from flue gases containing such substances, the process comprising contacting the flue gas with activated carbon that has been exposed to a non-halogenated additive comprising sulfur, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally, to a halogen and/or a halogen-containing compound, and that has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon without the exposure to the non-halogenated additive and, optionally to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon without the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon without the exposure.

[0008] The activated carbons of this invention can be, as before noted, derived from both cellulosic-based and coal-based materials.

[0009] The production of activated cellulosic-based carbons, e.g., wood-based PACs, is well known and generally entails either a thermal activation or chemical activation process. For more details see, *Kirk-Othmer Encyclopedia of Chemical Technology,* 4th Edition, Volume 4, pages 1015-1037 (1992). The activated wood-based carbon can be produced from any woody material, such as sawdust, woodchips, coconut shell materials, or other vegetative materials. The production of activated coal-based carbons, e.g., lignite-based PACs, are produced by similar processes.

[0010] Activated cellulosic-based carbons are commercially available. For example, activated wood-based carbons can be obtained from MeadWestvaco Corporation, Specialty Chemical Division. Activated coal-based carbons are also commercially available. Activated lignite-based carbons can be obtained from Norit Americas, Inc., whilst activated bituminous-based carbons can be obtained from Calgon Corporation. Activated carbons can be characterized by their particle size distribution (D^{10}, D^{50} and D^{90}); average particle size; BET surface area; Iodine No.; total pore volume; pore volume distribution (macro/meso and micro pores); elemental analysis; moisture content; and ash speciation and content. Particularly useful activated carbons have one or more of the following characteristics:

Characteristic	General Range	Specific Range
D^{10}	1-10 µm	2-5 µm
D^{50}	5-35 µm	10-20 µm
D^{90}	20-100 µm	30-60 µm
Average Particle Size:	10-50 µm	5-25 µm
BET:	>300 m^2/g	>500 m^2/g
Iodine No.:	300-1200 mg/g	>600 mg/g
Total Pore Volume:	0.10-1.20 cc/g	0.15-0.8 cc/g
Macro/Meso Pore Volume:	0.05-0.70cc/g	0.05-0.40cc/g
Micro Pore Volume:	0.05-0.50 cc/g	0.10-0.40 cc/g
Ash Content:	0-15 wt%	<10 wt%
Moisture Content:	0-15 wt%	<5 wt%

[0011] A non-halogenated additive comprising sulfur, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde can be used in treating carbons in accordance with this invention.

[0012] The halogen and/or the halogen-containing compound optionally used in treating cellulosic-derived carbons in accordance with this invention can comprise bromine, chlorine, fluorine, iodine, ammonium bromide, other nitrogen-containing halogen salts, sodium bromide, calcium bromide, potassium bromine, other inorganic halides, etc.

[0013] The non-halogenated additive and, optionally, the halogen and/or halogen-containing compound treatment of the carbons can be affected by batch or continuous methods. A suitable batch process feeds the carbon to a tumble reactor/dryer whereupon it is mixed with the non-halogen compound. The non-halogen compound can be added as a crystalline material, dry powder, slurry or solution depending upon the physical and/or solubility properties of the non-halogen compound. Upon completion of the feed of non-halogen compound, the treated carbon material can be dried as needed, especially if its moisture content exceeds 5 wt% based on the total weight of the fed carbon. In one application, gaseous Br_2, at its boiling point temperature, is optionally fed to the reactor/dryer at an initial temperature of from about

75 °C to about 82 °C. The reactor/dryer pressure is conveniently kept at around ambient pressure. The dryer is run in the tumble mode during and after the feed. The post-feed tumble period is from about 30 minutes to an hour. Quantitatively, the amount of Br_2 fed corresponds identically or nearly identically with the desired bromine content of self-ignition resistant carbon. For example, if a self-ignition resistant carbon having a bromine content of about 5 wt% is desired, then the amount of Br_2 fed is 5 parts Br_2 per 95 parts of treated carbon. The Br_2 feed rate is essentially uniform throughout the Br_2 feed period. After the post feed tumble period, the self-ignition resistant carbon is removed from the reactor/dryer to storage or packaging.

[0014] A suitable continuous process for treating carbon features a separate feed of non-halogenated additive, and optionally, the halogen and/or halogen-containing compound, and the carbon to a continuous reactor. The non-halogenated additive and the optional halogen and/or halogen-containing compound can be co-fed as well. The particulate carbon is conveniently transported to and through the continuous reactor by a gas such as air and/or nitrogen. To enhance mixing, a downstream eductor can be used to insure turbulent mixing. Quantitatively, the same proportions used as in the batch method are used in the continuous method.

[0015] In both the batch and continuous modes it may be preferable, depending upon the properties of the non-halogenated additive, to introduce the optional halogen and/or halogen-containing compound prior to introduction of the non-halogenated additive by methods described above.

[0016] In both the described batch and continuous methods, all of the optional halogen and/or halogen-containing compound is incorporated in the self-ignition resistant carbon material. Thus, it is convenient to refer to the amount of Br_2 in the self-ignition resistant carbon material by reference to the amounts of Br_2 and treated carbon fed to the reactor. A 5 kg feed of Br_2 and a 95 kg feed of treated will be deemed to have produced a gaseous bromine treated self-ignition resistant carbon material containing 5 wt% bromine. However, if a practitioner should desire to directly measure the incorporated bromine, such measure can be affected by Schöniger Combustion followed by silver nitrate titration.

[0017] The optional halogen and/or halogen-containing self-ignition resistant carbon material can contain from about 2 to about 20 wt% halogen, the wt% being based on the total weight of the self-ignition resistant carbon. A wt% halogen value within the

range of from about 5 to about 15 wt% is especially useful when treating flue gas from coal-fired boilers.

[0018] Several techniques exist for determining the thermal properties of materials. For example, one can determine (i) the temperature of initial energy release; (ii) the self-sustaining ignition temperature; and/or (iii) the early stage energy release values. For these determinations it is useful to have a Differential Scanning Calorimetry (DSC) trace of the heat flow values vs temperature (°C) of the treated and untreated activated cellulosic-based carbon samples as they are controllably heated. The DSC conditions can be as follows: the sample size is about 10 mg; the carrier gas is air at a flow rate of 100 ml/minute; the temperature ramp rate is 10 degrees centigrade/ minute from ambient temperature to 850 °C. The DSC can be run on a TA Instruments Thermal Analyst 5000 Controller with Model 2960 DSC/TGA module. The DSC traces created from the DSC test results can be analyzed with TA Instruments Universal Analysis Software, version 4.3.0.6. The sample can be dried thoroughly before being submitted to DSC testing. Thermal drying is acceptable, e.g., drying a 0.5 to 5.0 gram sample at a temperature of 110 °C for 1 hour. The values obtained from the DSC testing can be traced on a Heat Flow (watts/gram) versus Temperature (°C) graph.

[0019] The thermal stability of a substance can be assessed, e.g., via the temperature of initial energy release, a.k.a., the point of initial oxidation (PIO) of the substance. As used in this specification, including the claims, the PIO of compositions and/or sorbents of this invention is defined as the temperature at which the heat flow, as determined by DSC, has increased by 1.0 W/g with the baseline corrected to zero at 100 °C. PIO has been found to be a good predictor of thermal stability, especially when compared to values for PACs known to generally have suitable thermal stability, i.e. "benchmark carbons." One such a benchmark carbon is exemplified by the lignite coal derived PAC impregnated with NaBr marketed by Norit Americas, Inc., designated DARCO Hg-LH, which coated PAC has been found to have a PIO value of 343 °C.

[0020] Another thermal stability assessment method of comparison is the self-sustaining ignition temperature (SIT). The SIT is usually defined as the intersection of the baseline and the slope at the inflection point of the heat flow as a function of temperature curve. The inflection point can be determined using TA Instruments Universal Analysis Software. Generally, the inflection point is defined in differential calculus as a point on a curve at which the curvature changes sign. The curve changes

from being concave upwards (positive curvature) to concave downwards (negative curvature), or vice versa.

[0021] One final thermal stability assessment method involves determining the early stage energy release values by integration of the DSC trace between 125 °C to 425 °C and between 125 °C to 375 °C. The values from these two integrations are each compared against the same values obtained for PACs that are known to generally have suitable thermal stability, i.e. "benchmark carbons." Such a benchmark carbon is again exemplified by the lignite coal derived PAC designated as DARCO Hg-LH, which has been found to have an early stage energy release values (125 °C to 425 °C) of 1,378 joules/gram and 370 joules/gram for 125 °C to 375 °C.

EXAMPLES

[0022] The following examples, summarized in Table 1, are illustrative of the principles of this invention. It is understood that this invention is not limited to any one specific embodiment exemplified herein, whether in the examples or the remainder of this patent application. The general procedure used to prepare the samples comprised blending a solution of non-halogenated additive with activated carbon. Certain non-halogenated additives (e.g., elemental sulfur), due to their special handling and solubility properties, are more preferably blended as a dry powder with the carbon. The activated carbon mixture was dried overnight in a recirculating air oven to provide a treated carbon. The treated carbon was optionally brominated with elemental bromine according to the process disclosed in US 6953494 or blended with other halogen sources, such as sodium bromide, potassium bromide, calcium bromide, hydrogen bromide, and/or ammonium bromide.

Examples 1-56.

[0023] The following table lists PIO values for a series of samples. The PAC designations are as follows:

-DARCO Hg LH – commercially-available lignite-based powdered activated carbon treated with sodium bromide; particle size, avg. = 18.1 μm.

-TWPAC – thermally-activated wood-based powdered activated carbon, from MeadWestvaco; particle size = 15.4 μm; surface area = 756 m^2/g; pore diameter, avg. = 21.0 Å.

-CCN – activated coconut-based powdered activated carbon, from Jacobi; particle size, avg. = 20.7 μm.

-CWPAC – chemically-activated wood-based powdered activated carbon, from MeadWestvaco; particle size = 16.2 μm.

Table 1. Thermal Properties of Cellulosic PACs Treated with Non-Halogenated Additives and (Optionally) Sources of Halogen

Example	Activated Carbon	Treatment	PIO (°C)
1 (Comparative)	Lignite	DARCO Hg-LH	343
2 (Comparative)	TWPAC	None	266
3 (Comparative)	TWPAC	Br_2 (5%)	356
4 (Comparative)	TWPAC	HCl (3.5%)	310
5 (Comparative)	TWPAC	HNO3 (3.5%)	300
6	TWPAC	Sulfamic Acid (3%)	384
7	TWPAC	Sulfamic Acid (10%)	416
8	TWPAC	Sulfamic Acid (3%); Br_2 (5%)	392
9	TWPAC	Sulfamic Acid (1.5%); Br_2 (5%)	388
10	TWPAC	Sulfur (5%)	402
11	TWPAC	Sulfur (2.5%)	397
12	TWPAC	Sulfur (2.5%); Br_2 (5%)	376
13	TWPAC	Sulfur (1.2%); Br_2 (5%)	378
14	TWPAC	Sulfuric Acid (3%)	309
15	TWPAC	Sulfuric Acid (3%); Br_2 (5%)	386
16	TWPAC	Sulfuric Acid (1.5%); Br_2 (5%)	375
17	TWPAC	Boric Acid (5%)	338
18	TWPAC	Boric Acid (5%); Br_2 (5%)	411
19	TWPAC	Phosphoric Acid (5%)	373
20	TWPAC	Phosphoric Acid (5%); Br_2 (5%)	403
21	TWPAC	Ammonium Sulfate (5%)	399
22	TWPAC	Ammonium Sulfate (3.4%)	384
23	TWPAC	Ammonium Sulfate (5%); Br_2 (5%)	395
24	TWPAC	Urea (5%)	306
25	TWPAC	Urea (5%); Br_2 (5%)	377
26 (Comparative)	TWPAC	Br_2 (10%)	370
27	TWPAC	Sulfuric Acid (15%); Br_2 (10%)	413
28	TWPAC	Br_2 (10%); Sulfuric Acid (15%)	421
29 (Comparative)	TWPAC	NaBr (10%)	287
30 (Comparative)	TWPAC	NaBr (5%)	282
31	TWPAC	NaBr (5%); S (2.5%)	372
32	TWPAC	NaBr (5%); Ammonium Sulfate (1.2%)	363
33	TWPAC	NaBr (5%); Sulfamic Acid (5%)	392
34	TWPAC	NaBr (5%); Sulfamic Acid (1.5%)	358
35 (Comparative)	TWPAC	KBr (10%)	276
36 (Comparative)	TWPAC	KBr (5%)	270
37	TWPAC	KBr (5%); Sulfamic Acid (5%)	394
38	TWPAC	KBr (5%); Sulfamic Acid (1.5%)	343
39 (Comparative)	TWPAC	$CaBr_2$ (10%)	307
40 (Comparative)	TWPAC	$CaBr_2$ (5%)	347

Example	Activated Carbon	Treatment	PIO (°C)
41	TWPAC	$CaBr_2$ (5%); Sulfamic Acid (5%)	362
42	TWPAC	$CaBr_2$ (5%); Sulfamic Acid (1.5%)	320
43 (Comparative)	TWPAC	aq. HBr (10%)	305
44 (Comparative)	TWPAC	aq. HBr (5%)	338
45	TWPAC	aq. HBr (5%); Sulfamic Acid (5%)	390
46	TWPAC	aq. HBr (5%); Sulfamic Acid (1.5%)	335
47 (Comparative)	TWPAC	NH_4Br (10%)	398
48 (Comparative)	TWPAC	NH4Br (5%)	368
49	TWPAC	NH_4Br (5%); Sulfamic Acid (5%)	401
50	TWPAC	NH_4Br (5%); Sulfamic Acid (1.5%)	386
51 (Comparative)	CCN	None	320
52	CCN	Sulfamic Acid (5%)	430
53	CCN	Sulfamic Acid (5%); Br_2 (5%)	447
54	CCN	Sulfuric Acid (5%)	433
55	CCN	Sulfuric Acid (5%); Br_2 (5%)	417
56	CCN	Boric Acid	463
57	CCN	Boric Acid; Br_2 (5%)	455
58	CCN	Sulfur (2.5%)	438
59	CCN	Sulfur (5%)	441
60	CCN	Sulfur (2.5%); Br_2 (5%)	443
61 (Comparative)	CCN	NaBr (5%)	354
62 (Comparative)	CWPAC	None	353
63 (Comparative)	CWPAC	Br_2 (5%)	300
64	CWPAC	Boric Acid (5%)	371
65	CWPAC	Boric Acid (5%); Br_2 (5%)	353
66	CWPAC	Sulfamic Acid (5%)	389
67	CWPAC	Sulfamic Acid (5%); Br_2 (5%)	360
68	CWPAC	Phosphoric Acid (5%)	363
69	CWPAC	Phosphoric Acid (5%); Br_2 (5%)	342
70	CWPAC	Sulfur (5%)	378
71	CWPAC	Sulfur (2.5%)	375
72	CWPAC	Sulfur (2.5%(; Br_2 (5%)	342
73	Lignite	None	392
74	Lignite	Br_2 (5%)	358
75	Lignite	Boric Acid (5%)	452
76	Lignite	Boric Acid (5%); Br_2 (5%)	416
77	Lignite	Sulfamic Acid (5%)	421
78	Lignite	Sulfamic Acid (5%); Br_2 (5%)	382
79	Lignite	Phosphoric Acid (5%)	423
80	Lignite	Phosphoric Acid (5%); Br_2 (5%)	383
81	Lignite	Sulfur (5%)	410
82	Lignite	Sulfur (5%); Br_2 (5%)	398

[0024] The following data indicate that the processes of this invention not only improve the thermal properties of brominated and non-brominated activated carbons but also provide good mercury capture results as well. These data were obtained using the mercury capture device described in US 6953494.

Table 2. Mercury Capture Data for Treated PACs of Examples 2, 3, 8, 10, 12, 15, 18, 20, 23, 25, 26, 27, 28, 29, 30, 33, 36, 40, 47, 48

Brominated PAC	Mercury Capture, (%, Avg)
Example 2 (Comparative)	46
Example 3 (Comparative)	72
Example 8	75
Example 10	50
Example 12	77
Example 15	75
Example 18	76
Example 20	73
Example 23	70
Example 25	71
Example 26 (Comparative)	79
Example 27	76
Example 28	53
Example 29 (Comparative)	71
Example 30 (Comparative)	69
Example 33	59
Example 36 (Comparative)	61
Example 40 (Comparative)	68
Example 47 (Comparative)	74
Example 48 (Comparative)	69

[0025] It is to be understood that the reactants and components referred to by chemical name or formula anywhere in the specification or claims hereof, whether referred to in the singular or plural, are identified as they exist prior to being combined with or coming into contact with another substance referred to by chemical name or chemical type (e.g., another reactant, a solvent, or etc.). It matters not what chemical changes, transformations and/or reactions, if any, take place in the resulting combination or solution or reaction medium as such changes, transformations and/or reactions are the natural result of bringing the specified reactants and/or components together under the conditions called for pursuant to this disclosure. Thus the reactants

and components are identified as ingredients to be brought together in connection with performing a desired chemical reaction or in forming a combination to be used in conducting a desired reaction. Accordingly, even though the claims hereinafter may refer to substances, components and/or ingredients in the present tense ("comprises", "is", etc.), the reference is to the substance, component or ingredient as it existed at the time just before it was first contacted, combined, blended or mixed with one or more other substances, components and/or ingredients in accordance with the present disclosure. Whatever transformations, if any, which occur *in situ* as a reaction is conducted is what the claim is intended to cover. Thus the fact that a substance, component or ingredient may have lost its original identity through a chemical reaction or transformation during the course of contacting, combining, blending or mixing operations, if conducted in accordance with this disclosure and with the application of common sense and the ordinary skill of a chemist, is thus wholly immaterial for an accurate understanding and appreciation of the true meaning and substance of this disclosure and the claims thereof. As will be familiar to those skilled in the art, the terms "combined", "combining", and the like as used herein mean that the components that are "combined" or that one is "combining" are put into a container, e.g., a combustion chamber, a pipe, etc. with each other. Likewise a "combination" of components means the components having been put together in such a container.

[0026] While the present invention has been described in terms of one or more preferred embodiments, it is to be understood that other modifications may be made without departing from the scope of the invention, which is set forth in the claims below.

CLAIMS

What is claimed is:

1. An activated carbon that has been exposed to a non-halogenated additive comprising sulfur, sulfuric acid, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally to a halogen and/or a halogen-containing compound and that has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon without exposure to the non-halogenated additive and, optionally to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon without the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon without the exposure.

2. The activated carbon of claim 1 wherein the halogen and/or the halogen-containing compound comprises bromine, chlorine, fluorine, iodine, ammonium bromide, other nitrogen-containing halogen salts, or sodium bromide, potassium bromide, calcium bromide, or other inorganic bromide salts.

3. A process for enhancing the thermal stability of activated carbon, which process comprises exposing the activated carbon to a non-halogenated additive comprising sulfur, sulfuric acid, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally to a halogen and/or a halogen-containing compound at a temperature and for a time sufficient so that activated carbon that has been exposed to the non-halogenated additive and, optionally to the halogen and/or the halogen-containing compound has at least one of the following: (i) a temperature of initial energy release greater than the temperature of initial energy release for the same activated carbon prior to exposure to the non-halogenated additive

and, optionally to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon prior to the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon prior to the exposure.

4. The process of claim 3 wherein the halogen and/or the halogen-containing compound comprises bromine, chlorine, fluorine, iodine, ammonium bromide, other nitrogen-containing halogen salts, or sodium bromide, potassium bromide, calcium bromide, or other inorganic bromide salts.

5. A non-halogenated additive comprising sulfur, sulfuric acid, sulfamic acid, boric acid, phosphoric acid, ammonium sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally a halogen and/or a halogen-containing compound exposed, activated carbon that contains from about 2 to about 20 wt% halogen and has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon prior to exposure to the non-halogenated additive and, optionally the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon prior to the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon prior to the exposure.

6. The activated carbon of claim 5 wherein the halogen and/or the halogen-containing compound comprises bromine, chlorine, fluorine, iodine, ammonium bromide, other nitrogen-containing halogen salts, or sodium bromide, potassium bromide, calcium bromide or other inorganic bromide salts.

7. A process for mitigating the atmospheric release gaseous hazardous substances from flue gases containing such substances, the process comprising contacting the flue gas with an activated carbon that has been exposed to a non-halogenated additive comprising sulfur, sulfuric acid, sulfamic acid, boric acid, phosphoric acid, ammonium

sulfate, urea, ammonium sulfamate, monoammonium phosphate, diammonium phosphate, melamine, melamine phosphate, boric acid/borate combination, silica gel/sodium carbonate, or urea/formaldehyde and, optionally to a halogen and/or a halogen-containing compound and that has at least one of the following: (i) a temperature of initial energy release that is greater than the temperature of initial energy release for the same activated carbon prior to exposure to the non-halogenated additive and, optionally to the halogen and/or the halogen-containing compound; (ii) a self-sustaining ignition temperature that is greater than the self-sustaining ignition temperature for the same activated carbon prior to the exposure; or (iii) an early stage energy release value that is less than the early stage energy release value for the same activated carbon prior to the exposure.

8. The process of claim 7 wherein the flue gas has a temperature within the range of from about 100 °C to about 420 °C.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/048454

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01J20/20 B01D53/64 C01B31/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01J B01D C01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 088 719 A (TAKEDA CHEMICAL INDUSTRIES LTD) 16 June 1982 (1982-06-16) cited in the application claims 1,5-9 page 1, line 51 - line 55 page 2, line 53 - line 57 examples 4-6 tables 3-5 -----	1-8
X	GB 2 122 916 A (TAKEDA CHEMICAL INDUSTRIES LTD) 25 January 1984 (1984-01-25) claims 1-21 page 1, line 23 - line 24 page 2, line 23 - line 29 ----- -/--	1-8

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents .

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 November 2011	23/11/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kaluza, Nicoleta

2

Form PCT/ISA/210 (second sheet) (April 2005)

PACE PAL. EXHIBIT 1024
Page 304

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 261 709 A (ITOGA KIYOSHI ET AL) 14 April 1981 (1981-04-14) claims 1,4 table 2 column 3, line 28 - line 44	1-8
X	US 2005/019240 A1 (LU XIAO-CHUN [US] ET AL) 27 January 2005 (2005-01-27) claims 1,2,7,8 examples 4,8 figures 14,15	1-8
X	EP 1 987 873 A2 (RWE POWER AG [DE]) 5 November 2008 (2008-11-05) claims 1-7 figure 1 examples 2,3	1-8
X,P	WO 2010/114985 A1 (ALBEMARLE CORP [US]; O'DWYER JONATHAN P [US]; ZHOU QUNHUI [US]; LAMBET) 7 October 2010 (2010-10-07) claims 1-10	1-8
A	US 2004/003716 A1 (NELSON SIDNEY G [US] NELSON JR SIDNEY G [US]) 8 January 2004 (2004-01-08) cited in the application the whole document	1-8

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

PACE PAL. EXHIBIT 1024
Page 305

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/048454

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		NL 8302430 A	01-02-1984
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US 2005019240 A1	27-01-2005	US 2005019240 A1	27-01-2005
		US 2007207923 A1	06-09-2007
EP 1987873 A2	05-11-2008	DE 102007020422 A1	30-10-2008
		EP 1987873 A2	05-11-2008
		US 2008274874 A1	06-11-2008
WO 2010114985 A1	07-10-2010	CA 2755315 A1	07-10-2010
		WO 2010114985 A1	07-10-2010
US 2004003716 A1	08-01-2004	NONE	

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Janal M. Kalis/Megan Reed
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	10	100	1000
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1300	1300
		Total in USD ($)		**7840**

Electronic Acknowledgement Receipt

EFS ID:	36547902
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Janal M. Kalis/Megan Reed
Filer Authorized By:	Janal M. Kalis
Attorney Docket Number:	4820.001US10
Receipt Date:	10-JUL-2019
Filing Date:	04-JUN-2018
Time Stamp:	17:00:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$7840
RAM confirmation Number	071119INTEFSW00004067190743
Deposit Account	190743
Authorized User	Megan Reed

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SIGNED_4820_001U10_RCE_Resp_Ext_IDS_Dec_Tr12.pdf	7044486 57e39af4c9bf15046b2121f53577f53324282939	yes	131

Multipart Description/PDF files in .zip description

Document Description	Start	End
Affidavit-traversing rejectns or objectns rule 132	126	131
Affidavit-traversing rejectns or objectns rule 132	110	125
Affidavit-traversing rejectns or objectns rule 132	98	109
Affidavit-traversing rejectns or objectns rule 132	87	97
Extension of Time	86	86
Information Disclosure Statement (IDS) Form (SB08)	85	85
Transmittal Letter	83	84
TrackOne Request	82	82
Applicant Arguments/Remarks Made in an Amendment	9	81
Claims	3	8
Amendment Submitted/Entered with Filing of CPA/RCE	2	2
Request for Continued Examination (RCE)	1	1

Warnings:

Information:

2	Non Patent Literature	4820003US2_ADAR_05222019.pdf	385392 7d69afab34c3f12b945a35d7c984bceca9cdbed	no	3

Warnings:					
Information:					
3	Non Patent Literature	4820003US2_OARN_06212019.pdf	725411 e5cd411e36653e4663d76a883ea76ba917ef8147	no	7
Warnings:					
Information:					
4	Non Patent Literature	4820004US1_FOAR_06212019.pdf	3420798 4df6d6cc027a421318e268b85e3a594de4ac0eba	no	31
Warnings:					
Information:					
5	Non Patent Literature	4820007US4_NALL_05302019.pdf	405171 037a81efdb7cea4f080e1f3bdcb29430be815c0c	no	3
Warnings:					
Information:					
6	Non Patent Literature	4820007US4_NOAR_05082019.pdf	396732 58359b85ebd004efa827f412f8f5f4e1a2a5dda6	no	7
Warnings:					
Information:					
7	Foreign Reference	WO_2012030560_A1.pdf	956404 f3ba9bc976639c9f0ceaec2c4a975837f58c936b	no	19
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	39391 f6432a898ef1708fc674029c369ffeafbe9c7189	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	13373785	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/978,760 Group Art Unit: 1776
Filed: May 14, 2018 Docket No.: 4820.007US4
Confirmation No.: 6432
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION D

I, John Pavlish, declare and say as follows:

1. I have been the Chief Technology Officer and Senior Vice President of Midwest Energy Emissions Corporation since November 16, 2014. Prior to this, I served as an Executive Consultant Advisor to Midwest Energy Emissions Corporation. Prior to joining Midwest Energy Emissions Corporation, I was a Senior Research Advisor and the Director of the Center for Air Toxic Metals Program at the Energy & Environmental Research Center in Grand Forks, North Dakota. I have over 25 years of mercury-related experience and am regarded as an international expert on the topic of mercury. My primary areas of interest and expertise include research, technical consultation and development of mercury control technologies, in particular, for coal combustion and gasification systems. I am an inventor of a number of patented mercury control technologies and have years of experience in development and testing of these technologies for commercial applications. Over the last 15 years, I have spent much time evaluating the efficacy of a number of different mercury control technologies/approaches and their cost competitiveness in the commercial market. I also have years of power plant experience and have worked for an engineering/consulting company, Black & Veatch, where I served as Unit Leader/System Engineer. I am a professional engineer, a member of the American Society of Mechanical Engineers, and a member of the Air & Waste Management Association (A&WMA). I serve on numerous professional and

technical committees and am a U.S. Representative on the Mercury Emissions from Coal International Experts Working Group on Reducing Emissions from Coal and a member of the United Nations Environment Programme Global Mercury Partnership, Reduction of Mercury Releases from Coal Combustion. I have published over 200 papers, articles, and reports on various mercury-related topics and issues.

2. Declaration B at item 8 describes that a pilot-scale 550,000-Btu/hr pulverized coal (pc)-fired test unit was used to combust subbituminous coal and test mercury control using various sorbents. The coal combustion flue gas exiting the pilot unit was cooled down to a nominal temperature of 149°C (300°F) and then was introduced into a single wire tubular ESP unit. Activated carbon sorbents were fed with a K-Tron dual-screw feeder upstream of the ESP. The feeder was calibrated prior to the start of each carbon injection test. No scrubber was used. Before Hg control testing began, a baseline condition was established with the pilot-scale unit, and flue gas mercury content was measured before each test as about 6-10 $\mu g/m^3$. The flue gas HCl concentration, with no additives on the coal, as calculated by the chlorine measured in the coal, was 2-5 ppm.

3. U.S. patent publication no. 2004/0003716 ("Nelson") describes treatment of activated carbon outside the flue gas with hydrogen bromide (HBr), and describes testing to measure the percent mercury removal when the treated activated carbon was injected into either simulated or actual flue gas at various injection rates. Specifically, Nelson performed experiments in Example 5 (paragraphs [0082]-[0085]) and 7 (paragraphs [0089]-[0092]), and provides the data in FIG. 14 and FIG. 15.

4. In Example 5, Nelson treated Norit DARCO® FGD with gaseous HBr, and tested its use by injecting the HBr-treated sorbent into a simulated coal-fired flue-gas stream in a pilot-scale test system. Nelson's FIG. 14 shows data for one activated carbon sample treated with HBr. The activated carbon had 10 wt% HBr, and at a sorbent injection rate of about 3.7 lb/MMacf gave a mercury removal of about 82%. As reported in paragraph [0082] of Nelson, duct-injection runs were performed with a simulated coal-fired flue-gas

stream on a 50-acfm pilot-scale test system. As described, the mercury mass transfer to fluidized sorbent and adsorption kinetics in this system were similar to that in a full-scale utility application. The fully-instrumented duct-injection test system that was used included a propane burner unit to generate the hot flue gas; a humidification drum to add an appropriate degree of moisture to the gas; an elemental mercury spiking subsystem with elemental mercury permeation tubes; a flue gas spiking subsystem with mass flow controllers for SO_2, NO_x, and HCl; a small sorbent feeder and fluidizing injection subsystem to lessen sorbent pulsing; 10 meters of insulated, 10-cm-diameter ducting circling the ceiling; thermocouples; an electrostatic filter with an effective specific collection area (SCA) of about 500 ft^2/Kacf; a back-up fabric filter; a safety filter; an orifice plate to measure flow; and a variable-speed I.D. fan. The gas temperature at injection was about 175 °C and at the electrostatic precipitator (ESP) was about 145 °C and the spiked flue gas concentrations were about 24 $\mu g/Nm^3$ Hg(0), 1400 ppm SO_2 , 600 ppm NO_x, and 5 ppm HCl, typical values for coal-fired power plants.

5. In Example 7, Nelson treated Norit DARCO® FGD with gaseous HBr, and tested its use in a coal-fired power plant by injecting the treated sorbent into the flue gas prior to the electrostatic precipitator (ESP). Nelson's FIG. 15 shows data for two activated carbon samples treated with HBr. The two activated carbon samples contained 9 wt% HBr. The data in FIG. 15 for the two HBr-treated sorbents show that at a sorbent injection rate of about 2.2 lb/MMacf, 45% of the mercury was removed, and at a sobent injection rate of about 4.2 lb/MMacf, 62% of the mercury was removed. As reported in paragraphs [0089]-[0091] of Nelson, a large-scale duct-injection trial was performed at the 18-MW scale, with about 60,000 acfm of flue gas at 160 °C (320 °F). The plant had stoker-fed boilers, burned a high-sulfur bituminous coal, and had just a cold-side ESP for emission control. Baseline sampling according to the Ontario Hydro Method indicated no intrinsic mercury removal of mercury across the ESP. Without sorbent injection, the plant emitted about 10 $\mu g/Nm^3$ of mercury from the stack, with 80 to 90% of this in oxidized forms. In these trials, the mercury was measured using a speciating PS Analytical Sir Galahad continuous mercury monitor. Inlet mercury values were obtained

by sampling upstream of the sorbent injection point and outlet mercury was measured at the stack. The sorbents were injected into ductwork through a lance to mix with the flue gases about 40 feet from the entrance to the ESP. The flue gas contained about 1000 ppm of SO_2, 20 ppm of SO_3, 250 ppm of NO_x, and 25 ppm of HCl. The ESP had an SCA of 370 ft^2/Kacfm.

6. Nelson's Examples 5 and 7 do not describe the use of a scrubber. Example 7 of Nelson uses only a cold-side ESP for emission control, with injection of the activated carbon upstream of the ESP. Example 5 of Nelson describes an ESP that occurs after the point of injection and that has a temperature of 145 °C (293 °F) at the inlet, also corresponding to a cold-side ESP. Similarly, in the pilot-scale setup described at item 8 of Declaration B no scrubber was used, and activated carbon was injected upstream of the ESP. These similarities between Nelson's Example 5 and 7 and the pilot-scale setup described at item 8 of Declaration B allow for good comparison with the Nelson data.

7. Nelson's Example 5 describes a flue gas HCl concentration of 5 ppm, which is similar to the flue gas HCl concentration in the pilot-scale setup described at item 8 of Declaration B, allowing for good comparison between Nelson's Example 5 and the pilot-scale setup described at item 8 of Declaration B. However, Nelson's Example 7 describes a flue gas HCl concentration of 25 ppm. The higher HCl concentration in Nelson's Example 7 flue gas allows for easier mercury removal, due to HCl acting as a promotor of the activated carbon, as compared to the pilot-scale setup described at item 8 of Declaration B.

8. The mercury concentration of the flue gas from the pilot-scale setup described at item 8 of Declaration B was in the range of 6-10 $\mu g/m^3$, as compared to Nelson's Example 5 data for which the mercury concentration of the flue gas is about 24 $\mu g/m^3$. The higher mercury concentration in Nelson's Example 5 allows for easier mercury removal as the mercury concentration at the point of activated carbon injection is much higher. To illustrate this, to remove 70% of the mercury from Nelson's Example 5 setup,

the mercury concentration leaving the ESP after the mercury is captured by the treated activated carbon would be: 24 - (24*70/100) = 7.2 $\mu g/m^3$. To remove 70% of the mercury from the pilot-scale setup described at item 8 of Declaration B, the mercury concentration leaving the ESP after the mercury is captured by the activated carbon would be: 8 - (8*70/100) = 2.4 $\mu g/m^3$. When mercury concentration is lower, the probability of activated carbon sorbent particles contacting mercury in the flue gas is lower, and the overall number of encounters between activated carbon particles and mercury atoms or compounds per time is lower; therefore, the activated carbon sorbent particles must be more adsorptive (e.g., reactive) toward mercury in order to remove mercury at low concentrations as compared to the same activated carbon sorbent placed in a higher concentration of mercury. As the calculation shows, it is more difficult to remove the same percentage of mercury from the flue gas starting with a lower concentration of 8 $\mu g/m^3$ than starting at a higher concentration of 24 $\mu g/m^3$.

9. As explained at item 6, Nelson's experimental setup in Examples 5 and 7 and the experimental setup described at item 8 of Declaration B inject activated carbon sorbent into a flue gas upstream of an ESP and use no scrubber, making the procedures comparable. However, as explained at item 7, the higher HCl concentration in Nelson's Example 7 flue gas allows for easier mercury removal, due to HCl acting as a promotor of the activated carbon, as compared to the pilot-scale setup described at item 8 of Declaration B. Further, as explained at item 8, the higher mercury concentration in Nelson's Example 5 makes it easier for Nelson's sorbents to remove the same overall percentage of mercury from the flue gas, as compared to the pilot-scale setup described at item 8 of Declaration B. Therefore, if Nelson's Example 5 and 7 HCl and mercury concentrations were changed to match those of the pilot-scale setup described at item 8 of Declaration B, Nelson's sorbents would remove a lower percentage of mercury than found in Nelson's Examples 5 and 7.

10. I further declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by a fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and/or any patent issued thereon.

Dated: March 20, 2019 By: / John Pavlish /

John Pavlish

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/978,760 Group Art Unit: 1776
Filed: May 14, 2018 Docket No.: 4820.007US4
Confirmation No.: 6432
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION C

We, John Pavlish and Nicholas Lentz, declare and say as follows:

1. I, John Pavlish, have been the Chief Technology Officer and Senior Vice President of Midwest Energy Emissions Corporation since November 16, 2014. Prior to this, I served as an Executive Consultant Advisor to Midwest Energy Emissions Corporation. Prior to joining Midwest Energy Emissions Corporation, I was a Senior Research Advisor and the Director of the Center for Air Toxic Metals Program at the Energy & Environmental Research Center in Grand Forks, North Dakota. I have over 25 years of mercury-related experience and am regarded as an international expert on the topic of mercury. My primary areas of interest and expertise include research, technical consultation and development of mercury control technologies, in particular, for coal combustion and gasification systems. I am an inventor of a number of patented mercury control technologies and have years of experience in development and testing of these technologies for commercial applications. Over the last 15 years, I have spent much time evaluating the efficacy of a number of different mercury control technologies/approaches and their cost competitiveness in the commercial market. I also have years of power plant experience and have worked for an engineering/consulting company, Black & Veatch, where I served as Unit Leader/System Engineer. I am a professional engineer, a member of the American Society of Mechanical Engineers, and a member of the Air & Waste Management Association (A&WMA). I serve on numerous professional and

technical committees and am a U.S. Representative on the Mercury Emissions from Coal International Experts Working Group on Reducing Emissions from Coal and a member of the United Nations Environment Programme Global Mercury Partnership, Reduction of Mercury Releases from Coal Combustion. I have published over 200 papers, articles, and reports on various mercury-related topics and issues.

2. I, Dr. Nicholas Lentz, Field Technical Manager for Midwest Energy Emissions Corporation, have more than 10 years of experience conducting mercury research and tests, both in the lab and in the field with over 30 full-scale mercury test programs and also numerous bench- and pilot-test projects. I am also an expert in the identification and development of new analytical methods for the advancement of elemental and small molecule analysis in a wide range of matrices including coal and coal by-products, CO_2 capture solutions, oil and gas fuels; analysis for combustion flue gas, syngas, fuel oil, and biowaste. Prior to my current position, I was an Associate Director for Energy Technology Applications in the Institute for Energy Studies at the University of North Dakota. I also previously was a Center for Air Toxic Metals (CATM) Program Area Manager and Research Scientist at the Energy & Environmental Research Center where I was responsible for managing a portfolio of measurement-based research projects in the Analytical Measurement Area of CATM as well as experimental design and analysis related control technologies to remove mercury, trace metals, and halogens from combustion and gasification systems. I have a B.S. in Chemistry from Bemidji State University and Ph.D. in Analytical Chemistry from Iowa State University. I have authored and co-authored numerous publications.

3. All websites referenced in this document were accessed 3/15/2019.

4. Merriam-Webster dictionary defines "bromine" as "a nonmetallic halogen element that is isolated as a deep red corrosive toxic volatile liquid of disagreeable odor. See, https://www.merriam-webster.com/dictionary/bromine. Wikipedia defines "bromine" as "...a chemical element with symbol Br and atomic number 35. It is the

third-lightest halogen, and is a fuming red-brown liquid at room temperature that evaporates readily to form a similarly coloured gas." See, https://en.wikipedia.org/wiki/Bromine. Dictionary.com defines "bromine" as "an element that is a dark-reddish, fuming, toxic liquid and a member of the halogen family: obtained from natural brines and ocean water, and used chiefly in the manufacture of gasoline antiknock compounds, pharmaceuticals, and dyes. Symbol: Br; atomic weight: 79.909; atomic number: 35 ..." See, https://www.dictionary.com/browse/bromine.

5. Merriam-Webster dictionary defines "chlorine" as "a halogen element that is isolated as a heavy greenish-yellow diatomic gas of pungent odor and is used especially as a bleach, oxidizing agent, and disinfectant in water purification." See, https://www.merriam-webster.com/dictionary/chlorine. Wikipedia defines "chlorine" as "...a chemical element with symbol Cl and atomic number 17. The second-lightest of the halogens, it appears between fluorine and bromine in the periodic table and its properties are mostly intermediate between them. Chlorine is a yellow-green gas at room temperature." See, https://en.wikipedia.org/wiki/Chlorine. Dictionary.com defines "chlorine" as "a halogen element, a heavy, greenish-yellow, incombustible, water-soluble, poisonous gas that is highly irritating to the respiratory organs, obtained chiefly by electrolysis of sodium chloride brine: used for water purification, in the making of bleaching powder, and in the manufacture both of chemicals that do not contain chlorine, as ethylene glycol, and of those that do. Symbol: Cl; atomic weight: 35.453; atomic number: 17." See, https://www.dictionary.com/browse/chlorine.

6. Encyclopedia Britannica online states that "[a]t room temperature and atmospheric pressure the halogen elements in their free states exist as diatomic molecules." https://www.britannica.com/science/halogen-element. The Chemistry LibreTexts Library states that "[h]alogens form diatomic molecules (of the form X_2, where X denotes a halogen atom) in their elemental states. The bonds in these diatomic molecules are non-polar covalent single bonds" See, https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(I

norganic_Chemistry)/Descriptive_Chemistry/Elements_Organized_by_Block/2_p-Block_Elements/Group_17%3A_The_Halogens/0Group_17%3A_Physical_Properties_of_the_Halogens/Group_17%3A_General_Properties_of_Halogens. ThoughtCo.com states that "[h]alogens range from solid (I_2) to liquid (Br_2) to gaseous (F_2 and Cl_2) at room temperature. As pure elements, they form diatomic molecules with atoms joined by nonpolar covalent bonds." See, https://www.thoughtco.com/halogen-elements-and-properties-606650.

7. Sigma-Aldrich gives the properties of elemental bromine, Br_2 as including a molecular weight of 159.81 g/mol, a boiling point of 58.8 °C, and a melting point of -7.2 °C. See, https://www.sigmaaldrich.com/catalog/product/sigald/207888?lang=en&region=US.

8. Sigma-Aldrich gives the properties of Cl_2 as including a molecular weight of 70.91 g/mol, a boiling point of -34 °C, and a melting point of -101 °C. See, https://www.sigmaaldrich.com/catalog/product/aldrich/295132?lang=en&region=US.

9. Merriam-Webster dictionary defines "bromide" as "1: a binary compound of bromine with another element or a radical including some (such as potassium bromide) used as sedatives." See, https://www.merriam-webster.com/dictionary/bromide. Wikipedia defines "bromide" as "...a chemical compound containing a bromide ion or ligand. This is a bromine atom with an ionic charge of -1 (Br^-); for example, in caesium bromide, caesium cations (Cs^+) are electrically attracted to bromide anions (Br^-) to form the electrically neutral ionic compound CsBr. The term "bromide" can also refer to a bromine atom with an oxidation number of -1 in covalent compounds such as sulfur dibromide (SBr_2).." See, https://en.wikipedia.org/wiki/Bromide. Dictionary.com defines "bromide" as "1. A salt of hydrobromic acid consisting of two elements, one of which is bromine, as sodium bromide, NaBr; 2. A compound containing bromine, as methyl bromide." See, https://www.dictionary.com/browse/bromide.

10. Merriam-Webster dictionary defines "chloride" as "1: a compound of chlorine with another element or group especially :a salt or ester of hydrochloric acid; 2: a monovalent anion consisting of one atom of chlorine." See, https://www.merriam-webster.com/dictionary/chloride. Wikipedia defines "chloride" as "...a compound of chlorine with a salt or ester of hydrochloric acid" and as "...the anion (negatively charged ion) Cl^-." See, https://en.wikipedia.org/wiki/Chloride_(disambiguation) and https://en.wikipedia.org/wiki/Chloride. Dictionary.com defines "chloride" as "1. A salt of hydrochloric acid consisting of two elements, one of which is chlorine, as sodium chloride, NaCl; 2. A compound containing chlorine, as methyl chloride, CH_3Cl." See, https://www.dictionary.com/browse/chloride.

11. Wikipedia defines "hydrogen halides" as "... diatomic inorganic compounds with the formula HX where X is one of the halogens: fluorine, chlorine, bromine, iodine, or astatine. ... Hydrogen halides are gases that dissolve in water to give acids which are commonly known as hydrohalic acids. The direct reaction of hydrogen with fluorine and chlorine gives hydrogen fluoride and hydrogen chloride, respectively. Industrially these gases are, however, produced by treatment of halide salts with sulfuric acid. Hydrogen bromide arises when hydrogen and bromine are combined at high temperatures in the presence of a platinum catalyst. The least stable hydrogen halide, HI, is produced less directly, by the reaction of iodine with hydrogen sulfide or with hydrazine." See, https://en.wikipedia.org/wiki/Hydrogen_halide.

12. Merriam-Webster defines "hydrogen bromide" "a colorless irritating gas HBr that fumes in moist air and yields hydrobromic acid when dissolved in water." See, https://www.merriam-webster.com/dictionary/hydrogen%20bromide. Dictionary.com defines "hydrogen bromide" as "a colorless gas, HBr, having a pungent odor: the anhydride of hydrobromic acid." See, https://www.dictionary.com/browse/hydrogen-bromide. Wikipedia defines "hydrogen bromide" as "...the diatomic molecule with the formula HBr. It is a colorless compound and a hydrogen halide. Hydrobromic acid is a solution of HBr in water. Both the anhydrous and aqueous solutions of HBr are common

reagents in the preparation of bromide compounds. ...Hydrogen bromide (along with hydrobromic acid) is produced by combining hydrogen and bromine at temperatures between 200 and 400 °C. The reaction is typically catalyzed by platinum or asbestos."

13. Merriam-Webster defines "hydrogen chloride" as "a colorless pungent poisonous gas HCl that fumes in moist air and yields hydrochloric acid when dissolved in water." See, https://www.merriam-webster.com/dictionary/hydrogen%20chloride. Dictionary.com "hydrogen chloride" "a colorless gas, HCl, having a pungent odor: the anhydride of hydrochloric acid." Wikipedia defines "hydrogen chloride" as "[t]he compound hydrogen chloride has the chemical formula HCl and as such is a hydrogen halide. At room temperature, it is a colorless gas, which forms white fumes of hydrochloric acid upon contact with atmospheric water vapor. Hydrogen chloride gas and hydrochloric acid are important in technology and industry. Hydrochloric acid, the aqueous solution of hydrogen chloride, is also commonly given the formula HCl. ...pure chlorine gas can be combined with hydrogen to produce hydrogen chloride in the presence of UV light: $Cl_2(g) + H_2(g) \longrightarrow 2\ HCl(g)$."

14. Sigma-Aldrich gives the properties of HBr as including a molecular weight of 80.91 g/mol, a boiling point of -67 °C, and a melting point of -87 °C. See, https://www.sigmaaldrich.com/catalog/product/aldrich/295418?lang=en&region=US.

15. Sigma-Aldrich gives the properties of HCl as including a molecular weight of 36.46 g/mol, a boiling point of -85 °C, and melting point of -114 °C. See, https://www.sigmaaldrich.com/catalog/product/aldrich/295426?lang=en&region=US.

16. Wikipedia defines the "octet rule" as "... a chemical rule of thumb that reflects observation that atoms of main-group elements tend to combine in such a way that each atom has eight electrons in its valence shell, giving it the same electron configuration as a noble gas. The rule is especially applicable to carbon, nitrogen, oxygen, and the

halogens, but also to metals such as sodium or magnesium." See, https://en.wikipedia.org/wiki/Octet_rule.

17. As shown by items 3-16 herein, hydrogen halides are diatomic molecules including a halogen atom and a hydrogen atom; in contrast, elemental halogens are diatomic molecules including two of the same halogen atom. HBr and HCl each include a hydrogen atom and one halogen atom, while Br_2 and Cl_2 each include two halogen atoms. Hydrogen halides have different properties than elemental halogens and are therefore different compounds. HBr has a molecular weight of 80.91 g/mol, while Br_2 has a molecular weight of 159.81 g/mol; HBr has a boiling point of -67 °C, while Br_2 has a boiling point of 58.8 °C; HBr has a melting point of -87 °C, while Br_2 has a melting point of -7.2 °C. HCl has a molecular weight of 36.46 g/mol, while Cl_2 has a molecular weight of 70.91 g/mol; HCl has a boiling point of -85 °C, while Cl_2 has a boiling point of 70.91 g/mol; HCl has a melting point of -114 °C, while Cl_2 has a melting point of -101 °C. Hydrogen halides are not part of and cannot be extracted or isolated from elemental halides; rather, only via a chemical reaction that results in a chemical and structural change can hydrogen halides be formed from elemental halides. Hydrogen bromide is produced by reacting hydrogen and Br_2 at about 200-400 °C, a reaction that is typically catalyzed by platinum or asbestos. Hydrogen chloride is produced by reacting hydrogen and chlorine with one another. Therefore, elemental halogens are not hydrogen halides, and do not include hydrogen halides—Br_2 is not HBr and does not include HBr, and Cl_2 is not HCl and does not include HCl.

18. As shown by items 3-16 herein, chlorine has an atomic number of 17, meaning it has 17 protons and 17 electrons, giving it an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^5$, having 7 electrons in its outer shell. Bromine has an atomic number of 35, meaning it has 35 protons and 35 electrons, giving it an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$, also having 7 electrons in its outer shell. According to the octet rule, a halogen atom desires to fill its outer shell with 8 electrons total by gaining one electron. A halide ion is a halogen atom that has accepted an electron from an

electron doner, in the case of chloride giving it 18 total electrons to give a total charge of -1, and in the case of bromide giving it 36 total electrons to give a total charge of -1. Halogen atoms do not donate electrons to other atoms, because this would result in a halogen atom losing an electron to have 6 electrons in its outer shell, an unstable configuration according to the octet rule. In the case of an elemental halogen, which exists as a diatomic molecule, instead of donating electrons to one another, each halogen atom shares one of its electrons in the outer shell with the other halogen atom via overlapping electron orbitals in a covalent bond, allowing each halogen atom to have a filled octet while the diatomic molecule remains neutrally charged. Therefore, a halogen atom does not donate electrons to another halogen atom to form a halide, and a diatomic halogen molecule never includes a halide; Br_2 is not and does not include Br^-, and Cl_2 is not and does not include Cl^-.

19. As described in the paper "Effect of HBr formation on mercury oxidation via $CaBr_2$ addition to coal during combustion", Y. Yang et al., RSC Adv., 2016, 6, 59009-59015 ("Yang"), in a bench-scale simulated coal-fired power plant, $CaBr_2$ was added in various concentrations to three different types of coal that were combusted and the concentration of HBr and Br_2 in the released combustion gases were analyzed by quantitative gas analysis mass spectrometry. See, Yang at Sections 2.1-2.2. Section 3.4 states at page 59012 bridging to page 59013 that "[t]he results confirmed the generation of HBr in coal-fired flue gas due to the $CaBr_2$ additive in coal, but Br_2 was not detected." Near the end of Section 3.4 at page 59013 Yang states that "[t]he HBr concentration in flue gas increased with increasing amounts of $CaBr_2$ additive..." At the top of the right column on page 59013, Yang proposes the following formula for the generation of HBr from $CaBr_2$: $CaBr_2 + H_2O \longrightarrow CaO + HBr$, stating at page 59013 from the left column bridging to the right column that the water is generated by hydrogen-containing organisms in coal during combustion via $C_nH_mOH + O_2 \longrightarrow H_2O + CO_2$.

20. As described in the paper "Mercury control evaluation of calcium bromide injection into a PRB-fired furnace with an SCR", M. Berry, Proceedings of the Air

Quality VI Conference, Arlington, VA, 2007 ("Berry"), a $CaBr_2$ was injected at various concentrations into the furnace of a full-scale coal-fired power plant and the concentration of HBr in the released combustion gases were analyzed at the ESP inlet and at the ESP outlet. Berry found that HBr content increased with increasing calcium bromide injection. See, Berry at page 5, top two paragraphs and Figure 3.

21. As described in the book "Coal Combustion Products (CCPs) Characteristics, Utilization, and Beneficiation", T. Robl et al., Woodhead Publishing, 2017, ("Robl"), at page 91, last full paragraph and last partial paragraph:

> As described previously, eastern coals with a higher chlorine content produce mostly oxidized mercury in their flue gases, while western coals, such as PRB coals, that have a low chlorine content tend to produce mostly elemental mercury. ...
>
> Halogen salts such as calcium chloride ($CaCl_2$), calcium bromide ($CaBr_2$), or potassium iodide (KI) can be added to the coal as a means of supplementing the coal chlorine content. Salts added with the coal or injected into the furnace decompose at furnace temperatures to form vapor-phase acids (HCl, hydrogen bromide (HBr), or hydrogen iodide (HI)) in the flue gas.

22. Typical temperatures in a coal-combustion furnace range from 2,400-4,200 °F, with internal flame temperatures reaching 4,000-4,200 °F or higher. Table 1 lists select halide salt boiling points. Coal-combustion furnace temperatures are higher than the boiling points of halide salts such as NaBr and $CaBr_2$. Thus, the conditions and environment inside the furnace/boiler are adequate for boiling of halide salts (whether in a solid state, in a liquid solution, or as part of the coal) to form gaseous molecules.

Table 1. Common Halide Salt Boiling Points.[1]

Compound	Boiling point, °F
NaBr	2,534
NaCl	2,669
NaI	2,379
$CaCl_2$	3,516
$CaBr_2$	3,299
CaI	2,012
NH_4Br	745
NH_4Cl	640
NH_4I	761

23. The FactSage program (see, http://www.factsage.com/) is one of the largest fully integrated database computing systems for chemical thermodynamics calculations. The FactSage program is a series of information, database, calculation, and manipulation modules that access databases containing properties of materials. The FactSage program can calculate the conditions for multiphase, multicomponent equilibria, with a wide variety of tabular and graphical output modes, under a large range of constraints. Equilibrium calculations performed by the FactSage program can be used to determine equilibrium molecular decomposition states as a function of temperature. These thermodynamic models can be used to predict the chemical species that will be present to react with other molecules present in the flue gas at the same time, such as radicals, ionic compounds, elemental forms of chemical elements, and the like. FactSage was used to calculate equilibrium concentrations of materials present for a 100 g solid NaBr sample in a coal-combustion furnace as a function of temperature, shown in Figure 1. Figure 1 clearly shows the rapid emergence of gaseous NaBr molecules once the NaBr boiling point of 2,530 °F is reached. At temperatures of around 3,000 °F, nearly all the solid NaBr has been converted to gas phase NaBr molecules. As the gas phase NaBr molecules are brought to temperatures beyond 3,000 °F, dissociation into gaseous sodium atoms and bromine atoms occurs.

[1] Lide, D.R., 1995, CRC handbook of chemistry and physics: a ready-reference book of chemical and physical data, CRC press.

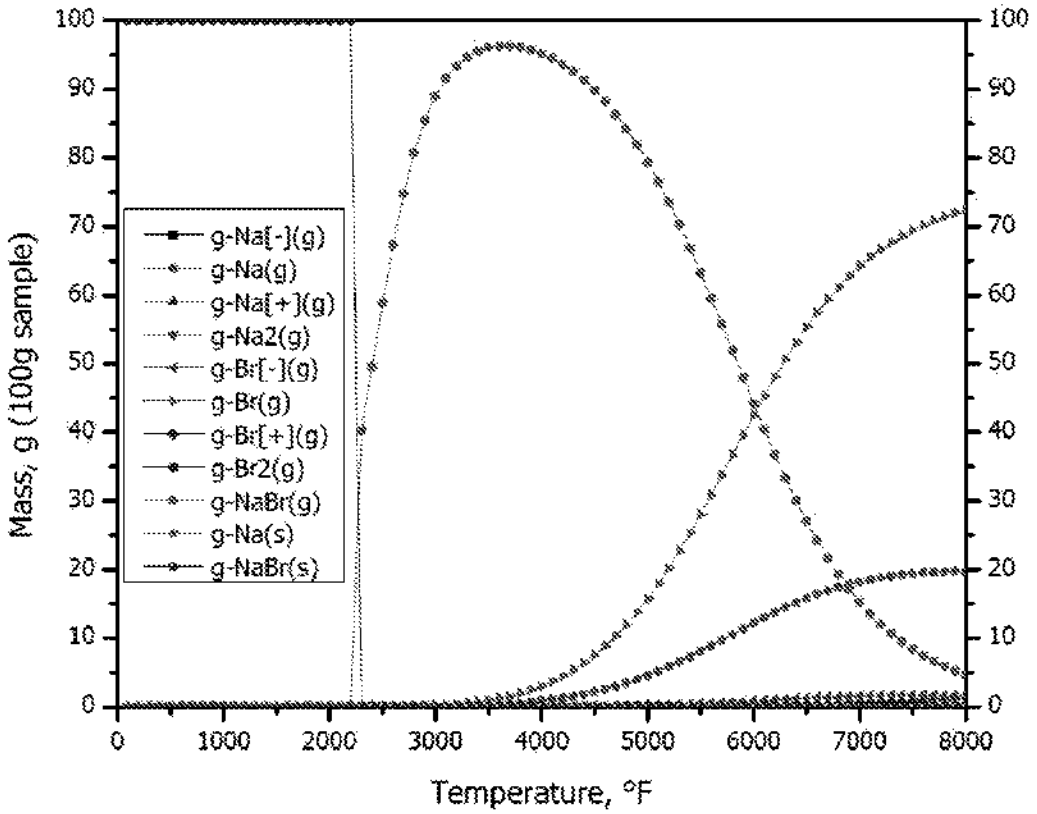


Figure 1. NaBr FactSage equilibrium calculation.

24. Not shown in Figure 1, the gaseous NaBr reacts with water molecules in the flue gas to form HBr, via $NaBr + H_2O \rightarrow NaOH + HBr$, see, Yang and discussion thereof at item 19 herein. The HBr is then available to react with Hg^0 released by the coal and with activated carbon sorbent that has been introduced further downstream into the flue gas.

25. The effect of chlorides in coal on flue gas HCl content has been studied much more than the effect of bromides on coal on flue gas HBr content, due in part to federal HCl emission regulations. Chlorides, like bromides, also exhibit a similar transformation to hydrogen chloride in coal combustion flue gas, see, Robl and discussion thereof at item 21 herein. Hydrogen chloride, as an acid gas, is one of the emission categories that the EPA regulates through the Mercury Air Toxics Standards (MATS)[2]. The MATS includes specific HCl limits that power plants must comply with by performing quarterly EPA

[2] https://www.epa.gov/mats

Method 26(A)[3] stack sampling to verify compliance. Inorganic and organically bound chlorides in the coal are volatilized and decomposed in the furnace and form HCl in the flue gas.

26. As shown in the report "Pilot- and full-scale demonstration of advanced mercury control technologies for lignite-fired power plants", S. Benson et al., Energy & Environmental Research Center, Final report, U.S. Department of Energy, National Energy Technology Laboratory, February 2005 ("Benson 1"), at figure 31 on page 37, addition of NaCl to lignite coal in a pilot-scale coal combustion system caused an increased HCl concentration in the flue gas. The HCl concentration in the flue gas increased with increased amounts of NaCl on the coal. Benson 1 shows at figure 36 on page 41 that addition of $CaCl_2$ to the coal caused increased HCl concentration in the flue gas. The HCl concentration in the flue gas increased with increasing amounts of $CaCl_2$ on the coal. Figures 31 and 36 of Benson 1 are reproduced below.

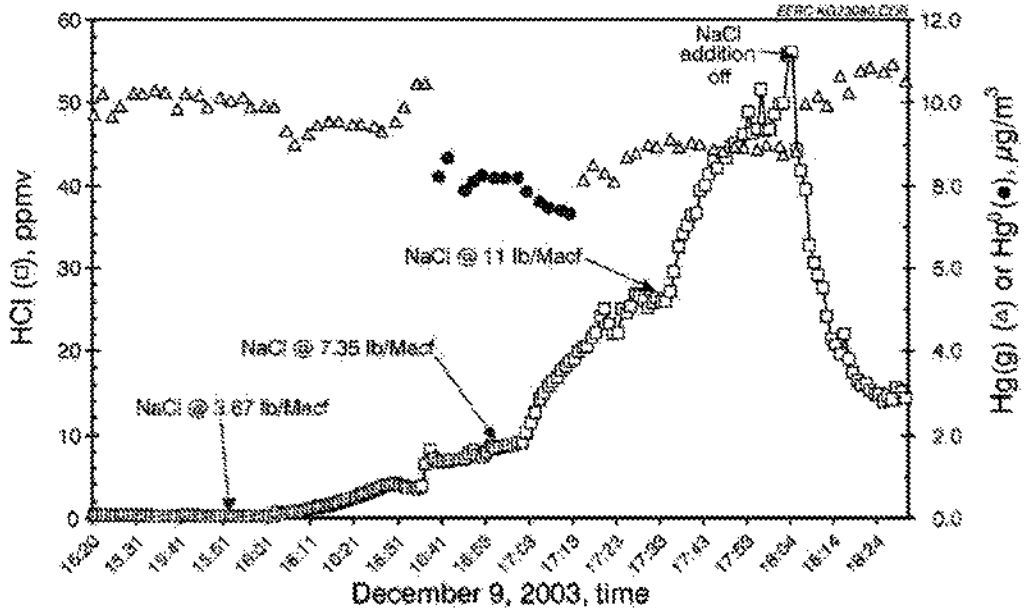


Figure 31. Temporal variations in SDA inlet HCl and FF outlet Hg(g) and Hg^0 concentrations as NaCl was added to the Center lignite coal.

[3] https://www.epa.gov/emc/method-26a-hydrogen-halide-and-halogen-isokinetic-method

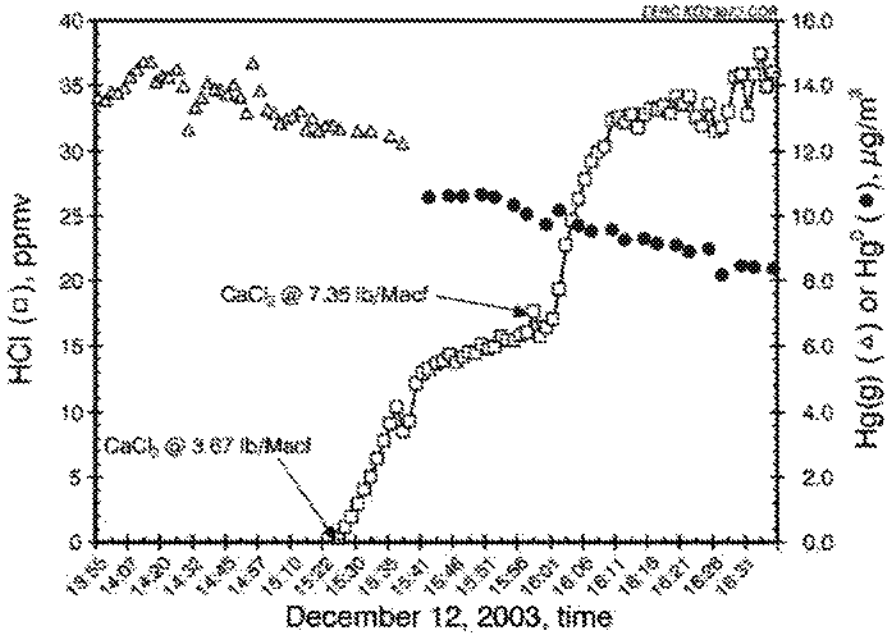


Figure 36. Temporal variations in SDA inlet HCl and FF outlet Hg(g) and Hg^0 concentrations during $CaCl_2$ additions to the Center lignite coal.

27. As shown in the report "JV Task 73—Mercury control technologies for electric utilities burning subbituminous coals", S. Benson et al., Energy and Environmental Research Center, Draft final report, June 2005 ("Benson 2"), at figure 11-11 at page 48, addition of $CaCl_2$ to subbituminous coal in a pilot-scale coal combustion system caused an increased HCl concentration in the flue gas. The HCl concentration in the flue gas increased with increased amounts of $CaCl_2$ on the coal. Figure 11-11 of Benson 2 is reproduced below.

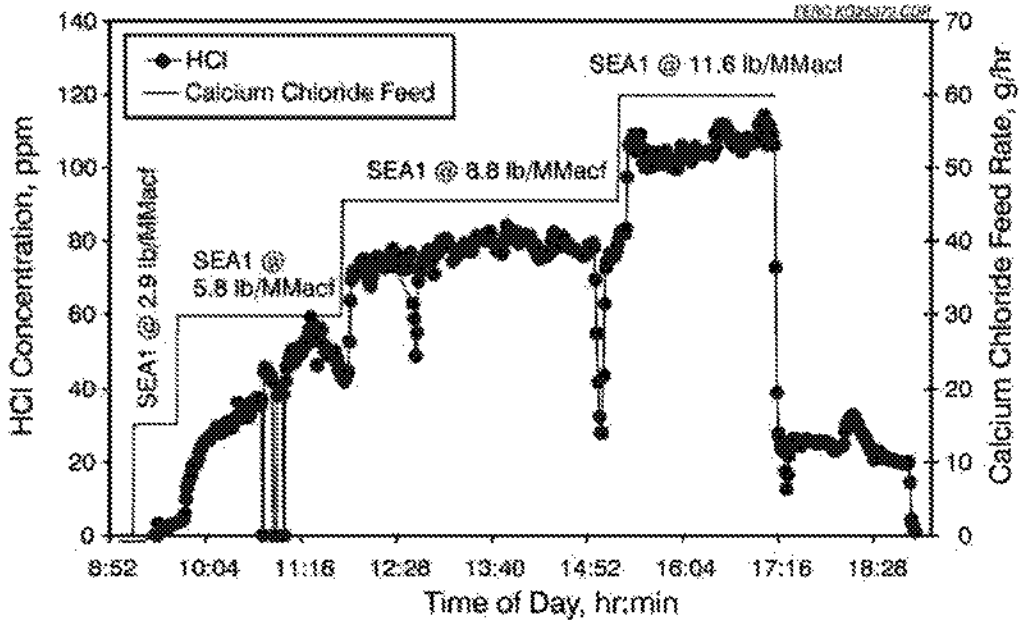


Figure 11-11. Temporal variations in ESP outlet HCl concentrations and SEA1 ($CaCl_2$) addition rates.

28. As shown by items 19-27 herein, in a coal-fired power plant, placing halide salts on the coal or in the combustion chamber results in formation of gaseous halide salt in the flue gas and formation of the respective hydrogen halide in the flue gas. Placing bromide salts such as NaBr or $CaBr_2$ on the coal or in the combustion chamber results in formation of gaseous NaBr or $CaBr_2$ in the flue gas, as well as formation of HBr in the flue gas. Likewise, placing chloride salts such as NaCl or $CaCl_2$ on coal or in the combustion chamber results in formation gasoues NaCl or $CaCl_2$ in the flue gas, as well as the formation of HCl in the flue gas.

29. Wikipedia defines "salt" as "...an ionic compound that can be formed by the neutralization reaction of an acid and a base. Salts are composed of related numbers of cations (positively charged ions) and anions (negative ions) so that the product is electrically neutral (without a net charge). These component ions can be inorganic, such as chloride (Cl^-), or organic, such as acetate ($CH_3CO_2^{-1}$), and can be monatomic, such as

fluoride (F^-), or polyatomic, such as sulfate (SO_4^{-2})." See, https://en.wikipedia.org/wiki/Salt_(chemistry).

30. Dictionary.com defines "bromide" as "Wikipedia defines "NaBr" as "a salt of hydrobromic acid consisting of two elements, one of which is bromine, as sodium bromide, NaBr." See, https://www.dictionary.com/browse/bromide.

31. Dictionary.com defines "salt" as "a Wikipedia defines "NaCl" as "a crystalline compound, sodium chloride, NaCl, occurring as a mineral, a constituent of seawater, etc., and used for seasoning food, as a preservative, etc." See, https://www.dictionary.com/browse/salt?s=t.

32. Sigma-Aldrich has an online products page entitled "Sodium Salts" that includes sodium bromide and sodium chloride. See, https://www.sigmaaldrich.com/materials-science/material-science-products.html?TablePage=19295381.

33. As shown by items 29-32 herein, NaBr is a salt that includes Na^+ ions and Br^- ions. NaCl is a salt that includes Na^+ ions and Cl^- ions. $CaBr_2$ is a salt that includes Ca^+ ions and Br^- ions. $CaCl_2$ is a salt that includes Ca^+ ions and Cl^- ions.

34. We further declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by a fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and/or any patent issued thereon.

Dated: March 20, 2019 By: / John Pavlish /

John Pavlish

Dated: March 15, 2019 By: / Nicholas Lentz /

Nicholas Lentz

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/978,760 Group Art Unit: 1776
Filed: May 14, 2018 Docket No.: 4820.007US4
Confirmation No.: 6432
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION B

I, John Pavlish, declare and say as follows:

1. I have been the Chief Technology Officer and Senior Vice President of Midwest Energy Emissions Corporation since November 16, 2014. Prior to this, I served as an Executive Consultant Advisor to Midwest Energy Emissions Corporation. Prior to joining Midwest Energy Emissions Corporation, I was a Senior Research Advisor and the Director of the Center for Air Toxic Metals Program at the Energy & Environmental Research Center in Grand Forks, North Dakota. I have over 25 years of mercury-related experience and am regarded as an international expert on the topic of mercury. My primary areas of interest and expertise include research, technical consultation and development of mercury control technologies, in particular, for coal combustion and gasification systems. I am an inventor of a number of patented mercury control technologies and have years of experience in development and testing of these technologies for commercial applications. Over the last 15 years, I have spent much time evaluating the efficacy of a number of different mercury control technologies/approaches and their cost competitiveness in the commercial market. I also have years of power plant experience and have worked for an engineering/consulting company, Black & Veatch, where I served as Unit Leader/System Engineer. I am a professional engineer, a member of the American Society of Mechanical Engineers, and a member of the Air & Waste Management Association (A&WMA). I serve on numerous professional and

technical committees and am a U.S. Representative on the Mercury Emissions from Coal International Experts Working Group on Reducing Emissions from Coal and a member of the United Nations Environment Programme Global Mercury Partnership, Reduction of Mercury Releases from Coal Combustion. I have published over 200 papers, articles, and reports on various mercury-related topics and issues.

2. U.S. patent publication no. 2004/0003716 ("Nelson") describes treatment of activated carbon outside the flue gas with hydrogen bromide (HBr), and describes testing to measure the percent mercury removal when the treated activated carbon was injected into either simulated or actual flue gas at various injection rates. Specifically, Nelson performed experiments in Example 5 (paragraphs [0082]-[0085]) and 7 (paragraphs [0089]-[0092]), and provides the data in FIG. 14 and FIG. 15.

3. In Example 5, Nelson treated Norit DARCO® FGD with gaseous HBr, and tested its use by injecting the HBr-treated sorbent into a simulated coal-fired flue-gas stream in a pilot-scale test system. Nelson's FIG. 14 shows data for one activated carbon sample treated with HBr. The activated carbon had 10 wt% HBr, and at a sorbent injection rate of about 3.7 lb/MMacf gave a mercury removal of about 82%.

4. In Example 7, Nelson treated Norit DARCO® FGD with gaseous HBr, and tested its use in a coal-fired power plant by injecting the treated sorbent into the flue gas prior to the electrostatic precipitator (ESP). Nelson's FIG. 15 shows data for two activated carbon samples treated with HBr. The two activated carbon samples contained 9 wt% HBr. The data in FIG. 15 for the two HBr-treated sorbents show that at a sorbent injection rate of about 2.2 lb/MMacf, 45% of the mercury was removed, and at a sobent injection rate of about 4.2 lb/MMacf, 62% of the mercury was removed.

5. The percent mercury removal, and the percent mercury removal per 1 wt% HBr additive on the sorbent, versus the sorbent injection rate for Nelson's HBr-treated activated carbon formed in Nelson's Examples 5 and 7 is given in the table below. The

percent mercury removal per 1 wt% HBr was calculated as the percent mercury removal divided by the HBr wt% on the sorbent. The units "lb/MMacf" are pounds of sorbent per 1 million actual cubic feet of flue gas.

Sample	Additive	Sorbent Description	Sorbent Injection Rate (lb/MMacf)	HBr wt% on Sorbent	%Hg Removal	%Hg Removal per 1 wt% HBr on Sorbent
N1	HBr outside flue gas	Norit DARCO® FGD	3.7	10	82	8.2
N2	HBr outside flue gas	Norit DARCO® FGD	2.2	9	45	5.0
N3	HBr outside flue gas	Norit DARCO® FGD	4.2	9	62	6.8

6. A bromine-treated activated carbon was prepared by exposing activated carbon (Norit DARCO® Hg, an activated carbon that a Norit Americas technical representative told me was rebranded for mercury control applications and was previously referred to as Norit DARCO® FGD) to gaseous bromine. A cement mixer was used to expose the activated carbon to the bromine gas. Tumbling vanes produced a dispersion of the activated carbon within the barrel. A cover was fit over the opening to keep the activated carbon dispersion inside the barrel. In the center of the lid, a small hole was drilled, and a tube extended to the center of the barrel. The tube was attached to a source of bromine vapor (Br_2) in dry nitrogen via a swivel so that the tube in the barrel would rotate and the tube to the source would be stationary. A charge of 1 to 5 kg of the activated carbon was weighed and transferred to the barrel. The weight of bromine transferred to the barrel was equal to 5 weight % of the amount of activated carbon.

7. An HCl-treated activated carbon was prepared by exposing activated carbon (Norit DARCO® Hg) to gaseous HCl. The carbon was weighed and added to a flask which was attached to a rotary apparatus. A hard-plastic tube was inserted into the

condenser end of the apparatus for introduction of the HCl/nitrogen gas mix. This extended to the center of the flask. HCl from a cylinder was run through a flow meter and mixed with a low flow of nitrogen in a T-tube attached to the inlet tube. The flow rate was set to provide 5 wt % HCl over 15 minutes exposure. The flask was slowly rotated in the apparatus at room temperature so that the carbon turned over but did not exit the flask. After the exposure period, the HCl flow was stopped and the HCl-treated activated carbon was removed.

8. A pilot-scale 550,000-Btu/hr pulverized coal (pc)-fired test unit was used to combust subbituminous coal and test mercury control using various sorbents. The coal combustion flue gas exiting the pilot unit was cooled down to a nominal temperature of 149°C (300°F) and then was introduced into a single wire tubular ESP unit. Activated carbon sorbents were fed with a K-Tron dual-screw feeder upstream of the ESP. The feeder was calibrated prior to the start of each carbon injection test. No scrubber was used. Before Hg control testing began, a baseline condition was established with the pilot-scale unit, and flue gas mercury content was measured before each test as about 6-10 $\mu g/m^3$. The flue gas HCl concentration, with no additives on the coal, as calculated by the chlorine measured in the coal, was 2-5 ppm. Percent mercury removal was then measured for the activated carbon alone (untreated), the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure, and with sodium bromide (NaBr) or sodium chloride (NaCl) added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas.

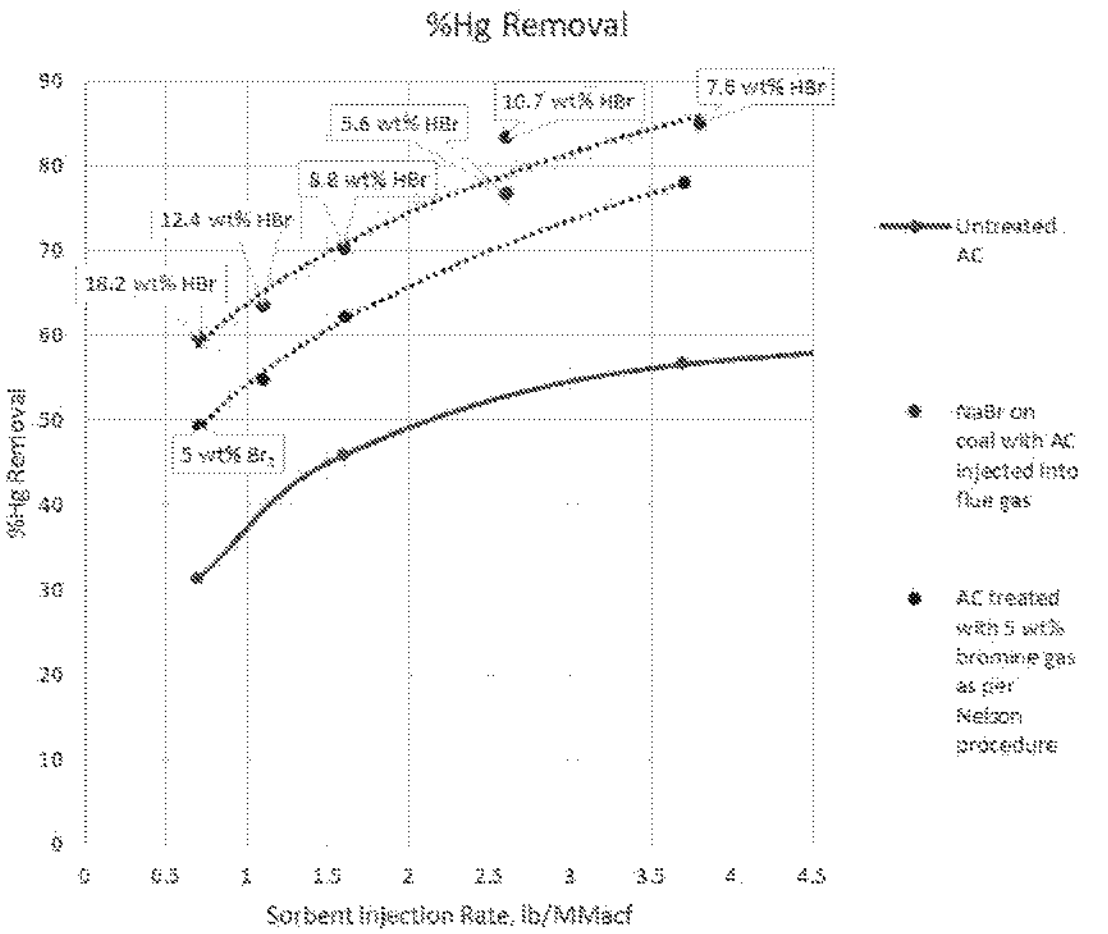
9. The results of the pilot-scale test with untreated activated carbon and with the activated carbon treated with Br_2 outside the flue gas described herein at item 6 are given in the table below.

Sample	Additive	Sorbent Description	Sorbent Injection Rate (lb/MMacf)	Br_2 wt% on Sorbent	%Hg Removal
1	None	Norit DARCO® Hg	0.7	0	31.4
2	None	Norit DARCO® Hg	1.6	0	45.9
3	None	Norit DARCO® Hg	3.7	0	56.6
4	None	Norit DARCO® Hg	9.2	0	61.2
5	None	Norit DARCO® Hg	25.7	0	62.5
6	Br_2 outside flue gas	Norit DARCO® Hg	0.7	5	49.5
7	Br_2 outside flue gas	Norit DARCO® Hg	1.1	5	54.9
8	Br_2 outside flue gas	Norit DARCO® Hg	1.6	5	62.2
9	Br_2 outside flue gas	Norit DARCO® Hg	3.7	5	78.1

10. The results from the pilot-scale test with sorbent enhancement additives (SEAs) NaBr or NaCl added to coal along with injection of untreated activated carbon into the flue gas, and with the activated carbon treated with HCl outside the flue gas described at item 7, are given in the table below. The bromide (Br^-) or chloride (Cl^-) injection rate was calculated as the SEA injection rate times the fraction of the additive (based on molecular weight) that is Br^- or Cl^-, for Br^-, Br^-/NaBr = 79.904/(79.904+22.9898) = 0.7766; for Cl^-, Cl^-/NaCl = 35.453/(35.453+22.9898) = 0.6066. The HBr or hydrogen chloride (HCl) equivalent injection rate was calculated as the Br^- or Cl^- injection rate times the molecular weight ratio of HBr/Br^- or of HCl/Cl^-; for HBr/Br^-, this is (1.00794+79.904)/79.904 = 1.013; for HCl/Cl^-, this is (1.00794+35.453)/35.453 = 1.028. The equivalent HBr or HCl wt% on sorbent was calculated as the HBr or HCl injection rate divided by the sum of the sorbent injection rate and the HBr or HCl injection rate (e.g., 100% of the HBr or HCl was assumed to react with the sorbent). The percent mercury removal per 1 wt% HBr or HCl was calculated as the percent mercury removal divided by the HBr wt% or HCl wt% on sorbent.

Sample	Additive	Additive injection rate (lb/MMacf)	Sorbent description	Sorbent injection rate (lb/MMacf)	Br or Cl injection rate (lb/MMacf)	HBr or HCl equivalent injection rate (lb/MMacf)	Equivalent HBr or HCl wt% on sorbent	%Hg removal	%Hg removal per 1 wt% HCl or HBr on sorbent	Milligrams HBr or HCl/MMacf per 1% Hg Removal
13	NaBr on coal	0.2	Norit DARCO® Hg	0.7	0.16	0.16	18.2	59.8	3.3	1211
14	NaBr on coal	0.2	Norit DARCO® Hg	1.1	0.16	0.16	12.4	63.6	5.1	1139
15	NaBr on coal	0.2	Norit DARCO® Hg	1.6	0.16	0.16	8.8	70.4	18.0	1029
16	NaBr on coal	0.2	Norit DARCO® Hg	2.6	0.16	0.16	5.6	76.7	13.6	944
17	NaBr on coal	0.4	Norit DARCO® Hg	2.6	0.31	0.31	10.7	83.3	7.8	1739
18	NaBr on coal	0.4	Norit DARCO® Hg	3.8	0.31	0.31	7.6	85.1	11.3	1702
19	NaCl on coal	2.4	Norit DARCO® Hg	0.7	1.46	1.50	67.5	60.6	0.9	11202
20	NaCl on coal	3.4	Norit DARCO® Hg	0.7	2.06	2.12	74.7	61.2	0.8	15714
21	NaCl on coal	4.9	Norit DARCO® Hg	0.7	2.97	3.06	80.9	57.8	0.7	23979
22	NaCl on coal	4.9	Norit DARCO® Hg	1.1	2.97	3.06	73.0	67.4	0.9	20564
23	NaCl on coal	4.9	Norit DARCO® Hg	1.6	2.97	3.06	65.0	69.6	1.1	19914
24	NaCl on coal	6.9	Norit DARCO® Hg	1.6	4.19	4.30	72.3	71.2	1.0	27412
25	HCl outside flue gas	0	Norit DARCO® Hg	0.7	0.04	0.04	5.0	27.9	5.6	569
26	HCl outside flue gas	0	Norit DARCO® Hg	1.6	0.08	0.08	5.0	34.2	6.8	1061
27	HCl outside flue gas	0	Norit DARCO® Hg	2.6	0.13	0.13	5.0	35.1	7.0	1680
28	HCl outside flue gas	0	Norit DARCO® Hg	4.9	0.24	0.25	5.0	40.3	8.1	2757
29	HCl outside flue gas	0	Norit DARCO® Hg	7.7	0.37	0.39	5.0	43.9	8.8	3978
30	HCl outside flue gas	0	Norit DARCO® Hg	15.5	0.75	0.78	5.0	52.9	10.6	6645

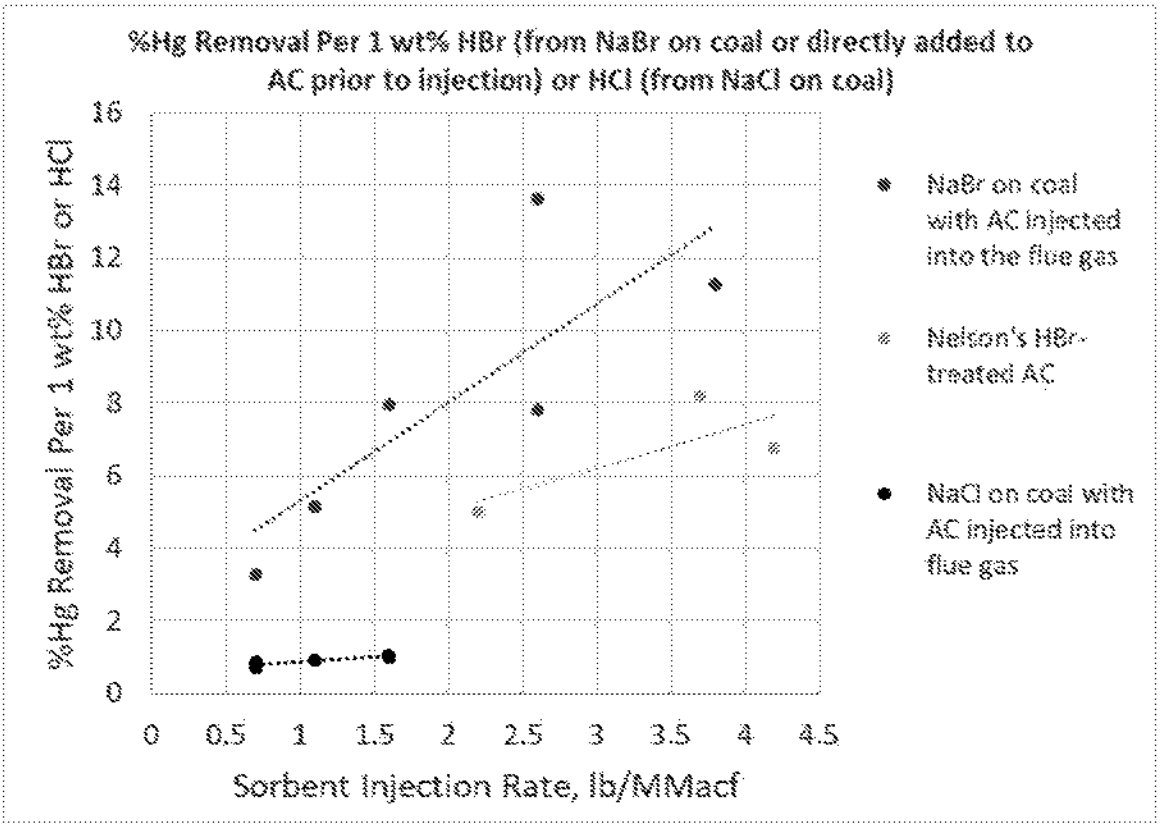
11. The following plot shows the percent mercury removal versus the sorbent injection rate for the activated carbon alone (untreated), the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure, and for NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. All of the data in the following plot is taken from the data in the tables at item 9 and 10, which was produced using the same pilot-scale setup described at item 8.

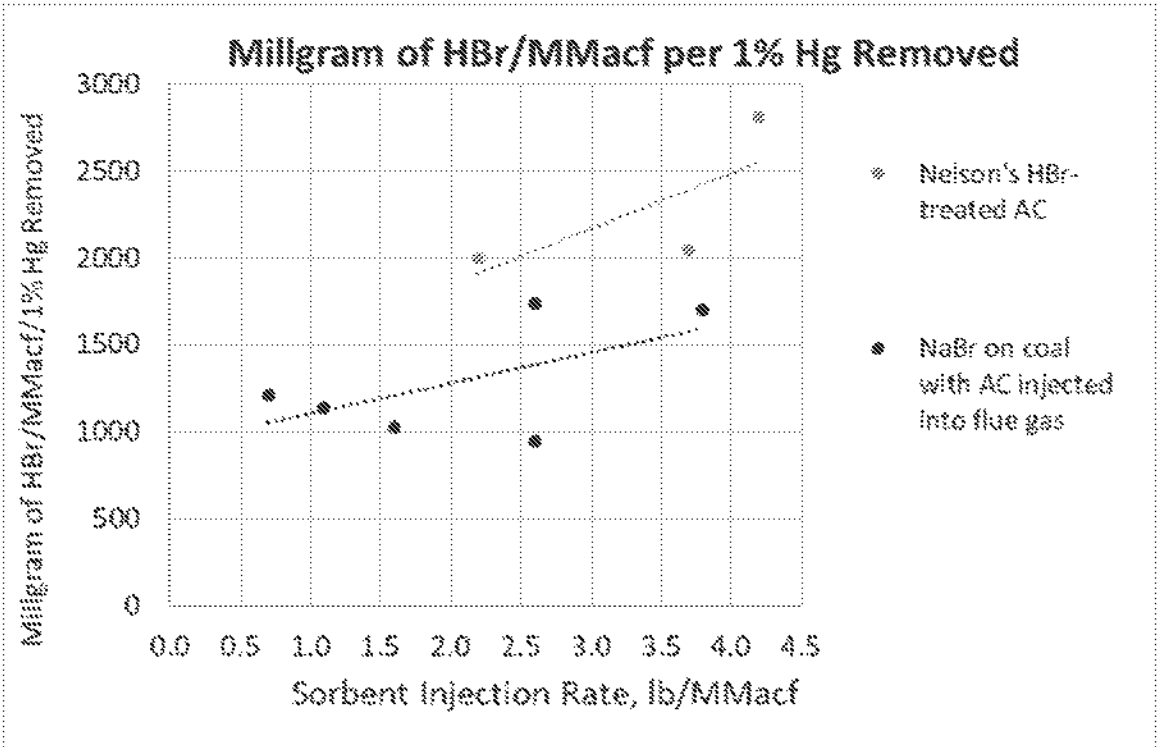


12. The data in the plot above show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas (in-flight promotion with Br^-) provided a higher percent of mercury removal at all tested sorbent

injection rates as compared to the activated carbon alone (untreated) and compared to the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure. With NaBr added to the coal and activated carbon injected into the flue gas, there was a significant reduction in the amount of sorbent required to acheive similar mercury removal compared to the activated carbon treated with Br_2 outside the flue gas. For example, to acheive 70% mercury removal, 2.5 lb/MMacf of Br_2-treated carbon was required, as compared to 1.6 lb/MMacf with NaBr added to the coal and activated carbon injected into the flue gas; an additional (2.5-1.6/1.6)*100% or 56% treated sorbent was required to achieve the same leval of mercury removal.

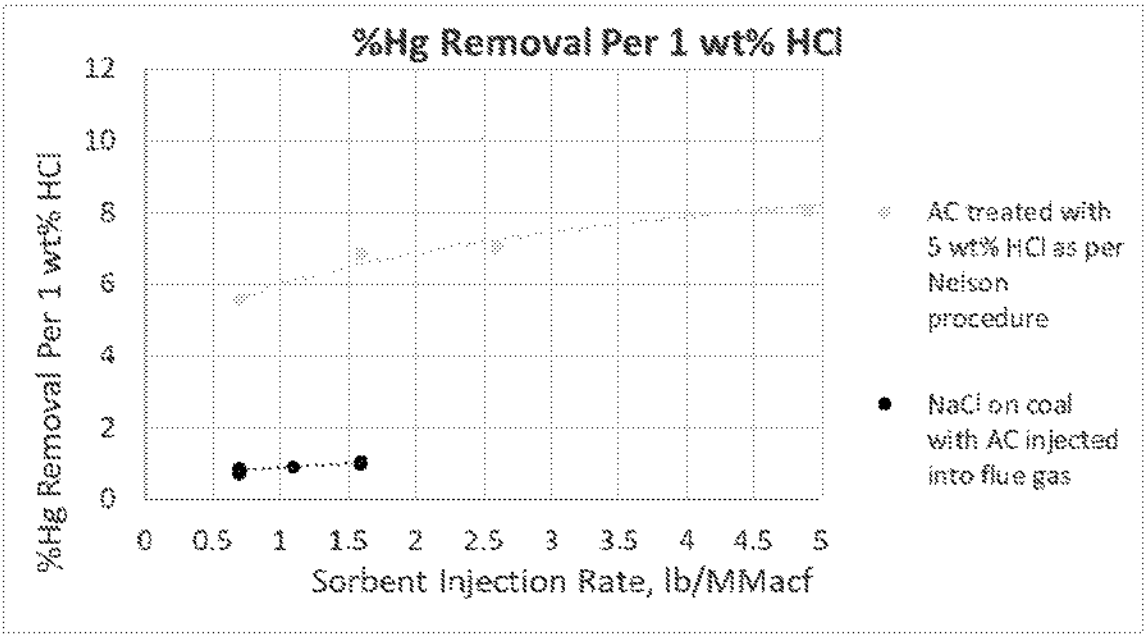
13. The following first plot shows the percent mercury removal per 1 wt% HBr or HCl versus the sorbent injection rate with NaBr or NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for Nelson's activated carbon treated with HBr outside the flue gas. The following second plot shows the milligrams of HBr/MMacf per 1% mercury removal versus the sorbent injection rate with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for Nelson's activated carbon treated with HBr outside the flue gas; NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas was omitted from this plot because the values for the milligrams of HCl/MMacf per 1% mercury removal were so high (about 10,000 to 30,000). The data sets in the following first and second plots "NaBr on coal with AC injected into the flue gas" and "NaCl on coal with AC injected into flue gas" are taken from the data in table at item 10, which was produced using the same pilot-scale setup described at item 8. The data set in the following first and second plots "Nelson's HBr-treated AC" is taken from the table at item 5, which is from Nelson's experimental setup.

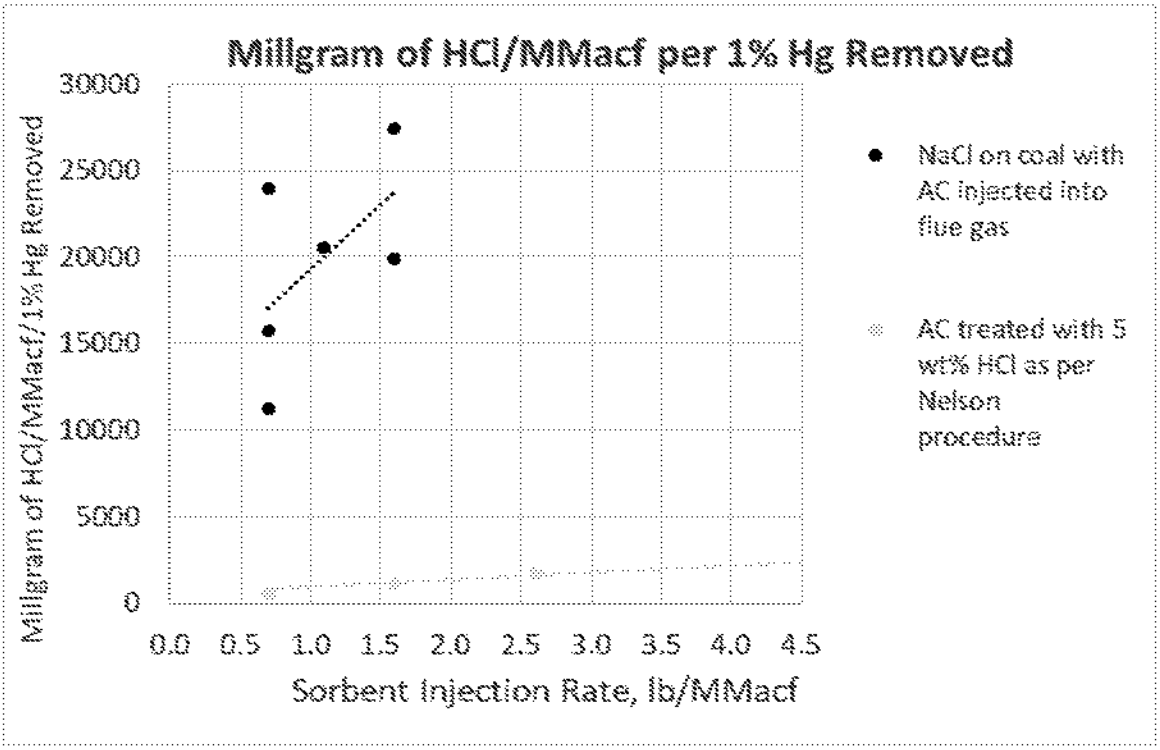

%Hg Removal Per 1 wt% HBr (from NaBr on coal or directly added to AC prior to injection) or HCl (from NaCl on coal)
%Hg Removal Per 1 wt% HBr or HCl
0
2
4
6
8
10
12
14
16
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Sorbent Injection Rate, lb/MMacf
NaBr on coal with AC injected into the flue gas
Nelson's HBr-treated AC
NaCl on coal with AC injected into flue gas


Milligram of HBr/MMacf per 1% Hg Removed
Milligram of HBr/MMacf/1% Hg Removed
0
500
1000
1500
2000
2500
3000
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Sorbent Injection Rate, lb/MMacf
Nelson's HBr-treated AC
NaBr on coal with AC injected into flue gas

14. The data in the first plot above show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 2x) percent mercury removal per 1 wt% HBr at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas. Further, the data show that NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 6-8x) percent mercruy removal per 1 wt% HBr or HCl at all tested sorbent injection rates compared to the NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The data in the second plot above shows that NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly lower milligrams of HBr/MMacf per 1% mercury removal at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas, indicating more efficient (approximately 2x) use of HBr for mercury removal during in-flight promotion of activated carbon than treatment of activated carbon outside the flue gas.

15. The following first plot shows the percent mercury removal per 1 wt% HCl versus the sorbent injection rate for NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure. The following second plot shows the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure. The data sets in the following first and second plots are taken from the data in table at item 10, which was produced using the same pilot-scale setup described at item 8.





16. The data in the first plot above show that activated carbon treated with HCl outside the flue gas as per the Nelson procedure provided a much higher percent of mercury removal per 1 wt% HCl at all tested sorbent injection rates as compared to NaCl

added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The data in the second plot above show that the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas was significantly higher as compared to the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure, indicating more efficient use of HCl for mercury removal by treatment of activated carbon outside the flue gas than by promotion in-flight.

17. I further declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by a fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and/or any patent issued thereon.

Dated: March 20, 2019

By: / John Pavlish /

John Pavlish

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/978,760 Group Art Unit: 1776
Filed: May 14, 2018 Docket No.: 4820.007US4
Confirmation No.: 6432
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION A

I, John Pavlish, declare and say as follows:

1. I have been the Chief Technology Officer and Senior Vice President of Midwest Energy Emissions Corporation since November 16, 2014. Prior to this, I served as an Executive Consultant Advisor to Midwest Energy Emissions Corporation. Prior to joining Midwest Energy Emissions Corporation, I was a Senior Research Advisor and the Director of the Center for Air Toxic Metals Program at the Energy & Environmental Research Center in Grand Forks, North Dakota. I have over 25 years of mercury-related experience and am regarded as an international expert on the topic of mercury. My primary areas of interest and expertise include research, technical consultation and development of mercury control technologies, in particular, for coal combustion and gasification systems. I am an inventor of a number of patented mercury control technologies and have years of experience in development and testing of these technologies for commercial applications. Over the last 15 years, I have spent much time evaluating the efficacy of a number of different mercury control technologies/approaches and their cost competitiveness in the commercial market. I also have years of power plant experience and have worked for an engineering/consulting company, Black & Veatch, where I served as Unit Leader/System Engineer. I am a professional engineer, a member of the American Society of Mechanical Engineers, and a member of the Air & Waste Management Association (A&WMA). I serve on numerous professional and

technical committees and am a U.S. Representative on the Mercury Emissions from Coal International Experts Working Group on Reducing Emissions from Coal and a member of the United Nations Environment Programme Global Mercury Partnership, Reduction of Mercury Releases from Coal Combustion. I have published over 200 papers, articles, and reports on various mercury-related topics and issues.

2. Herein, when I refer to the invention I am referring to a method of separating mercury from a mercury-containing gas as described in independent claim 2 of U.S. patent application serial no. 15/978,760. All websites referenced in this document were accessed March 20, 2019.

The EPA Calls For New Mercury Removal Technology in the 1990s

3. The background story for this technology begins with the Clean Air Act Amendments of 1990. That law required the U.S. Environmental Protection Agency (EPA) to study the impact of various air pollutants, including mercury.[1] To assist in the research, in 1992, the EPA established a National Center for Excellence at the Energy & Environmental Research Center (EERC) referred to as the Center for Air Toxic Metals (CATM). It is through the EERC that my fellow co-inventors and I would eventually discover the invention claimed in U.S. patent application serial no. 15/978,760. Our research focused heavily on developing new methods for detecting, measuring, and ultimately, removing mercury from coal-fired power plant exhaust gas.

4. In 1997 and 1998, the EPA issued two reports to Congress: *Mercury Study Report to Congress* (issued December 1997)[2] and *Study of Hazardous Air Pollutant Emissions*

[1] Website: https://www.epa.gov/clean-air-act-overview/1990-clean-air-act-amendment-summary-title-iii
[2] United States Environmental Protection Agency, "Mercury Study Report to Congress, Volume I: Executive Summary", EPA-452/R-97-003, December 1997, https://www.epa.gov/mercury/mercury-study-report-congress

from Electric Utility Steam (issued February 1998)[3]. As an outcome of these studies, the EPA found a pressing need for regulation of mercury pollution from power plants.[4] Unfortunately, it also found that no existing technologies were up to the task of significantly reducing the mercury pollution from those plants.[5]

5. With that said, the EPA did provide some indications as to promising areas for future research. For example, similar to cited reference U.S. patent no. 5,435,980 ("Felsvang"), the EPA noted a connection between the chlorine content in coal and potential ways to remove mercury.[6] It also identified activated carbon injection as a potential control technology for mercury removal.[7] Nonetheless, it acknowledged that much more research was needed:

> Research continues on the chemistry and interactions of flue gas, fly ash, and mercury species. This fundamental research is needed at various flue gas conditions encountered across the utility industry in order to develop low cost mercury strategies for full-scale utility operation. Thus, while AC injection shows promise as a mercury control technology, more data and research are needed to understand the factors that affect mercury removal.[8]

6. In the wake of these reports, various governmental and industry organizations injected millions of dollars into basic scientific research and experimental studies in the

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[3] United States Environmental Protection Agency, "Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units -- Final Report to Congress", United States Office of Air Quality EPA-453/R-98-004a, Environmental Protection Planning and Standards, February 1998, https://www.epa.gov/mats/study-hazardous-air-pollutant-emissions-electric-utility-steam-generating-units-final-report

[4] On March 15, 2005, the EPA issued the Clean Air Mercury Rule to significantly reduce mercury emissions from coal-fired power plants, with a goal of reducing utility emissions of mercury from 48 tons/year to 15 tons/year, a reduction of nearly 70 percent. See, https://en.wikipedia.org/wiki/Mercury_regulation_in_the_United_States.

[5] Footnote 3 reference at ES-19, "Regarding potential methods for reducing mercury emissions, the EPA has not identified any demonstrated add-on control technologies currently in use in the U.S. that effectively remove mercury from utility emissions."

[6] Footnote 3 reference at section 13, pages 37-38.

[7] Footnote 3 reference at section 13, pages 40-41.

[8] Footnote 3 reference at section 13, page 43, second full paragraph.

search for new mercury removal technologies.[9] Because increased regulation of mercury emissions was expected to require significant upgrades to the country's fleet of coal-fired plants, much of the research focused on retrofit technologies that could be adopted at relatively low cost, including sorbent injection systems[10].

The EPA Espouses the Conventional Wisdom in Favor of Pre-Treated Sorbents, Not In-Flight Sorbent Enhancement in the Flue Gas

7. In 2002, the EPA surveyed the state of research in this field and produced a follow-up report.[11] It noted that the complex chemistry of the coal combustion process was still not fully understood, but that progress had been made. It described how coals with higher halogen content (specifically, chlorine) were better able to oxidize mercury and promote its capture.[12] However, it also noted that this oxidation reaction could be inhibited by other chemicals present during combustion in the boiler.[13] The EPA also described promising experiments being performed with halogen-treated sorbents.[14]

8. Notably, the EPA did not recommend in-flight sorbent enhancement in the flue gas by spraying additives on coal or injecting halogens into the boiler. Rather, it described research into methods for *pre-treating* sorbents with various additives, including chlorine, and then injecting those pre-treated sorbents downstream from the

[9] T. D. Brown, D. N. Smith, R. A. Hargis Jr., W. J. O'Dowd, 1999, Mercury Measurement and Its Control: What We Know, Have Learned, and Need to Further Investigate, Journal of the Air & Waste Management Association, 49:6, 1-97, DOI: 10.1080/10473289.1999.10463841
[10] Footnote 9 reference at page 80, first column.
[11] J. D. Kilgroe, C. B. Sedman, R. K. Srivastava, J. V. Ryan, C. W. Lee, S. A. Thorneloe, Control of Mercury Emissions from Coal-Fired Electric Utility Boilers: Interim Report, U.S. Environmental Protection Agency, Office of Research and Development, EPA-600/R-01-109, December 2001
[12] Footnote 11 reference at section 6, page 7, first full paragraph.
[13] Footnote 11 reference at section 5, page 7, second full paragraph "It is speculated that SO_2 and water vapor may inhibit gas-phase oxidation of Hg^0 by scavenging the chlorinating agent."
[14] Footnote 11 reference at ES-8, second-to-last full paragraph, "Impregnation of carbons with sulfur, iodine, or chlorine can increase the reactivity and capacity of sorbents."

boiler.[15] This approach ensured that, e.g., chlorinating agents could react with the sorbent material without being "scavenged" by other chemicals present in the boiler. This approach also ensured that the sorbent additive would have plenty of time to react with the sorbent—the EPA explained that, for many plants, injected sorbents would have only a few seconds to find and react with mercury present in the flue gas, with high and costly carbon-to-Hg ratios needed to achieve adequate mercury removal.[16] This is consistent with the general understanding in the industry that sorbent additives such as halogens or halides should be mixed with sorbents *before* coming in contact with mercury-containing flue gas.

Sidney Nelson Touts Brominated Sorbent, Not In-Flight Sorbent Enhancement in the Flue Gas

9. The same year the EPA published its follow-up report,[17] on April 24, 2002, Sidney Nelson filed the provisional application for the cited reference U.S. patent publication no. 2004/0003716 ("Nelson"), U.S. provisional application no. 60/377,790 ("Nelson provisional"). His application reported experiments that he had conducted using sorbents pre-treated with Br_2 and HBr. His application demonstrated that those pre-treated sorbents could outperform some commercially available sorbents, explaining exposing the activated carbon to concentrated forms of Br_2 or HBr outside the flue gas allows a relatively large quantity of the concentrated Br_2 or HBr to react with the activated carbon.[18]

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[15] Footnote 11 reference at section 5, paragraph bridging pages 33-34.
[16] Footnote 11 reference at 5-33, "Activated carbon duct injection seems to be the most promising Hg control technology for coal-fired electric utility boilers equipped with ESPs. In this technology, the injected activated carbon removes Hg only while contacting the flue gas during very limited sorbent/gas contact time (<3 seconds)." Note that this section of the report refers to the reaction between pre-treated chlorinated sorbent and mercury as occurring "in-flight." To be clear, this portion of the report describes only the use of a pre-treated sorbent, not the claimed invention.
[17] Footnote 11 reference.
[18] Nelson at paragraph [0043], "…it appears that in exposing PAC to concentrated bromine gas, a relatively large quantity of the bromine reacts with the carbon, forming surface compounds on the large surface-area of the carbon."

10. Consistent with EPA teachings, Nelson did not recommend or teach adding chemicals to the flue gas or in-flight mixing of Br_2 and HBr with sorbents. Quite the contrary, he recommended that the bromine be contacted with the sorbent outside the presence of boiler gases "…for a sufficient time…" to ensure that enough bromine reacted with the sorbent.[19] Treatment times for HBr- and Br_2-treatment of activated carbon described by Nelson were on the order of several minutes (1.5-100 minutes)[20]; in contrast, only a few seconds are available for in-flight sorbent enhancement in the flue gas (e.g., generally less than 10 seconds)[16]. He also identified an even further reason to avoid in-flight sorbent enhancement in the flue gas: he noted that bromine compounds are "…quite corrosive."[21] As a result, he recommended mixing bromine and sorbent in equipment "…preferably lined with corrosion-resistant material…"[21] such as Teflon[22]—— an approach that is not possible when bromine is added to coal or injected upstream from or into the boiler.

11. Despite the development of brominated sorbents and other advancements in the field, by 2003, the EPA recognized that there was still no "single best technology that can be broadly applied" for mercury capture.[23]

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[19] Nelson at paragraphs [0023], [0028], and claim 1.
[20] Nelson at page 8, paragraph [0087] and the table at the top of the second column. For HBr-treated activated carbon, the adsorption rate was 1 gram of HBr absorbed per 1 kg of activated carbon per minute, or 0.1 wt% HBr absorbed per minute, meaning that to reach the 9 wt% HBr reported in the table required about 90 minutes. Note that Figure 14 reports results for 10 wt% HBr, and Figure 15 reports results for 9 wt% HBr. For Br_2-treated activated carbon, the adsorption rate was 10 grams of Br_2 absorbed per 1 kg of activated carbon per minute, or 1 wt% Br_2 absorbed per minute, meaning that to reach the 15 wt% Br_2 reported in the table required about 15 minutes. Note that Figures 14 and 15 report results for 1.5 wt%, 5 wt%, and 15 wt% Br_2, according to the table requiring about 1.5 to 15 minutes to form.
[21] Nelson at paragraph [0044].
[22] Nelson provisional at page 4, last paragraph.
[23] J. H. Pavlish, E. A. Sondreal, M. D. Mann, E. S. Olson, K. C. Galbreath, D. L. Laudal, S. A. Benson, "Status Review of Mercury Control Options for Coal-Fired Power Plants", Fuel Processing Technology 82 (2003) 89–165, at page 89, first paragraph.

The EPA Continues to Teach Away from In-Flight Sorbent Enhancement in the Flue Gas

12. In 2005, the EPA issued another follow-on report.[24] In this report, the EPA again noted the connection between chlorine content in coal and mercury capture.[25] It also recognized the advantages of brominated carbon sorbents.[26] The report also notes that halogen-containing sorbent enhancement additives have been added to coal along with injection of activated carbon sorbents into the flue gas to remove mercury.[27] However, despite being aware of these facts—facts that the examiner has relied on to demonstrate obviousness of the claims at issue—in the final summary the EPA does not recommend, or even mention, in-flight sorbent enhancement in the flue gas.[28] Although the EPA's "key observations" for retrofitting the country's coal plant fleet mention the use of fuel additives and the injection of activated carbon into the flue gas, the use of these technologies together is not mentioned, and in-flight enhancement of the sorbent in the flue gas is not mentioned; rather, injection of pre-treated halogenated activated carbon is emphasized.[29]

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[24] U.S. Environmental Protection Agency, "Control of Mercury Emissions from Coal Fired Electric Utility Boilers: An Update", Air Pollution Prevention and Control Division, National Risk Management Research Laboratory, Office of Research and Development, February 18, 2005

[25] Footnote 24 reference at page 25, third-to-last bullet point. See also, page 10, second paragraph, with regard to chloride salts on coal, noting that "Long term effects, such as corrosion, plugging, impacts on combustion equipment could not be assessed during the short-term parametric tests. Therefore, the use of coal additives offer some promise at improving mercury capture; however, they may have other impacts that need to be evaluated."

[26] Footnote 24 reference at pages 18-21.

[27] Footnote 24 reference at page 22, second paragraph. See also, page 24, second-to-last full paragraph, "Additives used to enhance PAC performance or other sorbents that may be used, however, might cause adverse effects on plant components. The potential for such impacts would have to be evaluated through long-term field testing conducted over time periods of several months or more."

[28] Footnote 24 reference at pages 30-32.

[29] Footnote 24 reference at pages 31-32, items 6 and 9, discussing injection of activated carbon and halogenated activated carbon, are the only items to highlight specific mercury removal levels, and fail to mention halogenated fuel additives or in-flight sorbent enhancement in the flue gas.

13. The EPA's failure to recommend the use of halogenated fuel additives in combination with injection of activated carbon into the flue gas to cause in-flight enhancement of the sorbent in the flue gas is particularly striking because my coinventors and I had already begun publishing results from initial testing of in-flight sorbent enhancement in the flue gas. The EPA acknowledged those results in their report, noting that 63% mercury removal was achieved, and specifically found that this approach is different from merely using pre-treated sorbent.[27] Nonetheless, despite having this initial data as a roadmap to arrive at the claimed invention, the EPA continued to espouse the conventional view in favor of pre-treated sorbents.

The Department of Energy Funds Research into In-Flight Sorbent Enhancement in the Flue Gas

14. Despite the EPA's optimism for injection of pre-treated halogenated carbon sorbents into the flue gas in the early 2000s, various research groups were pursuing alternative technologies during this time period. The EERC was one of those groups. After extensive research into methods for detecting and measuring mercury species, and some research into various sorbents, my co-inventors and I theorized that in-flight sorbent enhancement in the flue gas could provide an improvement over pre-treated sorbent.

15. The EERC obtained funding to test this theory in 2003 from the U.S. Department of Energy's National Energy Technology Laboratory (DOE/NETL) under the Office of Fossil Energy's Innovations for Existing Plants (IEP) Program.[30] The goal of Phases I and II of the program was development of Hg control technologies that could achieve 50 to 70% Hg capture at costs 25 to 50% less than the baseline 1999 estimate.[31] Our initial pilot-scale tests suggested that our approach could achieve mercury removal efficiencies

[30] T.J. Feeley III, J. Murphy, J. Hoffmann, S. A. Renninger, A Review of DOE/NETL's Mercury Control Technology R&D Program for Coal-Fired Power Plants, April 2003.
[31] Footnote 30 reference, page 3, second paragraph.

ranging from 50-90%. As a result, the EERC successfully obtained several multi-million-dollar awards under the program.[32]

In-Flight Sorbent Enhancement in the Flue Gas Is Finally Recognized as a Critical Advancement

16. It is estimated that over $60 million dollars was spent by the EERC on the research, development, testing, and demonstration of mercury removal from flue gas.[33] In 2008, DOE published a document highlighting the successful development and demonstration of the technology.[34] Some of the key advantages of the technology are highlighted as follows[34, 35]:

- Improves mercury oxidation and enhances activated carbon reactivity, which can improve capture in downstream equipment.
- Allows use of more abundantly available supplies of activated carbon (treated activated carbons have limited supply).
- Improves mercury capture while using far less activated carbon.
- Improves mercury capture efficiencies in some instances to greater than 90% (standard ACs can be limited to around 60%).
- Allows for performance and cost optimization of SEA and activated carbon at each site.
- Minimizes ESP particulate and opacity problems by using lower amounts of activated carbon.
- Minimizes fabric filter particulate emissions and pressure drop while allowing the unit to operate at maximum load by using lower amounts of activated carbon.

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[32] Footnote 30 reference, page 2, second paragraph; page 5 at Table 1; page 6 at Table 2; page 7 at Table 3; page 9, first full paragraph; page 13, last paragraph; page 17, last full paragraph; paragraph bridging pages 17-18; page 18, first full paragraph; and page 19, last partial paragraph.

[33] https://www.midwestemissions.com/

[34] U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, Cooperative Research and Development, "Successes: Sorbent Enhancement Additive Technology for Mercury Control", 2008

[35] A. P. Jones, J. W. Hoffmann, D. N. Smith, T. J. Feeley, J. T. Murphy, "DOE/NETL's Phase II Mercury Control Technology Field Testing Program: Preliminary Economic Analysis of Activated Carbon Injection," Environ. Sci. Technol., 2007, 41 (4), pp 1365–1371. DOI: 10.1021/es0617340, January 17, 2007.

In-Flight Sorbent Enhancement in the Flue Gas Experiences Commercial Success and Is Copied by Sidney Nelson and Other Competitors

17. One of the most straightforward indications of the success of the invention comes from chemical giant Albemarle, one of the largest suppliers of bromine worldwide. In 2008, Albemarle acquired Sidney Nelson's brominated sorbent company Sorbent Technologies Corp. and the Nelson patent.[36] Albermarle continued to market and sell brominated carbon sorbents. Nonetheless, today, even Albemarle now sells chemicals and systems for in-flight sorbent enhancement in the flue gas.[37]

18. In fact, even Mr. Nelson himself ultimately accepted the benefits of in-flight sorbent enhancement in the flue gas. In a post-Albemarle acquisition presentation entitled "How China Can Leapfrog the World in Mercury Emission Reduction", he noted that pre-treated sorbents were accepted in the U.S., but he recommended that Chinese operators should instead use in-flight sorbent enhancement in the flue gas.[38] As his basis for proposing that new approach he did not cite his own research or some commonly understood reference or theory from the 1990s or early 2000s. Rather, he relied on data collected by myself and my colleagues at the EERC and published in 2006.[39]

19. Despite the initial success of pre-treated sorbents, in-flight sorbent enhancement in the flue gas has more recently experienced important growth in the U.S. EPA data indicates that in-flight sorbent enhancement in the flue gas is currently used by more than

[36] See, U.S. assignment database for U.S. patent no. 6,953,494, assigned to Sorbent Technologies Corporation on 9/18/2006, and assigned to Albemarle Corporation on 9/30/2010. See also, http://www.chemeurope.com/en/news/85387/albemarle-corporation-acquires-sorbent-technologies-corporation.html.
[37] https://www.albemarle.com/businesses/bromine-specialties/bromine-&-derivatives/mercury-control, at the "ADDITIVES" tab.
[38] https://www.dri.edu/images/stories/editors/leapfrog/techprog/IId_3_NelsonJr.pdf at slide 24.
[39] Footnote 38 reference at slide 20.

one-third of all plants in the U.S.,[40] and it has been recognized as one of the key technologies enabling cost effective mercury removal from coal plant exhaust.

20. I further declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by a fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and/or any patent issued thereon.

Dated: March 20, 2019 By: / John Pavlish /

John Pavlish

[40] EPA Air Markets Program Data: https://ampd.epa.gov/ampd/. From this webpage, the "Query" tab was clicked. For programs and data sets, the program "mercury and air toxics standards (MATS)" and the data set "facility attributes" were selected, and then "next step" was clicked. For time frame, "select a range" was selected from 2019 to 2019, and then "next step" was clicked. For criteria, nothing was selected, and then "next step" was clicked. For variables, only the variables "owner", "fuel type (primary)", and "mercury controls" were selected, and then "next step" was clicked. The CSV file was downloaded, and then the "facility" file was opened as an Excel spreadsheet. The data was sorted to include only coal plants, column G, which totaled 606. Column H was then sorted to include only additives to enhance PAC; the total number was 70. Column H was then sorted to include only the units that had actually filled out what mercury control technology they are using, which totaled 228. Assuming that the 228 units are a random sampling of the 606 total, that number statistically represents all of the units and the distribution of different mercury control approaches. Thus, if 70 units are using coal additives with PAC and 228 units are representative of the 606, about 1/3 (e.g., 70/228 = 0.31) of the units are using coal additives with PAC.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

PETITION FOR A THREE-MONTH EXTENSION OF TIME

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P.O. Box 1450
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In accordance with the provision of 37 C.F.R § 1.136(a), it is respectfully requested that a three-month extension of time be granted in which to respond to the Final Office Action mailed January 11, 2019, said period of response being extended from April 11, 2019 to July 11, 2019.

Please charge Deposit Account No. 19-0743 in the amount of $1,400.00 to cover the required extension fee. Please charge any additional fees or credit overpayment to deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date July 10, 2019

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

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ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

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AMENDMENT	07/10/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 30	Minus	** 20	= 10		x $100 =	1000
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	1000

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 2	Attorney Docket No: 4820.001U10	

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	"Application Serial No. 15/295,594, Response filed 4-23-19 to Non Final Office Action mailed 10-23-18", 45 pgs	
	"Application Serial No. 15/382,114, Response filed 3-12-19 to Non Final Office Action mailed 12-12-18", 24 pgs	
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	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 2 of 2	Attorney Docket No: 4820.001U10	

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	NELSON, SID JR., et al., "How China Can Leapfrog the World in Mercury Emission Reductions", Proc. of the AWMA Intl. Specialty Conference on Leapfrogging Opportunities for Air Quality Improvement, (2010), 24 pgs	
	PAVLISH, JOHN H., et al., "Status review of mercury control options for coal-fired power plants", Fuel Processing Technology, Vol. 82, (2003), 77 pgs	
	YANG, YANG, et al., "Effect of HBr formation on mercury oxidation via CaBr(2) addition to coal during combustion", RSC Advances, 6(64), (2016), 7 pgs	

EXAMINER **DATE CONSIDERED**

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.	Examiner: Amber Orlando
Serial No.: 15/997,091	Group Art Unit: 1776
Filed: June 4, 2018	Docket: 4820.001U10
Customer No.: 21186	Confirmation No.: 5161
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R §1.97(e)(2)

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. Applicant respectfully requests that this Information Disclosure Statement be entered and the documents listed on the attached PTO 1449 Form be considered by the Examiner and made of record. Pursuant to the provisions of MPEP 609, Applicant requests that a copy of the PTO 1449 Form, initialed as being considered by the Examiner, be returned to the Applicant with the next official communication.

Pursuant to 37 C.F.R. § 1.97(d)(1) and 37 C.F.R. § 1.97(e)(2), Applicant states that no item of information contained in the Supplemental Information Disclosure Statement was cited in any communication from a foreign patent office in a counterpart foreign application and that no item of information contained in the Supplemental Information Disclosure Statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

Pursuant to 37 C.F.R. § 1.97(d)(2), Applicant hereby authorizes the Commissioner to charge the fee of $240.00 as set forth in 37 C.F.R. § 1.17(p), to Deposit Account No. 19-0743. Please charge any additional fees or deficiencies, or credit any overpayment to Deposit Account No. 19-0743.

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicant acknowledges the requirement to submit

copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date May 7, 2019 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:mlr1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X Supplemental Information Disclosure Statement (2 pgs.), Form 1449 (2 pgs.) Copies of Cited References (23).

X Authorization to charge Deposit Account 19-0743 in the amount of $240.00 to cover the fee for consideration of Information Disclosure Statement under 37 C.F.R. § 1.97(c).

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By: /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Steven M. Reid/Megan Reed
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	35939668
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Steven M. Reid/Megan Reed
Filer Authorized By:	Steven M. Reid
Attorney Docket Number:	4820.001US10
Receipt Date:	07-MAY-2019
Filing Date:	04-JUN-2018
Time Stamp:	14:32:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	050819INTEFSW00000839190743
Deposit Account	
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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	Transmittal Letter		2	3	
	Transmittal Letter		1	1	
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Information:					
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Modified form PTO/SB/08A(04-07) OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 4820.001U10	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-20190009247A1	1/10/2019	Olson, Edwin S, et al.

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Foreign Document Number	Publication Date	Name of Patentee or Applicant of cited Document	T 1

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 1
	"Application Serial No. 14/712,558, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-19-18", 28 pgs	
	"Application Serial No. 14/712,558, Final Office Action mailed 01-11-19", 27 pgs	
	"Application Serial No. 15/382,114, Non Final Office Action mailed 12-12-18", 46 pgs	
	"Application Serial No. 15/589,359, Amendment and Response filed 01-17-19 to Non Final Office Action mailed 10-22-18", 14 pgs	
	"Application Serial No. 15/974,343, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-29-18", 37 pgs	
	"Application Serial No. 15/974,343, Final Office Action mailed 01-14-19", 25 pgs	
	"Application Serial No. 15/978,760, Amendment and Response filed 12-03-18 to Non Final Office Action mailed 10-10-18", 25 pgs	
	"Application Serial No. 15/978,760, Final Office Action mailed 12-26-18", 21 pgs	

EXAMINER **DATE CONSIDERED**

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	David L. Buck/Jamie Johnson
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	35256393
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	David L. Buck/Jamie Johnson
Filer Authorized By:	David L. Buck
Attorney Docket Number:	4820.001US10
Receipt Date:	26-FEB-2019
Filing Date:	04-JUN-2018
Time Stamp:	15:42:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$240
RAM confirmation Number	022719INTEFSW00002460190743
Deposit Account	
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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	Transmittal Letter		2	3	
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Information:					
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Information:					
			Total Files Size (in bytes):	7951217	

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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X Supplemental Information Disclosure Statement **Pursuant to 37 C.F.R. § 1.97(d)(1) and 37 C.F.R. § 1.97(e)(2)** (2 pgs.), Form 1449 (1 pg.) Copies of Cited References (8).
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SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By: /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R §1.97(e)(2)

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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longer required to be provided to the Office. Applicant acknowledges the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 02/26/2019 By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

NPL:jj

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 01/11/2019

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
01/11/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Office Action Summary	Application No. 15/997,091	Applicant(s) Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/03/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1,4 and 6-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1,4 and 6-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the

contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claim 1, 4 and 6-20 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Felsvang et al. US 5,435,980 in view of Nelson US 2004/0003716.

For claim 1, the Felsvang et al. reference discloses a method for reducing mercury in a mercury-containing gas, the method comprising: combusting coal that comprises an additive (column 4, lines 39-45), to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site (figure, objects 14 and 4, and column 4, lines 5-11); collecting mercury in the mercury-containing gas on a sorbent to produce a cleaned gas (column 5, lines 41-65), wherein the sorbent comprises a promoted activated carbon that is promoted in-flight (column 4, lines 39-50, 5-15 and column 6, lines 12-31) in a gas stream at the coal combustion facility site comprising active carbon dispersed in the gas stream with at least one promoter (column 4, line 63 – column 5, line 2 and column 6, lines 29-42). The reference does not disclose the additive comprising is Br_2, HBr, Br^- or a combination thereof and the at least one promoter is HBr, Br^-, or a combination thereof.

The Nelson reference discloses the promoter/additive is Br_2, HBr, Br^- or a combination thereof (paragraphs [0017] and [0041]).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Felsvang et al. reference to either replace the Cl with or include in addition to the Cl, Br_2, HBr, Br^- or a combination thereof (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury. Furhter the Felsvang et al. reference discloses that the

For claim 4, the Felsvang et al. reference discloses the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor (column 4, lines 39-50).

For claims 6 and 7 as detailed above each of the claimed steps are disclosed by the combination of Felsvang and Nelson reference and therefore the result of performing the steps would inherently be the same and would result in the promoted activated carbon comprises active sites, comprising halide anions bound to the activated carbon and the promoted activated carbon comprises active sites comprising carbocations bound to halide anions.

For claim 8 the promoted sorbent is disclosed by the combination of Felsvang and Nelson. Further each of the steps as claimed above are also shown by Felsvang and Nelson and would inherently have the same results when the method is performed and would result in collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

For claims 9 and 10, the Felsvang et al. reference discloses injecting an alkaline sorbent into the mercury-containing gas stream, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof (column 4, lines 23-28, column 5, lines 26-40 and clam 3).

For claim 11, the Felsvang et al. reference discloses the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (column 4, lines 27-32).

For claim 12, the Felsvang et al. reference discloses the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof (column 3, lines 5-17).

For claim 13, the Nelson reference discloses the promoter is HBr or Br^- (paragraphs [0017] and [0041]).

For claim 14, the Felsvang et al. reference discloses the mercury-containing gas is a flue gas stream downstream of a boiler furnace (column 5, lines 23-26, abstract and column 3, lines 4-55).

For claim 15, the Felsvang et al. reference discloses monitoring the mercury content of the cleaned gas is performed substantially continuously (column 6, lines 42-47).

For claim 16, the Felsvang et al. reference does not explicitly state the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon. The reference does disclose optimizing the amount of Cl and activated carbon introduced (column 6, lines 42-47).

Further the Nelson reference also discloses optimizing of the promoter so as to obtain a desired mercury reactivity (paragraph [0054]).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Felsvang et al. reference to include the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon (Felsvang et al. column 6, lines 42-46 and Nelson paragraph [0054]) so as to adjust the among of halogen introduced based on the Hg content and to ensure optimum reaction between the halogen and the activated carbon. Further the courts have held that that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller,* 105 USPQ 233.

For claim 17, the Felsvang et al. reference discloses injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon (column 4, lines 39-46 and column 6, lines 6-11).

For claims 18 and 19, the Felsvang et al. reference discloses collecting greater than 70 wt% of the mercury in the mercury-containing gas and collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent (examples 1, 3 and 4). Further the examiner asserts that these limiations are the results of the method. As the method is disclosed by Felsvang et al. and Nelson as shown above, the result of such a combination would occur, i.e. the degree of separation of mercury.

For claim 20, the Felsvang et al. reference discloses the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method further comprising: monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting a sorbent comprising activated carbon into the mercury-containing gas, a rate at which the promoter is added to the sorbent comprising activated carbon, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (column 6, lines 42-47).

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file

provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 7,435,286 ('286) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '286 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. US 8,168,147 ('147) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '147 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,512,655 ('655) in view of Felsvang et al. US 5,435,980.

'655 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '655 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,821,819 ('819) in view of Felsvang et al. US 5,435,980.

'819 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '819 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-33 of U.S. Patent No. US 9,757,689 ('689) in view of Felsvang et al. US 5,435,980.

'689 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '689 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of U.S. Patent No. US 9,468,886 ('886) in view of Felsvang et al. US 5,435,980.

'886discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '886 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4,

lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. 8,652,235 ('235) in view of Felsvang et al. US 5,435,980.

'235discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '235 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/295594 ('594) in view of Felsvang et al. US 5,435,980.

'594 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '594 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 8-20 of copending Application No. 15/589359 ('359).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '359.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 14/712558 ('558). Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '558.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/951970 ('970). Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '970.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/382114 ('114) in view of Felsvang et al. US 5,435,980.

'114 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '114 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/978,760 ('760) in view of Felsvang et al. US 5,435,980.

'760 discloses the claimed invention except for the coal comprising the additive.

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '760 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1, 4 and 6-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-10, 14 and 21-25 of copending Application No. 15/974,343 ('343).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '760.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Response to Arguments

Applicant's arguments, see pages 5-9, filed 12/03/2018, with respect to the 35 U.S.C 112 rejections as well as the 35 U.S.C 102 rejection and the 35 U.S.C 103 rejections with Nelson as the primary reference have been fully considered and are persuasive.

Applicant's arguments filed 12/03/2018 pages 9-39 have been fully considered but they are not persuasive.

The applicant traverses the combination of Felsvang and Nelson combination stating that there is no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process. The applicant contends that one having ordinary skill in the art would not be motivated to replace Felsvang's chloride-treatment with treatment by another material as the prior art does not disclose the bromide additives performing the same or better mercury-removal efficiency.

The examiner disagrees. See Fig. 14 of Nelson which shows that about 3 times the amount of chlorine treated PAC was required to achieve the same degree of mercury removal as with bromine. (paragraph [0085]). Also see the absorption rate in the table on page 8. Further as the rejection above states. Both chlorine and bromine are known within the art to treat activated carbon and therefore it would be well within the capability of one having ordinary skill in the art to *either replace the Cl with or include in addition to* the halogen or halide promoter comprising HBr, Br^-, or a combination thereof to promote activated carbon (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury.

The applicant contends that the Nelson reference does not disclose HBR and Br^- being more effect with activated carbons than chlorides.

The examiner disagrees. The Nelson reference discloses that HBr is used to provide bromide to the system. Example 5, paragraph [0083] states that the brominated PACs were treated with HBr or Br_2. Figures 14 and 15 disclose that HBr treated PAC performs better than chlorine treated PAC. Further one having ordinary skill in the art would expect PAC treated with HBr or Br_2 would result in a very similar

modified PAC as they both include bromide (see paragraph [0092] which discloses that each of the brominated PACs performed similarly). The examiner also points to paragraph [0087] of Nelson which discloses that PAC adsorption of gaseous hydrogen bromide being ten times faster than it was for chlorine.

The applicant contends that the bromide pormoters are more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas. The applicant further provides a graph to demonstrate these unexpected results.

These unexpected results are not commensurate with the scope of the claims. The applicant is claiming HBr and Br- while the graph only demonstrates HBr. Further the comparisons between the prior art and that of the current invention do no demonstrate unexpected results. The applicants data is unclear as it is either HBr (as specified in the actual graph) or NaBr (as specified in the legend). Further the 18.2 data point has no labeling on what the promoter is. None of the data point include what amount is being specified, wt%, vol% etc. The results would be expected by one having ordinary skill in the art as the wt% (if we are to assume the amount specified is wt) of the amount supported on the upper most line is greater than that of the wt% on the middle trending line. Further claim 1 does not include NaBr on coal. Lastly is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods.

The second graph on page 12 comparing NaBr on coal to HBr treated AC and it is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. To do that the graph would have to be comparing HBr in the present method to HBr is the prior art method. Further the applicant has not shown the amount of promoter supported by each (wt%) data point. Lastly claim 1 does not include NaBr on coal.

The third graph on page 13 compares HBr treated AC and NaBr on coal with AC injected into flue gas. The graph states Milligram of HBr/MMacF/1%Hg Removed. As HBr is not a part of the current application data points it is unclear how to interpret this graph. Claim 1 does not include NaBr on coal. Further is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods.

The applicant contends that there is no way a person of ordinary skill in the art could predict from the cited references that in-flight promotion of a sorbent with bromide promoters is more effective for mercury removal.

The examiner contends that the applicant has not established that it is more effective.

The applicant contends that one having ordinary skill in the art would not have predicted in-flight chloride promotion of activated carbon to be more effective for mercury removal that in-fligh chloride promotion.

The examiner disagrees. Nelson discloses that bromide is a better promoter of AC for the purpose of mercury removal as shown above. Therefore one having ordinary skill in the art would expect an inflight bromide promoted sorbent to superior to and inflight chloride promoted sorbent.

The applicant argues that one having ordinary skill in the art would not predict this advantage from the cited references.

The examiner disagrees for the reasons stated above.

The applicant contends that "Even if a person of ordinary skill in th art compared the mercury removal of Felsvang's activated carbons promoted with Chloride in the flue gas to activated carbond treated with HCL outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties".

This appears to be merely conjecture by the applicant as no factual evidence has been presented.

The graphs on pages 18 and 19, has NaCl compared to HCl. It is unclear if the results are because of the different components being reacted or because of the different method being used. In order to establish that the method being used has unexpected results the components used must be the same for both methods. Further the examiner points to the y-axis which has HCl which is not included in one set (NaCl) of the data points so it is unclear how the data points are being obtained.

The applicant contends that using activated carbon treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide pormoters for in-flight promosotion results in greater mercury removal than using activated carbon only treated with bromide additives.

The results shown only described HCl and Br_2, HCl not being within the current claim set and Br_2 not encompassing each of the limitations claimed. Therefore the results shown are not commensurate with the scope of the claim. Further the results shown in the Mercury Vapor Species at ESP Outlet and %Hg Removal, disclose NaBr and NaCl, which is not claimed. Lastly the assertion is not commensurate with the scope of the claim as activated carbon treated with bromide additives outside the flue gas is not being claimed. Further the examiner asserts that merely adding more bromide to the activated carbon to produce more Hg removal would be expected as a great amount of bromide added to activated carbo results in greater Hg removal (Nelson paragraph [0054]).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ROSE ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Monday-Thursday 7:00-5:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571)272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer

Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AMBER ROSE. ORLANDO
Primary Examiner
Art Unit 1776

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	Art Unit
	AMBER R ORLANDO	1776

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Text Search (See east search history)	07/23/2018	AO
Inventor Search (DAV)	07/23/2018	AO
Text Search (See east search history)	10/29/2018	AO
Text Search (See east search history)	01/07/2019	AO

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776

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Group Art Unit	1776
Examiner Name	Amber Orlando

Sheet 1 of 19

Attorney Docket No: 4820.001U10

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	"Application Serial No. 10/554,018 Response filed 11-01-10 to Final Office Action mailed 04-27-10", 17 pgs	
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	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 7 of 19	Attorney Docket No: 4820.001U10	

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	"Application Serial No. 12/429,058, Advisory Action mailed 05-29-12", 3 pgs	
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	"Application Serial No. 14/712,558, Response filed 01-23-18 to Final Office Action mailed 12-06-17", 13 pgs	
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	"Application Serial No. 15//974,343 Preliminary Amendment Filed 5-15-2018", 7 pgs.	
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	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 13 of 19	Attorney Docket No: 4820.001U10	

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EXAMINER /AMBER R ORLANDO/ **DATE CONSIDERED** 01/07/2019

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant is to place a check mark here if English language Translation is attached

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	45	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S2	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorben and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S3	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:20
S7	73	("20020150516" | "4786483" | "5409522" | "5505766" | "6383981" | "6878358" | "20020033097" | "4530765" | "5346674" | "6080281" | "4708853" | "6027551" | "6136072" | "6258334" | "6818043" | "20060057044" | "20080207443" | "20010002387" | "3826618" | "4814152" | "4820318" | "4889698" | "5891324" | "6528030" | "20050227146" | "5419834" | "7942566" | "20080134888" | "3662523" | "3849267" | "4196173" | "4500327" | "6942840" | "20020134242" | "20030136509" | "20050147549" | "20060112823" | "20080134888" | "6471936" | "20010003116" | "20050019240" | "20060048646" | "4956162" | "5575982" | "6372187" | "6375909" | "7435286" | "7514052" | "20050074380" | "20090081092" | "5288306" | "1984164" | "4101631" | "5695726" | "6080281" | "6848374" | "20050000197" | "5300137" | "5607496" | "5672323" | "6214304" | "6953494" | "5245120" | "20070168213" | "7938571" | "20040003716" | "20040013589" | "3194629" | "3786619" | "5827352" | "20040109800" | "20070295347" | "5435980" | "6136749" | "20030206846").PN.	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:25
S8	13	"11209163"	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S9	3	"11209163" and non carbon	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S10	161	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:49
S11	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50

		sorbent and promoter and activated carbond and mercury				
S12	116	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S13	172	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S14	67	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S15	67	"6136749"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:11
S16	20	"684374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S17	1	"20040003716"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S18	68	"6848374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S19	41	"7435286"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S20	13	"8168147"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S21	69	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S22	181	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S25	28	"5266280"	US-PGPUB; USPAT	ADJ	ON	2016/06/07 13:41
S26	281	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:01
S27	148	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:02
S28	159	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 16:18
S29	206	(sorbent or activated carbon) with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4 and	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2016/09/29 16:22

		activated carbon	EPO; JPO; DERWENT; IBM_TDB			
S30	195	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/09/30 13:48
S33	6	"20040003719"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:56
S34	49	"2004003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:57
S35	81	"6848374"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:58
S36	56	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:02
S37	7	olson.in. and ("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:04
S38	0	("40" microns and halocarbon sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S39	0	(halocarbon sorbent).clm. and "40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S40	65	"40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2016/11/16 11:06

			DERWENT; IBM_TDB			
S41	3907	("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S42	29	("40" microns and sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S43	1	(halocarbon sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S44	36	(sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S45	0	(sorbent).clm. and olson.in. and "40" micron	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S46	17	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:09
S47	2	"20110233133"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:27
S48	7	"20110023427"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:28
S49	15	"2004025274"	US-PGPUB; USPAT; USOCR;	ADJ	ON	2016/11/16 11:32

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S50	11	"20040025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:32
S51	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S52	40	"6312489"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S53	30	("20030024872" | "20050045553" | "20050144916" | "4008060" | "4640779" | "4655921" | "4673503" | "4738778" | "4746432" | "4799944" | "5043000" | "5051118" | "5120296" | "5174896" | "5320657" | "5512075" | "5674302" | "6152979" | "6312489" | "6315130" | "6336946" | "6398836" | "6585793" | "6598749" | "7648546").PN. OR ("7931723").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:36
S54	33	("4200444" | "4640779" | "5968215" | "6059851").PN. OR ("6312489").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:40
S55	5	"8518142"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:54
S56	4	"8747505"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:57
S57	2	"14318270"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 12:06
S58	13	pac with size with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 12:13
S59	197	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/11/16 15:23
S60	0	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10,	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39

		B01D53/10).cpc. and (halogen or halide of HBr) with sorbent "4198388"				
S61	10	"4198388"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39
S62	0	"2010083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S63	2	"20100083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S64	2	absorp$5 with mea with methanol with acid	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:36
S65	2	"20070283813"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:39
S66	21	"4469596"	US-PGPUB; USPAT	ADJ	ON	2016/11/21 08:29
S67	4	"2003229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S68	2	"20030229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S69	45	"5,338,458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S70	45	"5338458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S71	213	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:02
S72	64	("1786483" | "1984164" | "2317857" | "20010002387" | "20010003116" | "20020134242" | "20020150516" | "20030136509" | "20040003716" | "20040013589" | "20050019240" | "20060048646" | "20060191835" | "20090062119" | "20100047146" | "20120183458" | "20140056787" | "3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "4196173" | "4500327" | "4814152" | "4820318" | "4889698" | "4959162" | "5300137" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" |	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:20

		"5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "7101631" | "7435286" | "7479263" | "7514052" | "7563311" | "7611564" | "8007749" | "8168147" | "8168149" | "8512655").PN.				
S73	3	("20090235848" | "20110076210" | "20150246315").PN.	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:31
S79	3	("20090235848" | "20110076210" | "20140224121").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:36
S80	96	("1984164" | "2317857" | "20010002387" | "20010003116" | "20020043496" | "20020134242" | "20020150516" | "20030104937" | "20030136509" | "20040003716" | "20040013589" | "20040076570" | "20050019240" | "20060048646" | "20060191835" | "20080182747" | "20080292512" | "20090062119" | "20090136401" | "20090320678" | "20100047146" | "20110168018" | "20120183458" | "20130280156" | "20140056787" | "20140255279" | "20140308188" | "20150098878" | "3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "3876393" | "4094777" | "4101631" | "4196173" | "4338896" | "4500327" | "4708853" | "4786483" | "4814152" | "4820318" | "4889698" | "4956162" | "5300137" | "5336835" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6638485" | "6808692" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "6960329" | "7081434" | "7211707" | "7435286" | "7479263" | "7514052" | "7521032" | "7544338" | "7563311" | "7611564" | "7622092" | "7722843" | "7767174" | "7780765" | "8007749" | "8168147" | "8168149" | "8216535" | "8512655" | "8652235" | "8821819" | "9011805").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:41
S81	593	honeycomb with plug$4 and plug$4 with length	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S82	0	honeycomb with plug$4 and plug$4 with length with less than with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S83	0	honeycomb with plug$4 and plug$4 with length with less than	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S84	127	honeycomb with plug$4 and plug$4 with length with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:46
S85	241	honeycomb with plug$4 and plug$4 with length with mm	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:47
S86	41	honeycomb with plug$4 and plug$4 with	US-PGPUB;	ADJ	ON	2017/06/27

		length with "3 mm "	USPAT			14:49
S87	28	honeycomb with plug$4 and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:52
S88	28	honeycomb and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:53
S89	43	honeycomb and plug$4 with porosity with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:06
S90	20	honeycomb and plug$4 with pore (size or diameter) with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:07
S91	8	saw with honeycomb with filter	US-PGPUB; USPAT	ADJ	ON	2017/06/29 13:31
S92	230	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/12/01 14:36
S93	2	"20060260468"	US-PGPUB; USPAT	ADJ	ON	2018/07/03 10:34
S94	19	engine with air with inlet with filter$4 with cone	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:26
S95	36	engine with air with inlet with filter$4 with (cone or conical or (diameter with (increas$4 or decreas$4)))	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:27
S96	24	("3771638" | "3870495" | "3872012" | "4157902" | "4702754" | "5125940" | "5522909" | "5549724" | "5632793").PN. OR ("5888260").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S97	41	("0153535" | "0439091" | "1398685" | "1530163" | "1887052" | "2087688" | "4003836" | "4018580" | "4032455" | "4039308" | "4065276" | "4261710" | "4410341" | "4414110" | "4699715" | "5106397" | "5178656" | "5522909" | "5549722" | "5549724" | "5888260" | "6397842" | "6508052" | "D401597" | "D401942" | "D403414" | "D403416").PN. OR ("6808552").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S98	15	("D403416").URPN.	USPAT	ADJ	ON	2018/07/03 15:33
S99	0	"20030089233"	USPAT	ADJ	ON	2018/07/04 12:29
S100	3	"20030089233"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S101	26	"6833023"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S102	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:08
S103	14	carbocations with sorbent with bromine	US-PGPUB; USPAT;	ADJ	ON	2018/07/09 13:14

			USOCR; FPRS; EPO; JPO			
S104	0	a side forming a cross sectional shape of each of the first	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:47
S105	0	non of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S106	0	none of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S107	0	none of sides forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S109	13	olson.in. and (alkali and promoter and earth).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S110	0	olson.in. and (alkali and promoter and earth with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S111	10	olson.in. and (alkali and promoter with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S112	0	"2015008283"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S113	2	"20150082833"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S114	24	olson.in. and liquid.clm. and promoted	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:50
S115	75	remov$4 with mercury and (br or bromine) with liquid with carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:54
S116	0	separating greater than "70" wt% of the mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17
S117	0	((separating greater) with (of the mercury)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17
S118	20	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:43

S119	40	(during with after with mercury with sorbent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:38
S120	304	sorbent with mercury and sorbent with boiler	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:39
S121	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:41
S122	18	before with burn$4 with coal with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:42
S123	204	("0174348" | "0202092" | "0208011" | "0224649" | "0229159" | "0298727" | "0346765" | "0347078" | "0367014" | "0537926" | "0537998" | "0541025" | "0625754" | "0647622" | "0685719" | "0688782" | "0700888" | "0744908" | "0846338" | "0894110" | "0896876" | "0911960" | "0945331" | "0945846" | "1112547" | "1167471" | "1167472" | "1183445" | "1788466" | "1984164" | "20020065581" | "20020114749" | "20020184817" | "20030088370" | "20030103882" | "20040003716" | "20040013589" | "20040086439" | "20040219083" | "20050039598" | "20060047526" | "20060210463" | "2016821" | "2059388" | "2089599" | "2511288" | "3194629" | "3288576" | "3437476" | "3599610" | "3662523" | "3725530" | "3764496" | "3823676" | "3838190" | "3849267" | "3849537" | "3956458" | "3961020" | "3974254" | "4040802" | "4075282" | "4094777" | "4101631" | "4115518" | "4148613" | "4174373" | "4196173" | "4226601" | "4233274" | "4272250" | "4280817" | "4305726" | "4322218" | "4377599" | "4387653" | "4394354" | "4440100" | "4472278" | "4474896" | "4519807" | "4519995" | "4555392" | "4582936" | "4602918" | "4629721" | "4693731" | "4716137" | "4741278" | "4758418" | "4764219" | "4786483" | "4804521" | "4807542" | "4824441" | "4830829" | "4873930" | "4886519" | "4892567" | "4915818" | "4933158" | "4936047" | "4964889" | "5013358" | "5024171" | "5049163" | "5116793" | "5126300" | "5137854" | "5162598" | "5190566" | "5238488" | "5350728" | "5368617" | "5409522" | "5435980" | "5447703" | "5460643" | "5505746" | "5505766" | "5571490").PN. OR ("5587003" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/01 17:42

		"5618508" | "5635150" | "5659100" | "5670122" | "5733516" | "5738834" | "5787823" | "5810910" | "5897688" | "5910292" | "5989506" | "6024931" | "6083289" | "6240859" | "6258334" | "6372187" | "6375909" | "6475451" | "6521021" | "6528030" | "6533842" | "6558454" | "6610263" | "6613110" | "6719828" | "6732055" | "6737031" | "6746531" | "6790420" | "6808692" | "6848374" | "6878358" | "6942840" | "6953494" | "6962617" | "6974564" | "6975975" | "7468170" | "7507083" | "7674442" | "7758827" | "7776301").PN.				
S124	1	"15573128"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:07
S125	2	"20110207597"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:08
S126	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S127	71	sorbent with before with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S128	234	"6953494"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:38
S129	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:40
S130	35	promoter with sorbent and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S131	28	promoter with sorbent with mercury and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S132	4	promoter with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:20
S133	4	promot$4 with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:23

S134	4	promot$4 with sorbent with mercury and pre.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:41
S135	2	promot$4 with sorbent with mercury and pre-heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:42
S136	2	promot$4 with sorbent with mercury and pre heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S137	57	promot$4 with sorbent with mercury and pre	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S138	24	sorbent with preheat$4 with coal	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:39
S139	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:47
S140	23	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:28
S141	5	"14102896"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:48
S142	7	"12429058"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:09
S143	4	"12202595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:23
S144	20	"12201595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:24
S145	3	"14564860"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:27

S146	1	"15978760"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:28
S147	1	"15589359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:32
S148	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:37
S149	8	"15997091"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S150	6	"14712558"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S151	2	"15951970"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:18
S152	4	"15382114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:47
S153	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:51
S154	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:18
S155	69	"4279873"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:42
S156	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 07:59
S157	4	"15295594"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 08:08

S158	1	("20180257030").PN.	US-PGPUB; USPAT	ADJ	ON	2018/10/04 09:31
S159	86	"5569436"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:32
S160	6	"5785935"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S161	8	"6475471"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S162	53	"6103205"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:46
S163	0	pyrolysis with char with mercury with activated	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S164	17	pyrolysis with char with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S165	121	pyrolysis with char with activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S166	0	pyrolysis with char with activated carbon with mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S167	43	pyrolysis with char with activated carbon and mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S168	118	pyrolysis with char with tire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 12:04
S169	58	pyrolysis with char with activated carbon and mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 12:04
S170	8	"20040081724"	US-PGPUB; USPAT; USOCR;	ADJ	ON	2018/10/04 15:07

			FPRS; EPO; JPO			
S171	4	"14128179"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 15:10
S172	84	activat$4 carbon with boiler with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S173	88	activat$4 carbon with boiler with coal and (remov$4 or filter$4 or absorb$4 or adsorb$4) with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S174	0	mercury with stabiliz$4 with sulfer dioxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 14:23
S175	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 15:07
S176	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:48
S177	17	"8821819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:51
S178	15	"8652235"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:55
S179	93	"6136749"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/24 09:08
S180	4	"9757689"	US-PGPUB; USPAT	ADJ	ON	2018/10/24 12:37
S181	9	"8939388"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 09:59
S182	669	urea with inject$4 with filter$4 with exhaust	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:15

S183	2	urea with inject$4 with filter$4 with exhaust and urea with quench$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:16
S184	13	"3615165"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:35
S185	136	urea with quench$4 with remov$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:39
S186	48	urea dust with scrub$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 11:25
S187	38	"6221155"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 12:04
S188	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 14:12
S189	773	ammonium with remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:14
S190	108	ammonium with salt with remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:15
S191	45	ammonium with salt with remov$4 with mercury and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:15
S192	42	"5556447"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:21
S193	174	"4500327"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:21
S194	72	"4500327" and ammonium	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:23

S195	3	anionic couterion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S196	3480	anionic counterion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S197	2422	anionic counterion and ammonium with salt	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S198	9	anionic counterion and ammonium with salt and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:32
S199	52	"6960329"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/03 14:50
S200	4	"20040003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/12/06 11:23
S201	1	"45219176".FMID.	US-PGPUB; USPAT; FPRS	ADJ	ON	2018/12/06 13:32

1/ 7/ 2019 8:55:29 AM
C:\ Users\ amillerharris\ Documents\ EAST\ Workspaces\ 12429058.wsp

S/N 15/997,091 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION CONCERNING PRIOR OR COPENDING APPLICATION(S)

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Pursuant to the guidance of MPEP §§ 2001.06(b) and 2004(9), Applicant would like to bring the following additional application(s) to the Examiner's attention. The identification of these applications is not intended to suggest that the subject matter claimed in any listed application is, or has been, substantially similar to any claim or claims in the present application.

Serial No./ Patent No.	Filing Date	Attorney Docket	Title
11/209,163 7,435,286	August 22, 2005	4820.001US1	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
12/201,595	August 29, 2008	4820.001US2	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
12/419,219 8,168,147	April 6, 2009	4820.001US3	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
13/427,665 8,512,655	March 22, 2012	4820.001US4	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
13/966,768 8,821,819	August 14, 2013	4820.001US5	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/318,270 9,757,689	June 27, 2014	4820.001US6	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/712,558	May 14, 2015	4820.001US7	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

/AMBER R ORLANDO/ 01/07/2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

15/951,970	April 12, 2018	4820.001US8	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/195,360 9,669,355	March 3, 2014	4820.003US1	ACTIVATED CARBON SORBENT INCLUDING NITROGEN AND METHODS OF USING THE SAME
15/974,343	May 8, 2018	4820.001US9	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/589,359	May 8, 2017	4820.003US2	ACTIVATED CARBON SORBENT INCLUDING NITROGEN AND METHODS OF USING THE SAME
15/382,114	December 16, 2016	4820.004US1	PROMOTED AMMONIUM SALT-PROTECTED ACTIVATED CARBON SORBENT PARTICLES FOR REMOVAL OF MERCURY FROM GAS STREAMS
15/449,112 10,130,930	March 3, 2017	4820.005US1	SORBENT COMPRISING CARBON AND NITROGEN AND METHODS OF USING THE SAME
16/130,670	September 13, 2018	4820.005US2	SORBENT COMPRISING CARBON AND NITROGEN AND METHODS OF USING THE SAME
12/429,058 8,652,235	April 23, 2009	4820.007US1	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/102,896 9,468,886	December 11, 2013	4820.007US2	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/295,594	October 17, 2016	4820.007US3	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/978,760	May 14, 2018	4820.007US4	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/853,029	December 22, 2017	4820.018US1	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Respectfully submitted,

/AMBER R ORLANDO/ 01/07/2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 12/04/2018 By /Nicholas P. Lanzatella/

Nicholas P. Lanzatella
Reg. No. 63,803

01/07/2019

/AMBER R ORLANDO/

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.O/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

INFORMATION DISCLOSURE STATEMENT

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. Applicant respectfully requests that this Information Disclosure Statement be entered and the documents listed on the attached PTO 1449 Form be considered by the Examiner and made of record. Pursuant to the provisions of MPEP 609, Applicant requests that a copy of the PTO 1449 Form, initialed as being considered by the Examiner, be returned to the Applicant with the next official communication.

Pursuant to 37 C.F.R. § 1.97(c)(2), Applicant hereby authorizes the Commissioner to charge the fee of $240.00 as set forth in 37 C.F.R. § 1.17(p), to Deposit Account No. 19-0743. Please charge any additional fees or deficiencies, or credit any overpayment to Deposit Account No. 19-0743.

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicant acknowledges the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 12/04/2018 By /Nicholas P. Lanzatella/

Nicholas P. Lanzatella
Reg. No. 63,803

NPL:jj

Modified form PTO/SB/08A(04-07) OMB 651-0031
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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	15/997,091
Filing Date	June 4, 2018
First Named Inventor	Edwin S. Olson
Group Art Unit	1776
Examiner Name	Amber Orlando

Sheet 1 of 19

Attorney Docket No: 4820.001U10

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document
	US-1,984,164	12/11/1934	Alfred, Stock
	US-2,317,857	4/27/1943	Soday, Frank J
	US-2,456,272	2/7/2002	Pahlman, John, et al.
	US-3,194,629	7/13/1965	Dreibelbis, John A, et al.
	US-3,341,185	9/12/1967	Kennedy, Sr, Walter L
	US-3,662,523	5/16/1972	Revoir, William H, et al.
	US-3,786,619	1/22/1974	Melkersson, Karl-axel
	US-3,826,618	7/30/1974	Capuano, Italo A
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Complete if Known	
Application Number	15/997,091
Filing Date	June 4, 2018
First Named Inventor	Edwin S. Olson
Group Art Unit	1776
Examiner Name	Amber Orlando

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Group Art Unit	1776
Examiner Name	Amber Orlando

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	"Application Serial No. 12/419,219, Response filed 07-15-10 to Non Final Office Action mailed 01-15-10", 22 pgs	
	"Application Serial No. 12/419,219, Response filed 10-27-11 to Non Final Office Action mailed 08-04-11", 12 pgs	

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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 8 of 19	Attorney Docket No: 4820.001U10	

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
Examiner Initial *	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T 1**
	"Application Serial No. 12/429,058, Advisory Action mailed 05-29-12", 3 pgs	
	"Application Serial No. 12/429,058, Ex Parte Quayle Action mailed 02-14-13", 7 pgs	
	"Application Serial No. 12/429,058, Examiner Interview Summary mailed 12-28-12", 4 pgs	
	"Application Serial No. 12/429,058, Final Office Action mailed 10-31-12", 21 pgs	
	"Application Serial No. 12/429,058, Final Office Action mailed 12-20-11", 21 pgs	
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	"Application Serial No. 12/429,058, Notice of Allowance mailed 09-11-13", 11 pgs	
	"Application Serial No. 12/429,058, Response filed 01-31-13 to Final Office Action mailed 10-31-12", 19 pgs	
	"Application Serial No. 12/429,058, Response filed 03-07-13 to Ex Parte Quayle Action mailed 02-14-13", 7 pgs	
	"Application Serial No. 12/429,058, Response filed 05-11-12 to Final Office Action mailed 12-20-11", 11 pgs	
	"Application Serial No. 12/429,058, Response filed 09-11-12 to Non Final Office Action mailed 06-11-12", 16 pgs	
	"Application Serial No. 12/429,058, Response filed 10-18-11 to Non Final Office Action mailed 07-19-11", 17 pgs	
	"Application Serial No. 13/427,665, Non Final Office Action mailed 01-04-13", 23 pgs.	
	"Application Serial No. 13/427,665, Non Final Office Action mailed 08-03-12", 12 pgs.	
	"Application Serial No. 13/427,665, Notice of Allowance mailed 04-16-13", 8 pgs	
	"Application Serial No. 13/427,665, Response filed 03-21-13 to Non Final Office Action mailed 01-04-13", 20 pgs	
	"Application Serial No. 13/427,665, Response filed 10-10-12 to Non Final Office Action mailed 08-03-12", 15 pgs	
	"Application Serial No. 13/427,685, Preliminary Amendment filed 03-22-12", 3 pgs	
	"Application Serial No. 13/453,274, Advisory Action mailed 11-24-14", 3 pgs	
	"Application Serial No. 13/453,274, Final Office Action mailed 10-16-14", 4 pgs	
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	"Application Serial No. 13/453,274, Notice of Allowance mailed 01-05-15", 5 pgs	
	"Application Serial No. 13/453,274, Response filed 09-02-14 to Non Final Office Action mailed 05-30-14", 13 pgs.	
	"Application Serial No. 13/453,274, Response filed 11-06-14 to Final Office Action mailed 10-16-14", 7 pgs.	
	"Application Serial No. 13/453,274, Response filed 12-09-14 to Advisory Action mailed 11-24-14", 6 pgs	
	"Application Serial No. 13/966,768, Non Final Office Action mailed 12-06-13", 7 pgs.	

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	"Application Serial No. 13/966,768, Notice of Allowability mailed 08-01-14", 6 pgs	
	"Application Serial No. 13/966,768, Notice of Allowance mailed 04-18-14", 7 pgs	
	"Application Serial No. 13/966,768, Preliminary Amendment filed 08-14-13", 3 pgs.	
	"Application Serial No. 13/966,768, Response filed 03-06-14 to Non Final Office Action mailed 12-06-13", 6 pgs.	
	"Application Serial No. 13/966,768, Supplemental Preliminary Amendment filed 08-15-13", 6 pgs.	
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	"Application Serial No. 14/102,896, Non Final Office Action mailed 03-23-15", 13 pgs	
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	"Application Serial No. 14/102,896, Response filed 01-22-16 to Advisory Action mailed 12-16-15", 11 pgs	
	"Application Serial No. 14/102,896, Response filed 06-22-15 to Non Final Office Action mailed 03-23-15", 10 pgs	
	"Application Serial No. 14/102,896, Response filed 11-24-15 to Final Office Action mailed 08-26-15", 5 pgs	
	"Application Serial No. 14/195,360, Corrected Notice of Allowance mailed 02-27-17", 2 pgs	
	"Application Serial No. 14/195,360, Corrected Notice of Allowance mailed 03-29-17", 2 pgs	
	"Application Serial No. 14/195,360, Final Office Action mailed 03-18-16", 18 pgs	
	"Application Serial No. 14/195,360, Final Office Action mailed 11-22-16", 7 pgs	
	"Application Serial No. 14/195,360, Non Final Office Action mailed 06-20-16", 11 pgs	
	"Application Serial No. 14/195,360, Non Final Office Action mailed 06-20-16", 11 pgs	
	"Application Serial No. 14/195,360, Non Final Office Action mailed 11-24-15", 19 pgs	
	"Application Serial No. 14/195,360, Notice of Allowance mailed 02-07-17", 5 pgs	
	"Application Serial No. 14/195,360, Response filed 01-18-17 to Final Office Action mailed 11-22-16", 7 pgs.	
	"Application Serial No. 14/195,360, Response filed 02-22-16 to Non Final Office Action mailed 11-24-15", 21 pgs.	
	"Application Serial No. 14/195,360, Response filed 05-17-16 to Final Office Action mailed 03-18-16", 15 pgs	
	"Application Serial No. 14/318,270, Advisory Action mailed 02-17-17", 4 pgs	
	"Application Serial No. 14/318,270, Corrected Notice of Allowance mailed 05-22-17", 2 pgs	
	"Application Serial No. 14/318,270, Final Office Action mailed 11-25-16", 25 pgs	
	"Application Serial No. 14/318,270, Non Final Office Action mailed 06-02-16", 24 pgs	
	"Application Serial No. 14/318,270, Notice of Allowance mailed 05-15-17", 8 pgs	
	"Application Serial No. 14/318,270, Response filed 01-25-17 to Final Office Action mailed 11-25-16", 14 pgs	

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	"Application Serial No. 14/318,270, Response filed 02-27-17 to Final Office Action mailed 11-25-16", 15 pgs	
	"Application Serial No. 14/318,270, Response filed 03-02-16 to Restriction Requirement mailed 01-14-16", 9 pgs.	
	"Application Serial No. 14/318,270, Response filed 08-22-16 to Non Final Office Action mailed 06-02-16", 14 pgs.	
	"Application Serial No. 14/318,270, Restriction Requirement mailed 01-14-16", 8 pgs	
	"Application Serial No. 14/564,860, Final Office Action mailed 11-17-16", 4 pgs	
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	"Application Serial No. 14/564,860, Preliminary Amendment filed 12-10-14", 6 pgs.	
	"Application Serial No. 14/564,860, Response filed 05-06-16 to Restriction Requirement mailed 03-16-16", 9 pgs.	
	"Application Serial No. 14/564,860, Response filed 10-03-16 to Non Final Office Action mailed 07-12-16", 11 pgs	
	"Application Serial No. 14/564,860, Restriction Requirement mailed 03-16-16", 5 pgs	
	"Application Serial No. 14/712,558, Advisory Action mailed 02-12-18", 8 pgs	
	"Application Serial No. 14/712,558, Examiner Interview Summary mailed 03-05-18", 3 pgs	
	"Application Serial No. 14/712,558, Final Office Action mailed 12-06-17", 9 pgs	
	"Application Serial No. 14/712,558, Non Final Office Action mailed 07-02-18", 16 pgs	
	"Application Serial No. 14/712,558, Non Final Office Action mailed 07-06-17", 7 pgs	
	"Application Serial No. 14/712,558, Non Final Office Action mailed 10-19-18", 26 pgs	
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	"Application Serial No. 14/712,558, Response filed 10-06-17 to Non Final Office Action mailed 07-06-17", 12 pgs	
	"Application Serial No. 14/712,558, Supplemental Amendment filed 06-13-2018", 14 pgs.	
	"Application Serial No. 14/712,558, Supplemental Amendment Filed 5-15-2018", 6 pgs.	
	"Application Serial No. 14/712,558, Supplemental Preliminary Amendment filed 05-15-15", 6 pgs	
	"Application Serial No. 15//974,343 Preliminary Amendment Filed 5-15-2018", 7 pgs.	
	"Application Serial No. 15//978,760, Preliminary Amendment Filed 5-15-2018", 7 pgs.	

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	"Application Serial No. 15/295,594, Non Final Office Action mailed 10-23-18", 20 pgs	
	"Application Serial No. 15/295,594, Preliminary Amendment filed 01-26-17", 8 pgs	
	"Application Serial No. 15/295,594, Preliminary Amendment filed 06-13-17", 7 pgs	
	"Application Serial No. 15/295,594, Response filed 07-03-18 to Restriction Requirement mailed 05-22-18", 9 pgs.	
	"Application Serial No. 15/295,594, Response filed 07-24-18 to Restriction Requirement mailed 06-29-18", 9 pgs.	
	"Application Serial No. 15/295,594, Restriction Requirement mailed 05-22-18", 6 pgs	
	"Application Serial No. 15/295,594, Restriction Requirement mailed 06-29-18", 5 pgs	
	"Application Serial No. 15/295,594, Supplemental Amendment Filed 5-15-2018", 10 pgs.	
	"Application Serial No. 15/382,114, Preliminary Amendment filed 04-04-17", 3 pgs	
	"Application Serial No. 15/382,114, Response filed 09-12-18 to Restriction Requirement mailed 08-28-18", 8 pgs.	
	"Application Serial No. 15/382,114, Restriction Requirement mailed 08-28-18", 9 pgs	
	"Application Serial No. 15/449,112, Advisory Action mailed 04-24-18", 3 pgs	
	"Application Serial No. 15/449,112, Final Office Action mailed 02-15-18", 13 pgs	
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	"Application Serial No. 15/449,112, Response filed 01-16-18 to Non Final Office Action mailed 09-27-17", 16 pgs	
	"Application Serial No. 15/449,112, Response filed 02-15-18 to Final Office Action mailed 02-15-18", 13 pgs.	
	"Application Serial No. 15/449,112, Response filed 04-06-18 to Final Office Action mailed 02-15-18", 13 pgs	
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	"Application Serial No. 15/589,359, Final Office Action mailed 06-04-18", 13 pgs	
	"Application Serial No. 15/589,359, Final Office Action mailed 09-12-18", 14 pgs	
	"Application Serial No. 15/589,359, Non Final Office Action mailed 02-21-18", 15 pgs	
	"Application Serial No. 15/589,359, Non Final Office Action mailed 10-22-18", 12 pgs	
	"Application Serial No. 15/589,359, Preliminary Amendment filed 01-03-18", 6 pgs	
	"Application Serial No. 15/589,359, Response filed 05-18-18 to Non Final Office Action mailed 02-21-18", 14 pgs.	
	"Application Serial No. 15/589,359, Response filed 07-26-18 to Non Final Office Action mailed 06-04-18", 14 pgs.	
	"Application Serial No. 15/589,359, Response filed 09-14-18 to Final Office Action mailed 09-12-18", 18 pgs.	
	"Application Serial No. 15/974,343, Non Final Office Action mailed 07-27-18", 12 pgs	
	"Application Serial No. 15/974,343, Non Final Office Action mailed 10-29-18", 22 pgs	

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	"Application Serial No. 15/974,343, Response filed 08-14-18 to Non Final Office Action mailed 07-27-18", 11 pgs	
	"Application Serial No. 15/978,760 , Response filed 07-13-18 to Non Final Office Action mailed 06-29-18", 12 pgs	
	"Application Serial No. 15/978,760, Non Final Office Action mailed 06-29-18", 9 pgs	
	"Application Serial No. 15/978,760, Non Final Office Action mailed 10-10-18", 17 pgs	
	"Application Serial No. PCT/US04/12828, International Search Report mailed 10/22/2004", 2 pgs	
	"Application Serial No. PCT/US2014/019916, International Preliminary Report on Patentability mailed 09-17-15", 14 pgs	
	"Application Serial No.14/195,360, Response filed 09-16-16 to Non Final Office Action mailed 06-30-16", 12 pgs.	
	"Bromine and its Compounds", Jolles, Z. E., Editor, Academic Press, Inc., New York, NY, (1966), pgs. 193 and 205	
	"Canadian Application Serial No. 2,523,132, Office Action mailed 07-18-11", 3 pgs	
	"Canadian Application Serial No. 2,523,132, Response filed 01-16-12 to Office Action mailed 7-18-11", 5 pgs	
	"Canadian Application Serial No. 2,584,327, Office Action mailed 03-03-09", 4 pgs.	
	"Canadian Application Serial No. 2,584,327, Office Action mailed 12-07-09", 2 pgs	
	"Canadian Application Serial No. 2,584,327, Response filed 03-19-10 to Office Action mailed 12-07-09", 8 pgs	
	"Canadian Application Serial No. 2,584,327, Response filed 09-02-09 to Office Action mailed 03-03-09", 21 pgs	
	"Canadian Application Serial No. 2,707,363, First Examiners Report Received 6/16/11", 2 pgs	
	"Canadian Application Serial No. 2,757,309, Office Action mailed 12-07-15", 3 pgs	
	"Canadian Application Serial No. 2,757,309, Response filed 06-06-16 to Office Action mailed 12-07-15", 13 pgs	
	"Canadian Application Serial No. 2,757,309, Voluntary Amendment filed 01-30-15", 27 pgs	
	"Canadian Application Serial No. 2,871,422, Response filed 02-26-16 to Office Action mailed 09-09-15", 13 pgs.	
	"Canadian Application Serial No. 2,871,422, Office Action mailed 04-02-15", 5 pgs	
	"Canadian Application Serial No. 2,871,422, Office Action mailed 04-24-18", 4 pgs	
	"Canadian Application Serial No. 2,871,422, Office Action mailed 08-31-17", 4 pgs	
	"Canadian Application Serial No. 2,871,422, Office Action mailed 09-09-15", 3 pgs	
	"Canadian Application Serial No. 2,871,422, Office Action mailed 12-22-16", 5 pgs	
	"Canadian Application Serial No. 2,871,422, Response filed 02-26-18 to Office Action mailed 08-31-17", w/ Amended Claims, 53 pgs	

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	"Canadian Application Serial No. 2,871,422, Response filed 06-21-17 to Office Action mailed 12-22-16", 41 pgs	
	"Canadian Application Serial No. 2,871,422, Response filed 08-28-15 to Canadian Office Action mailed 04-02-15", 22 pgs	
	"Chinese Application Serial No. 200480017704.4, Office Action mailed 12-08-11", (w/ English Translation), 6 pgs	
	"Chinese Application Serial No. 200480017704.4, Response filed 01-20-12 to Office Action mailed 12-08-12", (w/ English Translation of Amended Claims), 10 pgs.	
	"Chinese Application Serial No. 200580037037.0, Chinese Office Action, dated June 25, 2013 (and English translation)", no english translation, 46 pgs	
	"Chinese Application Serial No. 201380033231.6, Office Action mailed 09-21-15", w/ Partial English Translation, 6 pgs	
	"Chinese Application Serial No. 201380033231.6, Response filed 01-14-16 to Office Action mailed 09-21-15", w/ English Claims, 7 pgs	
	"Chinese Application Serial No. 201480025701.9, Office Action mailed 01-16-18", (w/ English Translation), 8 pgs	
	"Chinese Application Serial No. 201480025701.9, Office Action mailed 07-12-17", W/ English Translation, 8 pgs	
	"Chinese Application Serial No. 201480025701.9, Office Action mailed 07-25-16", (With English Translation), 4 pgs	
	"Chinese Application Serial No. 201480025701.9, Office Action mailed 12-23-16", W/ English Translation, 39 pgs	
	"Chinese Application Serial No. 201480025701.9, Office Action mailed 12-23-16", 24 pgs.	
	"Chinese Application Serial No. 201480025701.9, Response filed 03-27-18 to Office Action mailed 01-16-18", w/ English Claims, 20 pgs	
	"Chinese Application Serial No. 201480025701.9, Response filed 09-15-17 to Office Action mailed 07-12-17", w/ English Translation, 21 pgs	
	"DARCO® FGD- Powdered Activated Carbon", Norit Americas Inc. Datasheet No. 1100, (May 2009), 1 pg	
	"DATABASE WPI Week 197450", Thomson Scientific, London, GB; AN 1974-86199V XP002514926	
	"European Application Serial No. 05814011.2, Response filed 09-09-11 to European Search Report mailed 04-14-09 and Office Actioin mailed 11-05-09", 20 pgs.	
	"European Application Serial No. 05814011.2, Communication Pursuant to Article 94(3) EPC mailed 11-05-09", 4 pgs	
	"European Application Serial No. 05814011.2, Decision to grant mailed 06-08-12", 2 pgs	
	"European Application Serial No. 05814011.2, Extended European Search Report mailed 04-14-09", 13 pgs	
	"European Application Serial No. 05814011.2, Office Action mailed 01-25-08", 2 pgs.	
	"European Application Serial No. 05814011.2, Office Action mailed 01-31-12", 4 pgs	

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	"European Application Serial No. 05814011.2, Office Action mailed 11-05-09", 2 pgs.	
	"European Application Serial No. 05814011.2, Partial European Search Report mailed 04-14-09", 13 pgs.	
	"European Application Serial No. 05814011.2, Response filed 02-28-12 to Office Action mailed 01-31-12", 30 pgs	
	"European Application Serial No. 05814011.2, Response filed 04-18-08 to Office Action mailed 01-25-08 and Third-Party Observations submitted 12-04-07", 7 pgs.	
	"European Application Serial No. 05814011.2, Response filed 05-11-10 to Communication Pursuant to Article 94(3) EPC mailed 11-05-09", 11 pgs	
	"European Application Serial No. 05814011.2, Response filed 05-11-10 to Office Action mailed 11-05-09", 11 pgs.	
	"European Application Serial No. 05814011.2, Response filed 09-09-11 to Extended European Search Report mailed 04-14-09", 20 pgs	
	"European Application Serial No. 05814011.2, Third Party Observations submitted 03-19-12", 7 pgs.	
	"European Application Serial No. 05814011.2, Third Party Observations submitted 12-04-07", 5 pgs.	
	"European Application Serial No. 10767465.7, Decision to grant mailed 04-17-14", 2 pgs	
	"European Application Serial No. 10767465.7, Extended European Search Report mailed 12-06-12", 5 pgs	
	"European Application Serial No. 10767465.7, Intention to Grant mailed 03-17-14", 44 pgs	
	"European Application Serial No. 10767465.7, Intention to Grant mailed 09-30-13", 44 pgs	
	"European Application Serial No. 10767465.7, Response filed 02-03-14 to Intention to Grant mailed 09-30-13", 11 pgs	
	"European Application Serial No. 10767465.7, Response filed 06-20-13 to Extended European Search Report mailed 12-06-12", 18 pgs	
	"European Application Serial No. 10767465.7, Supplementary European Search Report dated December 6, 2012", 2 pgs	
	"European Application Serial No. 11189249.3, Communication Pursuant to Article 94(3) EPC mailed 11-26-12", 4 pgs	
	"European Application Serial No. 11189249.3, Decision to Refuse mailed 12-19-13", 18 pgs	
	"European Application Serial No. 11189249.3, Extended European Search Report mailed 02-01-12", 7 pgs	
	"European Application Serial No. 11189249.3, Office Action mailed 11-04-13", 4 pgs	
	"European Application Serial No. 11189249.3, Response filed 02-04-13 to Communication Pursuant to Article 94(3) EPC mailed 11-26-12", 9 pgs	
	"European Application Serial No. 11189249.3, Response filed 08-28-12 to Extended European Search Report mailed 02-01-12", 9 pgs	

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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	15/997,091
	Filing Date	June 4, 2018
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 15 of 19	Attorney Docket No: 4820.001U10	

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Examiner Initial *	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T 1**
	"European Application Serial No. 11189249.3, Summons to Attend Oral Proceedings mailed 04-15-13", 7 pgs	
	"European Application Serial No. 11189252.7, Communication Pursuant to Article 94(3) EPC mailed 01-09-13", 4 pgs	
	"European Application Serial No. 11189252.7, Decision to grant mailed 05-02-14", 2 pgs	
	"European Application Serial No. 11189252.7, Extended European Search Report mailed 01-23-12", 6 pgs	
	"European Application Serial No. 11189252.7, Extended European Search Report mailed 05-09-12", 12 pgs	
	"European Application Serial No. 11189252.7, Office Action mailed 10-30-13", 4 pgs	
	"European Application Serial No. 11189252.7, Office Action mailed 12-11-13", 6 pgs	
	"European Application Serial No. 11189252.7, Response filed 02-11-13 to Communication Pursuant to Article 94(3) EPC mailed 01-09-13", 5 pgs	
	"European Application Serial No. 11189252.7, Response filed 10-10-13 to Office Action mailed 04-15-13", 18 pgs	
	"European Application Serial No. 11189252.7, Response filed 11-22-12 to Extended European Search Report mailed 05-09-12", 13 pgs	
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Electronic Patent Application Fee Transmittal

Application Number:	15997091
Filing Date:	04-Jun-2018
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Jordan Rivard Golomb/Jamie Johnson
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
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Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
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28	Foreign Reference	0027_gb2122916a.pdf	2775276 7c0651663b3a05e840cf9a8433e1a159d7202e1f	no	20
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37	Foreign Reference	0036_kr20027006149a.pdf	406096 12aa74d61dbc9995842e1e73a07053cca1567105	no	15
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39	Foreign Reference	0038_su732207a1.pdf	727306 c1db7e0554eb4ed31d64590f278edb92bf5def42	no	11
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43	Foreign Reference	0042_wo_2004_089501a2.pdf	6205275 cadb9db10fc40ed1af20845929fa980e2897265a	no	28
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49	Foreign Reference	0048_wo2010123609a1.pdf	5656810 caed5e8a0e9a68bd42984830b59026dc700be6e3	no	41
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50	Foreign Reference	0049_wo2013162968a2.pdf	6839488 e8b5b2e477247fa8ce5a79494cdd544997ca1723	no	64
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51	Foreign Reference	0050_wo2013162968a3.pdf	759298 f4761a2c11a0b32c731d74591ba659202d19010a	no	8
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52	Foreign Reference	0051_wo2014137907a2.pdf	6927677 653f7595cf2fa6bd4d53745542c6b41ff49c5c0d	no	62
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53	Foreign Reference	0052_3338013us1_aarn_110110.pdf	1683177 a42ce96acfc0e2c6f9e2b6230b94f6678e56b1c0	no	17
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54	Non Patent Literature	0053_3338013us1_foar_042710.pdf	604965 a5c5ef9560d496f7cf965a5d2587e6d916c627a2	no	8
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56	Non Patent Literature	0055_10554018_noar_011912.pdf	915943 5c21ce92ff232a3a7393b88b4b98cd384a6e688e	no	7
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57	Non Patent Literature	0056_3338013us1_aarn_020810.pdf	705851 d8332c64ab60fb8329cfc7257a7f0b7793f54b34	no	9
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58	Fee Worksheet (SB06)	fee-info.pdf	30736 3a0e6409bb5f44c36fd52786828 3f8323c67a61f	no	2
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		Total Files Size (in bytes):	191895035		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X Communication Concerning Prior and Copending Applications (3 pgs.)
X Information Disclosure Statement (2 pgs.), Form 1449 (19 pgs.) Copies of Cited References (356).
X Authorization to charge Deposit Account 19-0743 in the amount of $240.00 to cover the fee for consideration of Information Disclosure Statement under 37 C.F.R. § 1.97(c).

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By: /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	15/997,091	Group Art Unit:	1776
Filed:	June 4, 2018	Docket:	4820.001U10
Customer No.:	21186	Confirmation No.:	5161
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION CONCERNING PRIOR OR COPENDING APPLICATION(S)

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Pursuant to the guidance of MPEP §§ 2001.06(b) and 2004(9), Applicant would like to bring the following additional application(s) to the Examiner's attention. The identification of these applications is not intended to suggest that the subject matter claimed in any listed application is, or has been, substantially similar to any claim or claims in the present application.

Serial No./ Patent No.	Filing Date	Attorney Docket	Title
11/209,163 7,435,286	August 22, 2005	4820.001US1	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
12/201,595	August 29, 2008	4820.001US2	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
12/419,219 8,168,147	April 6, 2009	4820.001US3	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
13/427,665 8,512,655	March 22, 2012	4820.001US4	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
13/966,768 8,821,819	August 14, 2013	4820.001US5	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/318,270 9,757,689	June 27, 2014	4820.001US6	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/712,558	May 14, 2015	4820.001US7	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

15/951,970	April 12, 2018	4820.001US8	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
14/195,360 9,669,355	March 3, 2014	4820.003US1	ACTIVATED CARBON SORBENT INCLUDING NITROGEN AND METHODS OF USING THE SAME
15/974,343	May 8, 2018	4820.001US9	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
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16/130,670	September 13, 2018	4820.005US2	SORBENT COMPRISING CARBON AND NITROGEN AND METHODS OF USING THE SAME
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15/295,594	October 17, 2016	4820.007US3	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/978,760	May 14, 2018	4820.007US4	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
15/853,029	December 22, 2017	4820.018US1	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 349-9580

Date 12/04/2018 By /Nicholas P. Lanzatella/

Nicholas P. Lanzatella
Reg. No. 63,803

Electronic Acknowledgement Receipt

EFS ID:	34478007
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
Receipt Date:	04-DEC-2018
Filing Date:	04-JUN-2018
Time Stamp:	13:34:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	0057_3338013us1_rerr_r_081009.pdf	81925 72e59225324f6ab4a66f6c40f1b788f49b083d42	no	1

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2	Non Patent Literature	0058_3338013us1_rerr_060909.pdf	417952 bbfb00b4e6c9be871af80adb7d6111d673a4ceac	no	5
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3	Non Patent Literature	0059_advisory_action_04_21_08.pdf	835797 d93ed6d3d79c8dcc92cbe3e9d000db1cb85aec01	no	3
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4	Non Patent Literature	0060_final_oa_01_23_2008.pdf	5840953 5a42bbdf8d5820dff59f3a35fe2988ac3cce7ba2	no	20
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5	Non Patent Literature	0061_non_final_oa_08_13_07.pdf	4408727 ba9a21e5e7d9c81e967df3d439ff3c1ec069cd09	no	14
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6	Non Patent Literature	0062_3338005us1_noar_101408.pdf	808897 aba50d92a717676173901 8cc986e1293e2bb20f8	no	7
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7	Non Patent Literature	0063_prel_azmend_02_27_07.pdf	1998865 37263ee9c075ab92cece76e2d98a4f2467ebf8da	no	9
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8	Non Patent Literature	0064_response_03_24_08.pdf	10172100 47a300ce2de2b096e7a8524a57485f146f9ed5fb	no	29
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9	Non Patent Literature	0065_3338005us1_rrr_070907.pdf	120264 48052a301c83e349c7290ee76eeedd3af1fc87a3	no	2
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10	Non Patent Literature	0066_3338005us1_aarn_111307.pdf	2255883 c24a72c080064c6508ea8bc6757493a78beb4a14	no	19
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12	Non Patent Literature	0068_3338002us1exir4511.pdf	386122 b21712ef791bde43a71c88716b5d406969b319d1	no	3
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13	Non Patent Literature	0069_3338002us1_foar_051111.pdf	1752780 08a7dba184fe71a98d45f5565e6aeb44e598c964	no	15
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14	Non Patent Literature	0070_3338002us1_oarn_011911.pdf	1489189 fd1ed2a6d0e135322f7fdf594b8937b818625739	no	14
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16	Non Patent Literature	0072_3338002us1_aarf_070811.pdf	95670 cc2bf9eb7f796cd792cb06820a33b2eb42e3aa7f	no	11
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18	Non Patent Literature	0074_nonfinal_oa_04_16_2009.pdf	6039020 70db9e93e9315da54e2bba1cbc24224235e836e3	no	21
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20	Non Patent Literature	0076_final_oa_10_14_10.pdf	5153948 b612fd30dfd07868318edcf3ee73d8bac119b9e6	no	17
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21	Non Patent Literature	0077_non_final_oa_1_15_10.pdf	3870509 966a63015160c62422fc2deb8382787bee35156f	no	13
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24	Non Patent Literature	0080_12419219__noar_011012.pdf	935306 ef91dea959b8a9810e3911761b55a90bae1c38ec	no	7
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28	Non Patent Literature	0084_3338005us3_aarn_071510.pdf	3249308 5cc16e4c54b708fca7838ac4955f199e5d9b87e5	no	22
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29	Non Patent Literature	0085_3338005us3_aarn_102711.pdf	126694 ec2a9ddd8d199ea9e89c7a71b9813b4e947c125f	no	12
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30	Non Patent Literature	0086_5_4820007us1_adar_052912.pdf	408771 51ba15895e2d5ed9e354e85d2bb6a76c57bdf7c6	no	3
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37	Non Patent Literature	0093_14_4820007us1_noar_011614.pdf	473573 a687c244409afc69fa7463587665b9fc16411211	no	5
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39	Non Patent Literature	0095_10_4820007us1_aarf_013113.pdf	2446062 2f89de17f3be7889c109146c8bb2b90e8ff58d15	no	19
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43	Non Patent Literature	0099_2_4820007us1_aarn_101811.pdf	2134590 bb73ceda08b93d385b38478bca6fda1580862adf	no	17
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44	Non Patent Literature	0100_non_final_oa_01_04_13.pdf	8931372 e9413dbe000b947fd5379bfe3f02f8853044 8cc9	no	23
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51	Non Patent Literature	0107_final_oa_10_16_2014.pdf	1118529 5097d73a8ecbe715c9cf09da5e8c039afdee0484	no	4
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57	Non Patent Literature	0113_nonfinal_oa_12_06_13.pdf	2944092 39b0944f20252f1d6856db0c8d643e0298d0c3d7	no	7
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58	Non Patent Literature	0114_noa_08_01_2014.pdf	2727728 490e02cbcb4ffee91100cd03c9b1ff8169a522d7	no	6
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59	Non Patent Literature	0115_noa_4_18_2014.pdf	2843980 dfc2d6f8c85b6d6166aa0f589013b9e3967e1c09	no	7
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60	Non Patent Literature	0116_prel_amend_08_14_13.pdf	427091 cf45471305eb7d1230df43c7ad0c072284f7d75a	no	3
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		Total Files Size (in bytes):	120699064		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Acknowledgement Receipt

EFS ID:	34478116
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
Receipt Date:	04-DEC-2018
Filing Date:	04-JUN-2018
Time Stamp:	13:39:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	0117_response_3_6_2014.pdf	62923 619accbcce44d4e226d6aa14cc62dd73874c2fa9	no	6

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2	Non Patent Literature	0118_supp_prel_amend_08_15_13.pdf	977863 eba2b5477166760 9f16465d97f454be239e102bc	no	6
Warnings:					
Information:					
3	Non Patent Literature	0119_4820007us2_adar_121615.pdf	349062 f69ad0bee4b0a47a17bc4f10f7d5edc79d002529	no	3
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Information:					
4	Non Patent Literature	0120_4820007us2_foar_082615.pdf	1154163 d7181d21c294e55939d4f659818b5ae77d351379	no	12
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5	Non Patent Literature	0121_4820007us2_oarn_032315.pdf	1210853 0cb757edf0a188a45e8c01b5e699b8a8b37f6106	no	13
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Information:					
6	Non Patent Literature	0122_4820007us2_noar_061016.pdf	952730 06d8c74421d2810b0a7f957a3fd63d5bffe7d441	no	7
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Information:					
7	Non Patent Literature	0123_4820007us2_adaf_012216.pdf	1435468 c2037b7b4bc11cbff6c53abcff851f64e210069d	no	11
Warnings:					
Information:					
8	Non Patent Literature	0124_4820007us2_aarn_062215.pdf	1176079 d07bc9cc1775d39f5b395897bf999b9523977b44	no	10
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9	Non Patent Literature	0125_4820007us2_aarf_112415.pdf	671173 0452e5393fd1d82390c922accd0171d80052e45f	no	5
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10	Non Patent Literature	0126_3338021us1_cnoa_022717.pdf	273818 e8b0dba6b97bd4cb23fa1318302aad2ca1c4fcod	no	2
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11	Non Patent Literature	0127_3338021us1_cnoa_032917.pdf	280726 8c90f6ae71415d742850d28732418383 3defd082	no	2
Warnings:					
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12	Non Patent Literature	0128_3338021us1_foar_031816.pdf	1635549 4183cb1b2c2d83159966924c7ca575d1389da212	no	18
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13	Non Patent Literature	0129_3338021us1_foar_112216.pdf	603834 dcbee2841d2888da9c247361bdc60e2aca6f7149	no	7
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14	Non Patent Literature	0130_pages_from_14195360oarnnonfinal_office_action_received20160620.pdf	1174774 49ad440a1ab98651b1db1b2d883ce87296ba3fe5	no	11
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15	Non Patent Literature	0131_3338021us1_oarn_062016.pdf	1021889 1532b6b1b7d7b0f4b04995f622775c7fc6980694	no	11
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16	Non Patent Literature	0132_3338021us1_oarn_112415.pdf	1707160 c334d5399908d3d2c06a96f6ca914fbaeec07cfc	no	19
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17	Non Patent Literature	0133_3338021us1_noar_020717.pdf	811258 fc74ece3641826e1c8505ae524111e57ad819660	no	5
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18	Non Patent Literature	0134_3338021us1_aarf_011817.pdf	69514 f602ba7460d3654d73ae8f0e1233b64f5840d246	no	7
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20	Non Patent Literature	0136_3338021us1_aarf_051716.pdf	2065532 7ff550048bab6d6329f5f6f7880f248182833c56	no	15
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21	Non Patent Literature	0137_3338005us6_adar_021717.pdf	597844 ebda420d03630d424afbeff4e7ced60d59305a1d	no	4
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26	Non Patent Literature	0142_3338005us6_aarf_012517.pdf	103977 2db91f52db9a94442f8f496eabe4070693076d690	no	14
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29	Non Patent Literature	0145_3338005us6_aarn_082216.pdf	120749 6ab5ea1e4350682f0815caf0208731376bc0dce3	no	14
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Information:					
36	Non Patent Literature	0152_3338016us2_aarn_100316.pdf	1046664 4d7e6c2436e256bc1fe6edc569c59446332ab6ea	no	11
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37	Non Patent Literature	0153_3338016us2_rerr_031616.pdf	617747 389d3c7838abf1f8ea6ad578201b4e5da712488b	no	5
Warnings:					
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39	Non Patent Literature	0155_4820001us7_exir_030518.pdf	290772 9ae6ededd117c5021e48924a1ab515ac1b12cf1a	no	3
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40	Non Patent Literature	0156_4820001us7_foar_120617.pdf	1013589 16691451c5e7186796bd6ecb0543f1fe0417b49b	no	9
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41	Non Patent Literature	0157_4820001us7_oarn_07022018.pdf	1483215 595cbf2fb2b5a49b6d8a044d59252bb18bd4a5a3	no	16
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42	Non Patent Literature	0158_4820001us7_oarn_070617.pdf	775286 bfa002a78131ed9efdcfd653dc5c4f14310d1bc1	no	7
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43	Non Patent Literature	0159_4820001us7_oarn_10192018.pdf	2771739 599ef3ac0e7b353f39b68c6a48a3c35c611a8281	no	26
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45	Non Patent Literature	0161_4820001us7_aarf_012318.pdf	1485269 af765f14228a96fbe5b38e028f7889f749596c8c5	no	13
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46	Non Patent Literature	0162_4820001us7_aarf_040218.pdf	55125 7a1ebe8b2b612e885c8d953b92e301b2bab8b4b6	no	7
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47	Non Patent Literature	0163_4820_001us7_aarn_08142018.pdf	96332 eec0206c4371758df933a57c2fcfeab6b50d6758	no	11
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48	Non Patent Literature	0164_4820001us7_aarn_100617.pdf	202187 8757f066632710fc5aa7776fc238d82ebc6c708f	no	12
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51	Non Patent Literature	0167_4820001us7_pamd2_051515.pdf	416313 82d52c2b5c89fd785dcb5414d2dd1d1f3e21ca90	no	6
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58	Non Patent Literature	0174_4820007us3_rrr1mo_072418.pdf	70585 4eb38cc8bd8e8c6ac7ecb877cfe1f214f96f357f	no	9
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59	Non Patent Literature	0175_4820007us3_rerr_05222018.pdf	656609 e96837e381d54a53b14effce8182a59e80a232ac	no	6
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		Total Files Size (in bytes):	48554461		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/12828

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B01J 20/34, 38/48, 38/60, 38/62
US CL : 502/22, 27, 28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 502/22, 27, 28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P --- Y,P	US 6,579,507 B2 (PAHLMAN et al) 17 June 2003 (17.06.2003), column 10, lines 39-67; column 40, lines 32-67.	1-3,11-14,17-22,26-32,36-38,42-48,55-58, and 62-69 --- 4-10,15,16,23-25,33-35,39-41,49-51, and 59-61
X	US 6,475,451 B1 (LEPPIN et al) 05 November 2002 (05.11.2002), see abstract.	43-48
A	US 5,827,352 (ALTMAN et al) 27 October 1998 (27.10.1998), see abstract and entire patent.	1-69
Y	US 5,480,619 (JOHNSON et al) 02 January 1996 (02.01.1996), see abstract, col . 4, lines 30-35.	7-10, 15,16,23-25,33-35,39-41,49-51 and 59-61
Y	US 4,196,173 (deJong et al.) 01 April 1980 (01.04.1980), see abstract.	4-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 2004 (22.09.2004)	22 OCT 2004
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner of Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Jonas N. Strickland Telephone No. 571-272-1700

Form PCT/ISA/210 (second sheet) (July 1998)

Continuation of B. FIELDS SEARCHED Item 3:
EAST, WEST search terms: sorbent, regeneration, mercury, acid, water, solvent, solution, liquid, reactivation

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
B01D 53/02 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200580037037.0

[43] 公开日 2007 年 10 月 3 日

[11] 公开号 CN 101048218A

[22] 申请日 2005.8.23
[21] 申请号 200580037037.0
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[32] 2004.8.30 [33] US [31] 60/605,640
[32] 2005.8.22 [33] US [31] 11/209,163
[86] 国际申请 PCT/US2005/030018 2005.8.23
[87] 国际公布 WO2006/039007 英 2006.4.13
[85] 进入国家阶段日期 2007.4.27
[71] 申请人 能源与环境研究中心财团
地址 美国北达科他
[72] 发明人 爱德温·S·奥尔森
迈克尔·J·霍姆斯
约翰·H·帕夫利施
[74] 专利代理机构 中原信达知识产权代理有限责任公司
代理人 王海川 樊卫民

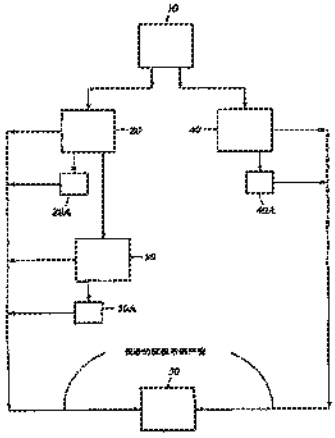
权利要求书 6 页 说明书 32 页 附图 7 页

[54] 发明名称

用于汞的氧化及清除的吸附剂

[57] 摘要

本发明描述了一种促进的活性炭吸附剂，其用于从烟道气流中高效地清除汞。该吸附剂包括含有活性形式的卤素和卤化物的新改性的碳形式。可以加入任选的组分以提高活性和汞容量。可以将这些任选组分与吸附剂直接加入，或者将这些加入到烟道气中以提高吸附剂性能和/或汞的捕集。得到的汞清除效率超过了常规的方法。吸附剂可以再生及重新使用。还描述了吸附剂处理及制备方法。描述了动态制备、引入及控制活性吸附剂到汞污染的气流中的新方法。



1. 一种促进的碳吸附剂，其包含已与选自卤化物、卤素及其组合的促进剂反应的基体活性碳，从而使反应产物有效用于从气流中清除汞。

2. 权利要求 1 的促进的碳吸附剂，其中基体活性碳选自粉状活性碳、粒状活性碳、碳黑、碳纤维、气凝胶碳、热解炭、平均粒度大于 40 微米的活性碳及其组合，促进剂选自分子态卤素、V 族卤化物、VI 族卤化物、氢卤化物及其组合。

3. 权利要求 2 的促进的碳吸附剂，其中相对于每 100 克的基体活性碳，该吸附剂包含约 1 至约 30 克的促进剂。

4. 权利要求 3 的促进的碳吸附剂，还包括含有卤素或氢卤化物的任选的次级组分，从而提高吸附剂的活性和汞容量。

5. 权利要求 4 的促进的碳吸附剂，还包含选自碱元素、碱土元素、碱盐、碱土盐及其组合的任选的碱性组分。

6. 权利要求 4 的促进的碳吸附剂，其中成品吸附剂中任选的次级组分的浓度范围为成品吸附剂中促进剂浓度的约 1 至约 15 wt%。

7. 权利要求 6 的促进的碳吸附剂，其中任选的次级组分选自 V 族卤化物、VI 族卤化物、HI、HBr、HCl 及其组合。

8. 权利要求 7 的促进的碳吸附剂，其中任选的次级组分选自 I_2、HI 及其组合。

9. 权利要求 8 的促进的碳吸附剂，其中与基体活性碳结合时的促

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进剂基本上是蒸汽形式的。

10. 权利要求 8 的促进的碳吸附剂，其中促进剂在与基体活性碳反应之前与有机溶剂结合。

11. 权利要求 8 的促进的碳吸附剂，其中促进剂和任选的次级组分基本上同时与基体活性碳结合。

12. 权利要求 8 的促进的碳吸附剂，还包含选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 及其组合的汞稳定剂。

13. 权利要求 12 的促进的碳吸附剂，其中促进剂选自 Br_2、HBr 及其组合。

14. 权利要求 3 的促进的碳吸附剂，还包含选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 及其组合的汞稳定剂。

15. 权利要求 14 的促进的碳吸附剂，还包括含碱或碱土元素的任选的碱性组分，其中促进剂选自 Br_2、HBr 及其组合。

16. 一种方法，其包括：提供粒状的活性碳；使活性碳与选自卤素、卤化物及其组合的促进剂反应，从而使反应产物包含有效用于从气流中清除汞的促进的碳吸附剂。

17. 权利要求 16 的方法，其中相对于每 100 克的活性碳，反应产物包含约 1 至约 30 克的促进剂。

18. 权利要求 16 的方法，其中反应产物的平均粒度分布大于约 40 微米。

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19. 权利要求 16 的方法，其中促进剂选自分子态卤素、氢卤化物、V 族卤化物、VI 族卤化物及其组合。

20. 权利要求 19 的方法，其中促进剂与活性碳接触时是在气相中。

21. 权利要求 19 的方法，其中促进剂在接触活性碳时在有机溶剂中。

22. 权利要求 20 的方法，其中促进剂选自 Br_2、V 族溴化物、VI 族溴化物及其组合。

23. 权利要求 18 的方法，还包括提供任选的碱性组分以改善汞清除的有效性。

24. 权利要求 20 的方法，还包括使粒状的活性碳与包括卤素或氢卤化物的任选的次级组分进行反应，从而使吸附剂的活性和汞容量得以提高。

25. 权利要求 24 的方法，还包括提供任选的碱性组分以改善汞清除的有效性。

26. 权利要求 24 的方法，其中促进剂和任选的次级组分同时与活性碳接触。

27. 权利要求 24 的方法，其中任选的次级组分包括 I_2 或 HI。

28. 权利要求 20 的方法，还包括加入选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 及其组合的汞稳定剂。

29. 权利要求 24 的方法，还包括加入选自 S、Se、H_2S、SO_2、H_2Se、

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SeO_2、CS_2、P_2S_5及其组合的汞稳定剂。

30. 一种降低烟道气中的汞的方法，其包括：提供吸附剂，将吸附剂注入到包含汞的烟道气流中，在吸附剂上收集烟道气中超过70wt%的汞以产生清洁的烟道气，以及从清洁的烟道气中基本回收吸附剂。

31. 权利要求30的方法，还包括将任选的碱性组分共注入到含汞的烟道气流中。

32. 权利要求30的方法，还包括监测清洁的烟道气中的汞含量、使回收的吸附剂再生以及应用清洁的烟道气中的监测汞含量来控制吸附剂的注入速率。

33. 权利要求30的方法，其中通过使活性碳与促进剂在气动运输管线内反应来动态地制备注入的吸附剂，反应产物从该管线中注入到含汞的烟道气流中。

34. 权利要求33的方法，其中促进剂选自分子态卤素、卤化物及其组合。

35. 权利要求34的方法，其中促进剂选自Br_2、HBr、V族溴化物、VI族溴化物及其组合。

36. 权利要求35的方法，其中促进剂在气相中或以蒸汽形式进行反应。

37. 权利要求36的方法，其中相对于每100克的活性碳加入约1至约30克促进剂。

38. 权利要求37的方法，其中通过在气动运输管线内使活性碳、

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促进剂和任选的次级组分进行反应来动态地制备注入的吸附剂，从而提高吸附剂的活性和容量，反应产物从该管线中注入到包含汞的烟道气流中。

39. 权利要求 38 的方法，其中任选的次级组分选自碘、氢卤化物、V 族卤化物、VI 族卤化物及其组合。

40. 权利要求 39 的方法，还包括将任选的碱性组分共注入到含汞的烟道气流中。

41. 权利要求 39 的方法，其中任选的次级组分的加入量为促进剂含量的约 1 至约 15 wt%。

42. 权利要求 41 的方法，其中任选的次级组分选自 I_2、HI 及其组合。

43. 权利要求 42 的方法，其中在气相中或以蒸汽形式加入任选的次级组分。

44. 权利要求 41 的方法，还包括在吸附剂中加入选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 及其组合的汞稳定剂。

45. 权利要求 32 的方法，还包括应用清洁的烟道气中的监测汞含量来控制吸附剂的组成。

46. 权利要求 40 的方法，还包括监测清洁的烟道气中的汞含量以及应用监测的汞含量来控制吸附剂的组成和碱与吸附剂的注入比。

47. 权利要求 45 的方法，其中通过使活性碳与促进剂在气动运输管线内反应来动态地制备注入的吸附剂，反应产物从该管线注入到含

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汞的烟道气流中，其中促进剂选自分子态卤素、卤化物及其组合，其中促进剂在气相中或以蒸汽形式进行反应，其中相对于每 100 克的活性碳加入约 1 至约 30 克促进剂，其中至少部分地基于清洁的烟道气中的监测汞含量、通过数字计算机来确定促进剂的加入速率和吸附剂的注入速率。

48. 一种降低气流中的汞含量的方法，其包括以下步骤：将质均粒度>40 μ m 的粉状活性碳吸附剂注入到包含汞及灰分粒子的气流中，从气流中将汞捕集于吸附剂粒子上，将吸附剂粒子与灰分粒子机械分离开，以及将分离的吸附剂粒子再注入到气流中。

49. 权利要求 48 的方法，还包括使吸附剂粒子再生，从而从中基本清除污染物以恢复汞捕集的容量。

50. 权利要求 48 的方法，还包括将选自碱元素、碱土元素、碱盐、碱土盐及其组合的碱性组分共注入到气流中。

51. 权利要求 48 的方法，其中粉状活性碳吸附剂还包含选自卤化物、卤素及其组合的促进剂。

52. 权利要求 51 的方法，还包括将选自碱元素、碱土元素、碱盐、碱土盐及其组合的碱性组分共注入到气流中。

53. 权利要求 48 的方法，其中微粒活性碳吸附剂具有的质均粒度 >60 μ m。

54. 权利要求 52 的方法，其中微粒活性碳吸附剂具有的质均粒度 >60 μ m。

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用于汞的氧化及清除的吸附剂

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发明背景

发明技术领域

本发明涉及用于从气化系统的产物气或者烟道气中清除污染物的方法及材料。具体而言，本发明涉及通过高活性的可再生吸附剂从化石燃料的燃烧或气化期间产生的气流中清除汞。

发明背景

诸如煤炭的化石燃料的燃烧和气化能产生包含源自于燃料的汞及其它痕量元素的烟道气。必须通过使用吸附剂、涤气器、过滤器、沉降器以及其它清除技术来控制汞(和其它污染物)向环境中的排放。在燃烧和气化期间汞最初以元素态的形式存在。在诸如燃烧系统的管道及烟道的下游工艺部分中，一些元素态的汞被氧化。被氧化的量取决于烟道气中酸性气体的存在量以及其它的因素。汞的量随燃料不同而变化，但煤炭燃烧的烟道气流中汞的浓度通常为每十亿份中低于 5 份(ppb)。诸如电力设施的大型煤炭燃烧设备每天可能排出一磅的汞或更多。汞清除的应用领域包括但不限于煤炭(或其它化石燃料)燃烧中的烟道气、废物焚烧、气化中的产物气以及矿物加工、金属提炼、干馏、水泥制造、氯碱工厂、牙科设施和火化场中的尾气。

汞吸附剂技术

已经研究了几种类型的用于烟道气中汞的控制方法，包括将细吸附剂粒子注入到烟道气管道内，并使烟道气通过吸附剂床。细粒子注

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入吸附剂包括活性碳、金属氧化物吸附剂、硫化钠粒子和碱性硅酸盐或氧化物吸附剂。当采用粒子注入时，在袋滤室或静电沉降器(ESP)中将捕集到吸附剂粒子上的汞从气流中清除并与灰分微粒一起收集起来。硫化物和碱性硅酸盐及氧化物粒子仅对氧化态的汞是有效的，且与碳粒子相比，金属氧化物吸附剂显示出降低的捕集动力学性能。此外，将细碳粒子注入到烟道气流内来清除汞，尤其是清除元素态的汞，仅仅是部分成功，在使用 FF(织物过滤器)以收集碳和灰分的某些应用中，仅仅达到约 60%的有效清除。当使用 ESP 来收集碳时，因为碳与气体的接触时间非常短，观察到得到甚至更低的清除比率。

现有的碳注入系统的主要问题是，吸附剂初始为非活性的，只有在烟道气中长时间地暴露以后吸附剂才能具备有效的适应性，并提供对气体中汞的增强活性。因此，为了有效地捕集汞，必须以较大的量、较高的吸附剂/汞比例使用这些吸附剂。这些吸附剂往往相对昂贵，不易从灰分中分离出来以再生及重新使用。灰分中碳的收集也造成了固体废物处理的问题，用过的吸附剂可能污染收集的灰分，妨碍其在各种应用当中的用途。

因此，需要有一种更加经济和有效的汞清除技术。本发明提供包含汞的污染物的成本有效清除方法，其使用吸附剂增强添加剂和/或高活性吸附剂，接触时间为若干秒(或更短)，且可以再生及重新使用。

发明概述

因此，本发明的目的是克服现有技术的不足，从而提供新的和经济的方法，用于在利用化石燃料而产生的气体中清除汞。

本发明描述了一种卤素/卤化物促进的活性碳吸附剂，其用于高效地从烟道气流中清除汞。该吸附剂含有新的卤化物改性碳形式，其包含由溴(或卤化物或其它卤素)与碳反应生成的活性化合物。可以加入任选的次级组分和碱以进一步提高活性及汞容量。得到的汞清除效率超

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过或相当于常规的方法，还具有附加的益处例如成本降低。任选地，可以再生及重新使用吸附剂。还描述了吸附剂处理和/或制备方法。描述了活性吸附剂的动态(in-flight)制备、引入到汞污染的气流中以及控制的新方法。

在一些实施方案中提供了促进的碳吸附剂，其包含已经与选自卤化物、卤素及其组合的促进剂反应的基体活性碳，从而使反应产物可有效用于从气流中清除汞。

在一个实施方案中提供了促进的碳吸附剂，其中基体活性碳选自粉状活性碳、粒状活性碳、碳黑、碳纤维、气凝胶碳、热解炭、平均粒度大于所产生的飞灰的活性碳(从而可以从中物理地分离出来) 以及它们的组合。促进剂选自分子态卤素、第 V 族(全部采用 CAS 术语)卤化物、第 VI 族卤化物、氢卤化物以及它们的组合。在一个实施方案中，基体活性碳可以具有这样的质均粒径，使得可以基本上通过物理方法将其从气流中夹带的含有欲清除的汞的灰分中分离出来。在一个实施方案中，基体活性碳可以具有大于约 40 微米的质均粒径。

在另一个实施方案中，对于每 100 克的基体活性碳而言，吸附剂包含约 1 至约 30 克的促进剂。另一实施方案中还包含任选的包括卤素或氢卤化物的次级组分，从而提高吸附剂的活性和汞容量。

在另一个实施方案中，成品吸附剂中任选次级组分的浓度范围在成品吸附剂中促进剂浓度的约 1 至约 15 wt%以内。

在另一个实施方案中，优选可以加入任选的碱性组分以通过该碱与初级吸附剂的组合提供协同效应。

在另一个实施方案中，任选的次级组分选自 V 族卤化物、VI 族卤化物、HI、HBr、HCl 以及它们的组合。在另一个实施方案中，与基体

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活性碳结合时的促进剂基本上是蒸汽形式的。在另一个实施方案中，促进剂在与基体活性碳反应之前与有机溶剂结合。在另一个实施方案中，促进剂和任选的次级组分基本上同时与基体活性碳结合。另一个实施方案中还包括加入选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 以及它们的组合的汞稳定剂。另一个实施方案中还包括加入任选的碱性组分。

在一个实施方案中提供了一种方法，其包括：提供粒状的活性碳；使活性碳与选自卤素、卤化物以及它们的组合的促进剂反应，使反应产物包含能从气流中有效清除汞的促进的碳吸附剂。在进一步的实施方案中，相对于每 100 克活性碳，反应产物中包含约 1 至约 30 克促进剂。在另一个实施方案中，反应产物具有的平均粒度分布大于欲清除汞的气流中夹带的灰分粒子的平均尺寸，从而使得可以通过物理方法将反应产物从夹带的灰分粒子中基本移出。在另一个实施方案中，反应产物具有大于约 40 微米的质均粒径。

在另一个实施方案中，促进剂选自分子态卤素、氢卤化物、V 族卤化物、VI 族卤化物以及它们的组合。在另一个实施方案中，促进剂在接触活性碳时是在气相中。在另一个实施方案中，促进剂在接触活性碳时在有机溶剂中。

在另一个实施方案中，促进剂选自 Br_2、V 族溴化物、VI 族溴化物以及它们的组合。

在另一个实施方案中，所述方法还包括使粒状的活性碳与任选的次级组分进行反应，所述次级组分包括卤素或氢卤化物，从而使吸附剂的活性和汞容量得以增加。在另一个实施方案中，促进剂和任选的次级组分同时与活性碳接触。在另一个实施方案中，所述方法还包括加入选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 以及它们的组合的汞稳定剂。在一个实施方案中提供了一种以较低的清除速率控制烟

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道气中汞的方法，所述方法对吸附剂的要求充分的低。通过吸附剂活性的增强，每克吸附剂的汞清除量也增加，因此，通过降低对吸附剂的要求可以降低投资和操作成本。

在一个实施方案中提供了一种减少烟道气中的汞的方法，所述方法包括提供吸附剂、将吸附剂注入到包含汞的烟道气流内、在吸附剂上收集超过 70 wt%的烟道气中的汞以产生清洁的烟道气以及从清洁的烟道气中基本回收吸附剂。在期望汞的清除低于 70 wt%的实施方案中，优选可以通过使用低于采用标准(非增强的)碳时所需碳量的一半的碳来达到所需的清除 。在进一步的实施方案中，所述方法还包括监测清洁的烟道气中的汞含量、使回收的吸附剂再生及应用监测的清洁的烟道气中的汞含量来控制吸附剂的注入速率。在另一个实施方案中，通过使活性碳与促进剂在气动的运输管线内反应来动态地制备注入的吸附剂，反应产物从该管线中注入到包含汞的烟道气流内。

在另一个实施方案中，促进剂选自分子态卤素、卤化物以及它们的组合。在另一个实施方案中，促进剂在气相中或以蒸汽形式进行反应。在另一个实施方案中，相对于每 100 克的活性碳加入约 1 至约 30 克促进剂。

在另一个实施方案中，通过在气动的运输管线内使活性碳、促进剂和任选的次级组分进行反应来动态地制备注入的吸附剂，从而增加吸附剂的活性和容量，反应产物从该管线中注入到包含汞的烟道气流内。

在另一个实施方案中，任选的次级组分选自碘、氢卤化物、V 族卤化物、VI 族卤化物以及它们的组合。在另一个实施方案中，任选的次级组分的加入量为促进剂含量的约 1 至约 15 wt%。在另一个实施方案中，所述方法还包括在吸附剂中加入选自 S、Se、H_2S、SO_2、H_2Se、SeO_2、CS_2、P_2S_5 以及它们的组合的汞稳定剂。

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在一个实施方案中，所述方法还包括共注入任选的包括但不限于碱和碱土组分的碱性物质，从而通过捕集被氧化的汞和/或捕集可能会降低吸附剂容量的气态组分来改善汞捕集效率。在另一个实施方案中，任选的碱性物质优选可以包括氧化钙、碳酸钠等等，如在本领域中已知的那些。

在另一个实施方案中，所述方法还包括应用监测的清洁的烟道气中的汞含量来控制吸附剂的组成。在另一个实施方案中，通过使活性碳与促进剂在气动的运输管线内反应来动态地制备注入的吸附剂，反应产物从该管线中注入到包含汞的烟道气流内，其中促进剂选自分子态卤素、卤化物以及它们的组合，其中促进剂在气相中反应或以蒸汽形式进行反应，其中相对于每 100 克的活性碳加入约 1 至约 30 克促进剂，其中至少部分地基于清洁的烟道气中的监测汞含量，通过数字计算机来确定促进剂的加入速率和吸附剂注入速率。

在一个实施方案中，提供了减少包含汞及灰分的气流中的汞含量的方法，其中将质均尺寸大于 40 μm 的微粒活性碳吸附剂注入到气流中，通过吸附剂粒子从气体中清除汞，基于尺寸大小使吸附剂粒子与灰分粒子分离，将吸附剂粒子再注入到气流中。在另一个实施方案中，使包含汞的吸附剂粒子再生，从而清除一些或基本上所有的汞。在另一个实施方案中，将碱性组分共注入到气流中。在另一个实施方案中，吸附剂可以还包含促进剂。促进剂优选可以包含卤化物、卤素，或包含它们二者。

如以下将更详细描述的那样，本发明从而提供了优于以前已知技术的若干优点，包括对流出气体显著更有效及经济性的汞吸附剂，可以有利地适用于燃烧设备及气化系统的气流处理。

为了可以更好地理解随后对本发明的详细描述，前述内容已经相

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当广泛地概括了本发明的特点和技术优势。以下将描述本发明另外的特点及优势，其构成本发明的权利要求的主题。本领域技术人员应该理解的是，可以很容易地利用所公开的概念和具体实施方案为基础，修改或设计出其它的结构以实现与本发明相同的目的。本领域技术人员还应该意识到，这种等价的构造并不偏离随附的权利要求中限定的本发明的实质和范围。

附图说明

本发明优选实施方案的更详细描述可参考所给出的附图。

图 1 示意性地例示根据本发明的促进的碳吸附剂的制备方法。

图 2 例示了提出的导致汞氧化及捕集的化学反应的机理模型。

图 3 示意性地例示根据本发明的促进的碳吸附剂的制备以及降低气化系统的产物气和/或烟道气中的烟道气汞的方法，包括促进的碳吸附剂的动态制备。

图 4 为例示 5 wt/wt %溴化 NORIT Darco FGD 吸附剂(37 mg+113 mg 砂) 在低-HCl (1 ppm) 合成烟道气中的穿透曲线的图示。

图 5 为例示非卤化 NORIT Darco FGD 吸附剂(37 mg+113 mg 砂) 在低-HCl (1 ppm) 合成烟道气中的穿透曲线的图示。

图 6 为例示中试规模汞清除结果的条形图表，包括大尺寸吸附剂的结果。

图 7 为例示对于 ESP 和织物过滤器而言的吸附剂尺寸和注入速率对汞清除的影响的图示。

图 8 为例示具有惰性砂的溴化 NORIT Darco FGD 吸附剂的穿透曲线的图示。

图 9 为例示具有共注入碱性物质的溴化 NORIT Darco FGD 吸附剂的穿透曲线的图示。

图 10 为具有和不具有共注入的碱性物质时的汞清除对碳注入速率的图示。

优选实施方案的详细描述

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此处将详细描述本发明具体的优选实施方案，须理解的是，应该认为此处的公开内容为本发明原理的例证，并不意味着将本发明限制在此处例示和描述的内容上。本发明容许不同形式或次序的优选实施方案，不应该认为限制在具体表述的方法或本文所包含的组分上。特别而言，本发明各种优选的实施方案提供了本发明方法、成分以及它们的用途的许多不同构造和应用。

本发明提供利用异常活性的卤素/卤化物促进的碳吸附剂来捕集污染物的成本有效的方法，所述吸附剂使用溴化物(或其它卤素/卤化物)处理的碳，其在若干秒或更短的接触时间内通过汞-吸附剂表面反应来捕集汞。与常规的活性碳吸附剂不同，该吸附剂不需要在气流中的原位活化以达到较高的活性（没有诱导期）。吸附剂对污染物的活性大大增加，可以恢复吸附容量， 可以再生、再循环和/或重新使用促进的吸附剂。

除了对于燃烧系统的烟道气之外，此处讨论的处理的碳、处理技术以及任选的添加剂对于产物气或排出气或者气化系统、合成气发生炉的气体以及其它含汞气流中的汞控制也具有适用性。因此，应该理解的是，本说明书中全文中使用的术语燃烧系统和烟道气可同样地应用于气化系统以及合成气或燃料气，如本领域的技术人员将会理解的那样。

现在参考图 1，显示的是例示本发明方法的一些优选实施方案的方框流程图，用来制备用于从气化系统流的产物气和/或烟道气中捕集汞的促进的吸附剂。在一个由路径 10-20 例示的优选实施方案中，方框 10 例示的是提供基体活性碳，方框 20 例示的是加入与碳反应的卤素或卤化物促进剂，以生成产物促进的碳吸附剂。在以例如蒸汽的形式加入卤素或卤化物的实施方案中，可不需要有另外的步骤。在以例如溶剂的形式加入卤素或卤化物的实施方案中，则可以期望采用如方框 20A 例示的溶剂清除。

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仍然参考图 1，路径 10-20-30 例示了本发明方法的另一个优选的实施方案，包括如方框 10 表示的提供基体活性碳、方框 20 例示的加入与碳反应的卤素或卤化物促进剂以及方框 30 例示的加入与方框 20 的产物反应的次级组分，以生成产物促进的碳吸附剂。在卤素或卤化物促进剂以及次级组分均以例如蒸汽形式加入的实施方案中，可以无需另外的步骤。在以例如溶剂的形式加入卤素或卤化物促进剂和/或次级组分的实施方案中，则可以期望采用如方框 30A 例示的溶剂清除。

仍然参考图 1，路径 10-40 例示了本发明方法的另一个优选的实施方案，其包括如方框 10 表示的提供基体活性碳、方框 40 例示的将卤素或卤化物促进剂以及次级组分一道加入至与之反应的活性碳中，生成产物促进的碳吸附剂。如上所述，在采用蒸汽加入至活性碳的实施方案中，可以无需另外的步骤。在以溶剂形式加入一种或多种组分的实施方案中，则可以需要提供如方框 40A 例示的溶剂清除步骤。

仍然参考图 1，其还例示了优选实施方案，其中如方框 50 所例示，采用如上所述制备的产物促进的碳吸附剂来处理烟道气流。

本领域技术人员可以理解的是，在一些优选的实施方案中，所提供的活性碳优选可以为若干类型中的任何种类。例如，活性碳可以包括粉状活性碳、粒状活性碳、碳黑、碳纤维、碳蜂窝或板状结构碳、气凝胶碳薄膜、热解炭、源于产物促进的碳吸附剂的再生活性碳或本领域中已知的其它类型。

本领域技术人员可以理解的是，在一些优选的实施方案中，所提供的活性碳优选可以为若干类型中的任何种类。例如，活性碳可以包括粉状活性碳、粒状活性碳、碳黑、碳纤维、碳蜂窝或板状结构碳、气凝胶碳薄膜、热解炭、质均粒度大于欲处理烟道气流中的飞灰的活性碳或再生活性碳。

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本领域技术人员可以理解的是，在一些优选的实施方案中，所提供的活性碳优选可以为若干类型中的任何种类。例如，活性碳可以包括粉状活性碳、粒状活性碳、碳黑、碳纤维、碳蜂窝或板状结构碳、气凝胶碳薄膜、热解炭、活性碳或再生活性碳，所述活性碳或再生活性碳的质均粒径优选大于 40 微米，更优选大于 60 微米，或者粒度分布比欲处理的烟道气流中的飞灰或夹带灰分更大，从而使得可以通过物理方法来分离活性碳和灰分。

作为例示而非限制，在一些优选的实施方案中，加入到基体活性碳中并与之反应的卤素或卤化物促进剂优选可以包括：蒸汽或气体形式的分子态卤素；在有机溶剂中的分子态卤素；蒸汽、液体或溶液形式(但不在含水溶剂中)的 V 族或 VI 族卤化物，例如分别是 PBr_3 或 SCl_2。

还提供了这样的实施方案，其中有机溶剂优选可以包括氯代烃如二氯甲烷，例如包括石油醚、轻石油、戊烷、己烷、甲苯和苯的烃溶剂，二硫化碳，废弃溶剂，醚，再循环溶剂，超临界溶剂如超临界 CO_2，水(但不是在 V 族或 VI 族卤化物的情况下)，以及对于本领域的技术人员显而易见的其它溶剂。

现在参考图 2，其例示了由科学性的论据导出的理论，用以解释促进性化合物的性质。例如，如图 2 所例示，溴化氢与活性碳的不饱和结构发生反应。仅作为例示而言，这可以是位于碳的石墨烯(graphene)片层结构的边缘上的碳烯物质。分子态溴或溴化合物的反应可形成类似的结构，带有对汞的氧化具有活性的正碳，随后被吸附剂所捕集。

现在已经发现，与碳形成新的溴化合物增大了它们对于汞和其它污染物的活性。另外，所得到的溴化合物对于促进汞的氧化具有独特的适用性。氧化的有效性显然是源于卤化物对氧化期间在汞上逐渐发展的正电荷产生的促进效果，这在化学领域中被认为是特定催化效应。

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因此，当汞的电子被拉向正碳时，卤化物阴离子的电子则从另一侧推进，使在汞上逐渐发展的正电荷稳定化，降低氧化过程所需的能量。溴化物是特别有活性的，这是由于其离子的外层 4p 轨道上的可高度极化的电子的缘故。因此，在碳上加入 HBr 或 Br_2 形成类似的碳溴化物，其中正碳在溴离子的协助下将汞氧化。

现在参考图 3，提供了汞控制系统 100 的示意流程图，依照本发明优选的实施方案，其包括制备促进的碳吸附剂和降低烟道气中的汞。提供了基体活性碳储槽 110、任选的卤素/卤化物促进剂储槽 120、任选的次级组分储槽 130 和任选的碱性组分储槽 180，它们的每一个都带有各自相应的流动控制装置 201、202、203 和 208/209。对于任选的碱性组分储槽 180，可以独立地使用任选的流动控制装置 208 和 209，或一起使用它们，或者不使用它们。

储槽 110、120、130 和 180 通过它们各自的流动控制装置经由相关的管道连接至运输管线 115。任选的碱性组分储槽 180 也可以通过各自的流动控制装置经由相关的管道连接至运输管线 118。通过气体源 170 将空气、氮或其它运输气体源提供至运输管线 115，使之夹带从储槽 110、120、130 和 180 中排出的物料，并经由注入点 116 将这种物料注入到污染的烟道气流 15 之内。可以通过气体源 171 将空气、氮或其它运输气体源提供至运输管线 118，使之夹带从储槽 180 中排出的物料，并经由注入点 119 将这种物料注入到烟道气流 15 之内。根据需要，气体源 170 和 171 可以相同或不同。或者，可以通过气体源 170 将运输气体提供至运输管线 115 和 118 两者(从源 170 至管线 118 的连接未示出)。虽然在图 3 中显示的气体源 170 和 171 为压气机或鼓风机，但本领域的技术人员将会意识到，本领域中已知的任何运输能量源都是可以接受的。

为清楚起见，在图 3 中显示了单一注入点 116 或 119，本领域的技术人员可以理解的是，多重注入点也在本发明的范围之内。光密度

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测量装置 204 连接至运输管线 115 和/或 118，从而提供代表运输管线 115 和/或 118 内部的光密度的信号，其为时间的函数。

注入点 116 和 119 的下游提供了微粒分离器 140。以说明而非限制性的方式，微粒分离器 140 可以包括一种或多种织物过滤器、一种或多种静电沉降器(以下称“ESP”)或本领域中已知的其它微粒清除装置。还应该指出的是，可以存在顺序配置或并列配置的一个以上微粒分离器 140，当存在并列配置、顺序配置或它们的组合配置时，注入点 116 和 119 可以在 140 的上游和/或下游的位置。微粒分离器 140 至少产生主导性的气态(“清洁”) 流 142 和包含分离的固体物质的流 141。吸附剂/灰分分离器 150 将流 141 分离成大体为灰分的流 152 和大体为吸附剂的流 151。然后优选可以使流 151 通过任选的吸附剂再生器 160，其产生再生吸附剂流 161 和废物流 162。

在废气流 35 中提供任选的汞连续排放监测器(以下称“CEM”) 205，用以提供代表废气流 35 中汞浓度的电信号，其为时间的函数。任选的汞 CEM205 与流动控制器 201、202、203、208 和 209 经由任选的线路 207(或无线地)电连接至任选的数字计算机(或控制器) 206，其接收和处理信号，并优选控制促进的碳吸附剂的制备及其向污染的烟道气流 15 内的注入。

在操作中，将促进的碳吸附剂和/或任选的碱性组分注入到污染的烟道气流 15 内。在注入的物质与污染的烟道气流 15 接触以后，注入的物质使汞的浓度降低，将污染的烟道气转变为汞降低的烟道气 25。通过分离器 140 从烟道气 25 中清除注入的物质，分别地将其处理掉或通过任选的分离器 150 进行进一步的分离，再处理掉或通过任选的再生器 160 进行再生。然后，汞降低的“清洁”烟道气流 142 中采用任选的 CEM205 监测汞含量，其向任选的计算机/控制器 206 提供相应的信号。然后，依照本领域中熟知的控制算法，使来自 206 中的逻辑及最优化信号调节流动控制器 201、202、203、208、209，从而保持废气

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流 35 中汞浓度在期望的限度以内。流动控制器 201、202、203、208、209 也可以是手动调节的或某些其它的自动化装置，从而依照本领域中熟知的控制算法以保持废气流 35 中汞浓度在期望的限度以内。

仍然参考图 3，例示了依照本发明的促进的碳吸附剂和/或碱性组分的制备及注入的若干优选的实施方案。流 111 提供从储槽 110 的基体活性碳的引入，这通过流动控制器 201 手动地或者在计算机 206 的指令下进行计量。根据任何所提供的若干方法，可以使卤素/卤化物和基体活性碳结合并与之进行反应。卤素/卤化物优选可以经由管线 121 直接结合到运输管线 115 内，在其内于注入点 116 之前和基体活性碳接触并与之反应。依照本发明，该选择为本文所指的促进的碳吸附剂的“动态”制备的一种形式。进一步地，卤素/卤化物在进入运输管线 115 之前可以经由管线 121b 与基体活性碳结合。更进一步地，卤素/卤化物可以通过经由管线 121c 引入到储槽 110 内而和基体活性碳接触并与之反应。当例如储槽 110 包括基体活性碳的沸腾床或流化床时，卤素/卤化物在其中以气体的形式或作为蒸汽流动，该选择是优选采用的。当然，如前面讨论到的那样，卤素/卤化物也可以优选以液体的形式或在溶剂中与基体活性碳接触，然后，如果需要的话，如参考图 1 所讨论的实施方案所提到的那样，可以提供溶剂清除(图 3 中未示出)。

类似地，任选的次级组分可以经由管线 131、或任选地如上面所描述的卤素/卤化物那样经由管线 131b 和 131c 而直接在运输管线 115 中接触与反应。

类似地，180 中任选的碱性组分既可以直接加入到运输管线 115 中，或者也可以通过运输管线 118 单独地注入，在下游结合到烟道气 15 中，与基体活性碳、促进的碳或任选的次级组分产生协同效应。能够相对于基体活性碳、促进的碳或任选的次级组分而原位地改变任选的碱性组分的量，这是克服位置特异性操作及烟道气条件并优化之的一个关键性特征。

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在一些其中组分之间的接触及反应是在液体或溶剂相中进行的优选实施方案中，可以提供对这种液体和/或浆料混合物的搅拌。在其它的实施方案中，优选可以溶液的形式将卤素/卤化物促进剂和任选的次级组分喷射到基体活性碳之内或之上。在一些这样的实施方案中，然后可以提供干燥、过滤、离心、沉降、倾析或本领域中已知的其它溶剂清除方法。

在其中卤素/卤化物促进剂为气体或蒸汽形式的实施方案中，可视情况将其在空气、氮或其它气体中进行稀释。可以使例如气态 HBr 或 Br_2 的卤化物/卤素气体通过粒状或纤维状活性碳的沸腾床或流化床，经由气体夹带将如此生成的促进的碳吸附剂从床的顶部移走，用于注入。

在一些实施方案中，次级组分优选可以包括碘或其它卤素，氢卤化物，包括但不限于 HI、HBr、HCl，V 族或 VI 族元素与分子态卤素，例如 SCl_2 及其它。在一些优选的实施方案中，相对于每 100 g 基体活性碳，促进的碳吸附剂可以包含约 1 至约 30 g 的卤素/卤化物。在一些优选的实施方案中，促进的碳吸附剂可以包含次级组分，其浓度为卤素/卤化物组分浓度的约 1 至约 15 wt%。

还在其它的实施方案中，可以将产物促进的碳吸附剂施加到基材上。在其它的实施方案中，为了达到降低汞的目的，可以使这样制备的基材与污染的烟道气或气化系统的产物气流接触。这样的基材可以是单片的(monolithic)、旋转的，或者以本领域技术人员已知的任何方式暴露于气流中。

在一些实施方案中，提供了这样的方法，其中汞稳定剂加入到促进的碳吸附剂中，从而产生双功能吸附剂。可以在卤素/卤化物的加入及反应之前或之后顺序地加入这种稳定剂。在一些优选的实施方案中，卤素/卤化物优选包括 Br 或 HBr，汞-稳定剂可以包括 S、Se、H_2S、SO_2、

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H_2Se、SeO_2、CS_2、P_2S_5以及它们的组合。

汞的捕集中的卤素

在使用卤素来处理烟道气的方法学上已经产生一些问题，这是由于它们对其它气体及金属具有的活性，导致腐蚀及健康方面的问题。“卤素”定义为一系列的非常活跃的元素，包括周期表中的 VIIA 族(通篇使用 CAS 命名；VIIA 族(CAS)对应于 VIIB 族(IUPAC))。分子态元素形式的卤素，包括 F_2、Cl_2、Br_2和 I_2，其与热烟道气组分的反应后，几乎没有剩余可与元素汞反应。原子态元素的卤素形式包括氟、氯、溴和碘原子，其对汞的反应活性要大出约一百万倍，但原子态形式的浓度通常是极低的。在大部分的电业煤炭燃烧设施中，其浓度通常不足以使显著量的汞被氧化。

此处采用的术语“卤化物”定义为由卤素与另一种元素或基团反应形成的化合物。一般地，卤化物比起分子态卤素来讲活性要低得多，具有较低的化学势。卤化物被认为是不能单独氧化其它化合物的还原态形式。因此在传统的观点当中，卤化物-盐-处理的活性碳不能有效地将元素态的汞氧化及捕集元素态的汞。

卤素促进的吸附剂特性

这里描述的吸附剂对于汞的氧化具有非常高的初始活性，因此使用非常少的量就可以得到非常高的捕集效率，从而降低操作成本，减少废物处理的问题。此外，对采用本发明技术生成的吸附剂进行再生及重新使用可以获得进一步的处理减少。汞与本发明的促进的碳吸附剂在烟道气导管中顺利地相互作用以及随后汞在吸附剂和灰分上的收集所需的时间间隔非常短，不到几秒钟。很显然，这样的收集时间需要吸附剂对汞既具有高容量又具有高活性。可以非常细的粉末形式利用促进的碳吸附剂，从而使传质限制最小化。但此外，活性应该非常之高，从而捕集细粒子所遇到的所有的汞。另外，采用这些增强技术可以容许得到对更大吸附剂粒子而言的有效捕集，而更大的吸附剂粒

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子使得吸附剂能从灰分中分离，从而能够进行随后的再生以及灰分的利用。本发明的一个特点在于制备含有在碳结构上形成的卤化物的吸附剂的方法，其提供与汞污染的气流初始接触时具有高度活性的吸附剂，这使得能非常有效地捕集汞。

看起来本发明的吸附剂用活性碳(边缘位置)例如从溶液中与分子态溴化学地结合。X 射线光电子能谱法已经确定，溴、氯、HBr 或 HCl 的加入在碳结构中形成了化学的化合物。因此，由卤素和活性碳生成的吸附剂不再是分子态卤素的形式，而是一种新的化学改性的碳(或卤化碳)结构。除卤化物离子外，在低活性的碘中可能不出现这种现象，其中 I_2 分子络合物可能存在于碳基面上。在溴的情况下，改性的阳离子碳具有使汞氧化的高化学势。因此而给出了溴处理的碳对汞的活性的全新模型。优选可以通过加入溴、溴化氢或如本文中描述的溴与其它元素的组合来产生活性的碳形式。卤素处理产生具有更高活性的碳，因为卤化物(特别是溴化物和碘化物)阴离子通过使在氧化的过渡态中汞上逐渐发展的正电荷稳定化而有效地促进氧化。基于该模型而产生若干创新、价廉、活性增强的特点。

任选的次级组分

已经证实，除了溴以外任选的次级组分的加入导致吸附剂活性和容量的改善，通常超过了未处理的碳和溴化的碳。次级化合物或者包括次级卤素，或者包括次级卤素衍生的化合物，例如 HI。因此，除了存在具有活性的碳形式外，次级组分产生 Lewis 碱，其具有更强的能力以使在汞上逐渐发展的正电荷稳定化。因此，次级组分为具有更大程度极化电子(4p 和 5p)的元素。

任选的碱性组分

已经证实，在基体活性碳或促进的活性碳中加入任选的碱性组分可以导致汞捕集的改善，通常要超过未处理的碳和促进的碳。测试数据表明，烟道气污染物、烟道气成分(SO_2、NO_x、HCl 等)、操作温度、

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汞的形式以及汞的浓度可以影响到碱加入的有效性。这就暗示需要能够原位地调节及定制碱与活性碳的比率，从而能克服给定的原位条件并优化之。

可以如下地解释当共注入两种材料时得到的协同。首先，测试表明，活性碳(以下称作“AC”)上的结合位置可以被氯物质、硫物质(即硫酸盐)和其它的烟道气污染物(砷酸盐、硒酸盐等)所消耗。加入的任选碱材料将与这些物质/污染物相互作用及反应，从而使它们对于 AC 汞的结合位置的消耗最小化。其次，测试还表明，即使结合位置完全被消耗，标准 AC 也将继续进行汞的氧化。然后该被氧化的汞可以与碱性物质反应，并随后被粒子控制装置所捕集。因此，任选的碱性组分的加入起到保护汞结合位置及捕集被氧化的汞的作用，从而导致在更低成本下的汞降低的改善。与活性碳相比，碱成本通常要低得多(差了~一个数量级)，因此可以更多地使用，而总体成本仍然较低。

“动态的”吸附剂制备

此外，已经证实可以容易“动态地”生成卤素促进的碳吸附剂。这可以通过以下来实现，例如，使卤素和任选次级组分的任意组合的蒸汽动态地与非常细的碳粒子接触。粒子可以被分散在运输空气(或其它气体)流中，该气流也将卤素/卤化物促进的碳吸附剂粒子输送至烟道气导管或其它污染的气流中，然后汞从那里被清除。对于该接触没有特别的温度要求。该技术的实施显然非常简单，并在很大程度上导致将该技术用于汞捕集的设备成本的节省。

原位制备的优点

在原位置动态地制备卤素/卤化物促进的碳吸附剂具有某些优点。例如，处理系统可以在最终使用位置上与碳注入系统结合。采用此技术时，卤素/卤化物被引入到运输管线(或吸附剂存储及注入系统的其它部分)中的碳-空气(或其它气体)混合物中。这提供了如下优于现有的离位处理吸附剂的常规概念的益处：

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●排除了处理设施的投资设备成本

●排除了操作处理设施的的成本

●没有关于将碳和添加剂运输到处理设施的成本

●本发明方法使用现有的硬件及操作步骤

●本发明技术确保吸附剂始终是新的，因此更具有活性

●没有引入新的处理方面的问题

●没有从处理系统中清除碳的成本

●本发明方法可以容许添加剂-吸附剂比的快速原位定制，从而可以适应例如当改变燃料或减少负载时可能需要的烟道气变化的要求，因此可进一步优化经济性

●本发明技术使需处理的用过的吸附剂量减少

考虑到前述内容以及其它特点，根据本发明，提供了以下实施方案，包括制备和再生卤素/卤化物促进的碳吸附剂的方法，通过将卤素(例如溴)加入到碳结构中增强其汞捕集的活性。

吸附剂注入位置

一些优选实施方案设想以粉末形式使用卤素促进的吸附剂，其在清除灰分微粒之前或之后注入到烟道气流中。本发明其它实施方案的卤素促进的碳吸附剂的组成包括通过加入 Br_2 或 HBr 和任选的次级组分而制备的粉状改性活性碳。其它实施方案容许与基体活性碳协同地加入任选的碱性组分、和/或使用卤素基吸附剂，以及本专利中提供的吸附剂技术的任意其它的组合。或者，实施方案包括这样的方法，其中吸附剂在由含有一种或多种上列组成的粒子或纤维组成的移动接触器上。

吸附剂再生

可以很容易地使任何上述实施方案的卤素/卤化物促进的碳吸附剂再生；优选清除烟道气中的毒害性污染物，加入便宜的促进剂，从而恢复汞吸附活性。该促进碳本身的活性的方法与在吸附剂中加入试剂(例如过氧化物、金、三碘化物等)的早期更昂贵的常规方法形成对比。

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本发明的卤素/卤化物促进的碳吸附剂是用溴和/或任选组分处理的，是非腐蚀性的。吸附剂再生技术的详细实例描述于标题为“PROCESS FOR REGENERATING A SPENT SORBENT”的共同未决、共有的PCT专利申请No. PCT/US04/12828中，现将其全文引入以供参考。

吸附剂注入控制方案

本发明另一优点涉及使用反馈系统来更有效地利用本发明的某些方面。在可能和期望的情况下，本发明的汞控制技术优选可以利用汞排放的连续测量作为反馈，协助控制吸附剂注入速率。可以这样地达到吸附剂和任选组分水平的更严格控制，这将保证汞清除的条件符合最低的物质要求，从而使相关成本最小化。在一个实施方案中，在注入位置的下游，优选在烟道的废气中连续测定汞排放。

促进的碳吸附剂

卤素和酸性物质与活性碳吸附剂上的碱性结合位置的反应产生了将汞氧化的位置。诸如硼、锡、砷、镓、Sb、Pb、Bi、Cd、Ag、Cu、Zn的其它金属离子或其它污染物也将与碳上产生的氧化位置进行反应。

根据我们的模型，将溴试剂中的溴或卤化氢酸中的质子加入到碳边缘结构上的碱性碳烯位置上，以形成碳正离子，其接受中性汞原子中的电子，形成结合到吸附剂表面上的氧化了的汞物质。活性位置还可以在碳的活性位置上产生活性的溴基或碳基。因此活性碳用于使溴稳定化，但能提供高度活性的含溴试剂，该试剂可以使汞氧化并促进其在活性碳上的捕集。预计包含溴的吸附剂比相应的包含氯的吸附剂活性大，且比包含碘的吸附剂便宜得多。

实施例

为了更清楚地例示本发明，下面给出若干实施例。这些实施例是作为例示目的的，本文中给出的实施例不应该理解或推断为对本发明

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的限制。

实施例 1-制备及测试卤化的碳(及比较例)

气相卤化

将细的粉末活性碳(例如 NORIT Darco FGD，NORIT Americas，Inc.，Marshall，Tex.(USA)，尽管如本领域技术人员可认识到的那样，也可适用其它的)置于带有侧叶片的旋转式塑料桶(5 ft^3 (0.14 m^3) 水泥搅拌器)中，其上安装有紧密的塑料盖以防止在制备期间细粉末的损失。在一个单独的容器中，气相溴的制备是通过使氮流流过被暖热至约 40℃-50℃的已称重量的液体溴来实现的。溴的蒸汽压力使得产生的暗红色气体流出发生器。气态溴发生器的出口经由一个 1/4 英寸(0.64 cm)的塑料胶管连接至固定的金属管，所述金属管通过法兰插入到塑料盖的中心并穿入到桶的中心内部。法兰不是空气密闭的，当溴被传递至翻转的碳上之后，过剩的氮被释出。如此，溴气流不断地流入到旋转桶的内部，在那里与翻转的碳接触。然后操作该单元，直到期望数量的溴与碳结合。通常是，0.4 至 1 kg 的溴对 20 kg 的碳(2-5 wt. %)。当反应完毕时，称量碳的重量。处理过的碳是无嗅的，不会产生皮肤刺激性，因为溴已经完全与碳反应而生成了溴化的碳。

XPS 光谱表明，溴化的碳包含与碳键合的(有机)共价溴化物以及阴离子溴化物。产物中包含的湿度与初始存在于活性碳中的相同(5-17 wt %)，但无需进一步的干燥即可使用。在更高的温度下(>150℃)湿度被去除，直到非常高的温度时才会释放出溴。

汞的氧化及捕集效率的实验室规模测试

使用基于以上描述的实验室规模的装置和步骤测试若干促进的活性碳吸附剂的初始活性及容量， 所述吸附剂使用粉状碳，包括由多种碳制备的含溴活性碳，包括商业上可得到的吸附剂、气凝胶膜吸附剂和初始前体碳用于比较。

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文献 Dunham，G.E.；Miller，S. J. Chang，R.；Bergman，P. *Environmental Progress* **1998**，17，203 提供了装置及其操作的详细描述，在此全文引入以供参考。用细粉(-400 目)状吸附剂(37 mg)与 113 mg 砂混合，装填在石英过滤器(2.5 英寸(6.35 cm))中，进行烟道气组合物中的实验室规模汞吸附剂测试。在模拟的烟道气流(30 SCFH (标准立方英尺/小时)或 0.79 NCMH (标准立方米每小时))下将装填的过滤器和支架于炉中(125℃)加热，所述模拟的烟道气流包含如下成分：O_2 (6%)、CO_2 (12%)、SO_2 (600 ppm)、NO (120 ppm) NO_2 (6 ppm)、HCl (1 ppm)、Hg^0(11 μ g/m^3)、H_2O (15%)和 N_2 (余量)。通过置于双夹套玻璃冷凝器中并加热至所期望温度的标准渗透管源提供元素汞。使用连续汞排放监测器(Sir Galahad 汞 CEM，制造商 P.S. Analytical Deerfield Beach FL USA)确定气流中的汞浓度，并使用 $SnCl_2$ 池将被氧化的物质转变为元素态，从而可以获得对于从吸附剂床的流入及流出浓度的元素态及被氧化的汞的浓度数据。根据采用的流速校准汞浓度。对用过的吸附剂进行汞的分析以确定质量平衡。

现在参考图 4，给出作为流入汞百分数的流出汞浓度数据对时间的图示。卤化的吸附剂所得到的曲线(穿透曲线)显示流出物中最初有 0%-1%的 Hg(99+% 捕集)，仅在 30-60 分钟(穿透点)之后有所增加，这取决于吸附剂情况。图 4 例示的是对于 5 wt/wt %溴化的 NORIT Darco FGD 吸附剂(37 mg+113 mg 砂)与包含 1 ppm HCl 的合成烟道气的穿透曲线。流出物中总 Hg(实心圆)和元素态 Hg(实心方框)给出为入口 Hg 的百分数。“EOT”表示测试的终点(后面显示的数据点用于校准核对)。

图 5 给出的是依照合成烟道气中的 HCl 浓度情况，通常起始为 5%-50%入口汞时相应的非卤化吸附剂的比较穿透曲线，由此表明了非卤化吸附剂具有相当低的汞氧化及捕集活性。无论是卤化或非卤化的吸附剂，在穿透以后，流出物中大部分的汞为被氧化的汞。

实施例 2 -流态化碳的气相卤化

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通过氮流使由玻璃棉塞支撑在垂直管中的活性碳床流态化。流化床管的顶部与用于吹出管顶部的碳细粒的捕集器连接。如实施例 1 中描述的溴气体发生器与流化碳床相连，使期望数量的气态溴流到床内。然后将捕集器中的内含物与床内的物质混合并称重。得到的溴化的碳表现出与实施例 1 中溴化的碳类似的性能。

实施例 3 -液相(水)卤化

将 50 g 溴小心地加入到 1 升冷水中，制备溴的 5%水溶液。将一 kg 的活性碳加入到大金属罐里的溴溶液中。在加入的期间用大桨叶片对得到的浆料搅拌，经短时间后，直到红色消失表明所有的溴已经与碳反应。然后用布氏漏斗真空过滤浆料。将过滤器中收集到的潮湿碳在 110℃炉中干燥若干小时至恒重。如在实施例 1 中那样，碳中还仍然留有一定湿度。然后使干燥的碳在旋转桶中翻转，利用金属片破碎及疏解(fluff)碳。

实施例 4 -任选次级卤化物组分的加入

通过类似于根据实施例 3 所描述的溶液相溴化生成溴化的碳。然而在过滤之前，将氢碘酸(HI)溶液加入到浆料中，其量等于溴量的 10%。搅拌浆料以完成反应，然后如实施例 3 中描述的那样进行过滤及干燥。

实施例 5-液相磷卤化

在大金属罐中搅拌三溴化磷(500 g)的轻石油(10 升)溶液，加入 10 kg 的活性碳。用大桨叶片在环境温度下对所得到的浆料进行搅拌以完成反应。以若干批次在大的布氏漏斗中真空过滤浆料。湿滤饼在 110℃炉中干燥至恒重。干燥的产物如在实施例 3 中所描述的那样在旋转桶中疏解。

实施例 6-更大粒子碳的制备及其上的吸附

燃烧次烟煤炭，用中试规模的燃烧器进行测试，通过注入大于正常尺寸的处理的活性碳来评估汞的控制。标准 AC 吸附剂通常为细尺寸

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的，平均粒径小于 20 微米，这也是煤粉燃烧产生的飞灰的典型尺寸。因此，由于标准 AC 与飞灰的尺寸类似，两者的分离是困难的。通常不考虑注入更大尺寸的 AC，因为吸附剂的有效性随尺寸而降低。在使注入的碳再循环的方案中，从飞灰中分离出碳。基于尺寸分级的分离需要处理的更大粒子的吸附剂。为了验证这种观点，开发、制备和测试了处理的更大尺寸的(>60 μ m)吸附剂。

处理-气相卤化

研磨粒状活性碳(Calgon F400)并用常规网筛进行筛分。收集-170 至+240 的网目尺寸部份(相当于约 60 至约 88 微米)并置于如上面实施例 1 中描述的旋转容器中。也如在实施例 1 中描述的那样，在单独的容器中，气相溴的产生是通过使氮流在被暖热至约 40℃-50℃的已称重量的液体溴之上流过来实现的，该气态溴发生器的出口经由一个 1/4 英寸(6.35 mm)的塑料胶管连接至固定的金属管，所述金属管通过法兰插入到盖的中心并穿入到旋转容器的中心内部。操作该单元，直到期望量的溴与碳结合，在这里是 0.05 kg 的溴与 1 kg 的碳(5 wt.%)。当反应完毕时，称量碳的重量。如上面已经描述的那样，处理的碳是无嗅的。

PTC 装置

中试规模燃烧器即已知的“微粒测试燃烧器”(以下称作“PTC”)，其为 550,000-Btu/hr(约 161 kW)的粉煤(“PC”)燃烧单元，其用来产生燃烧烟道气性能以及飞灰，用以代表大规模动力锅炉所产生的那些物质。使燃烧器垂直定向以使壁上沉积最小化。耐火衬里有助于保证完全燃烧的足够火焰温度，并阻止聚结或凝结的飞灰的迅速淬灭。基于表观气体速度，粒子在燃烧器中的平均滞留时间为大约 3 秒钟。PTC 的煤炭喷嘴从燃烧器的底部轴向地向上燃烧，以紊流混合将次级空气同心式地引入初级空气中。经由螺旋进料机和喷射器将煤炭引入到初级空气流中。使用电空气预热器精确控制燃烧空气温度。最初，PTC 使用冷水环形热交换器对集尘室(也指的是“织物过滤器”)或静电沉降器(ESP)提供烟道气的温度控制。然而，对从热交换器中收集到的灰分

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沉积物的分析表明，一些汞积聚在管道壁上。为了使这种影响最小化，对热交换器进行改进以提供更高的管道壁温度。

PTC 仪器设备容许连续地监测系统温度、压力、流速、烟道气成分浓度以及微粒控制装置(集尘室、高级混合式粒子收集器/AHPC™ 和/或静电沉降器/ESP)的操作数据并用数据记录器记录。

PTC 步骤

烟道气样本的选取为三个可取的系统样本点—炉子出口、粒子控制装置入口、粒子控制装置出口—中两个的组合。将烟道气通过样本调节装置以去除水分之后，通常对烟道气中的 O_2、CO、CO_2、SO_2 和 NO_x 进行分析。通常使用两个分析仪同时在炉子出口和粒子控制装置出口对每种成分进行分析。连续记录所有仪器上的浓度值。此外，以设定的时间间隔手动记录数据。使用一对 Rosemount Analytical NO_x 化学发光分析仪确定 NO_x。使用一对 Ametek Instruments 光度气体分析仪测定 SO_2。通过一对 Rosemount Analytical 多气体连续排放监测器对其余的气体进行测定。定期校准及维护各自的这些分析仪，从而提供准确的烟道气浓度测量。

集尘室容器为 20 英寸(50.8 cm)(ID)热跟踪及隔绝的腔室，引入的烟道气在底部附近。在 300℉(约 150℃)下燃烧器生成约 200 ACFM(实际立方英尺每分钟；约 5.7 实际 m^3/min)的烟道气，因此，三个 13 英尺 x5 英寸(3.96 m x12.7 cm)的袋子提供 4 英尺/min (1.22 m/min)的气布比。每个袋子随其自身的隔膜脉冲阀的操作而单独地进行清洁。为了对不同测试条件下压降的差值定量化，袋子的清洁是基于时间的，而不是基于压降引发的清洁周期。一旦引发袋子的清洁，以快速的顺序性在线对所有三个袋子进行脉冲。

还用单线式管状 ESP 代替织物过滤器进行了测试。设计 ESP 单元以使在 300℉(150℃)下提供的比收集面积为 125。因为 PTC 的烟道气

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流速为 130 SCFM(标准立方英尺每分钟；约 3.7 NCMM (标准 m^3/min))，则通过 ESP 的气体速度为 5 英尺/分钟(约 1.52 m/min)。ESP 单元的板距为 11 英寸(27.9 cm)。ESP 的设计要有利于各测试之间的彻底清洁，从而使所有的测试能具有相同的基础。

PTC 结果

结果例示于图 6 中。在图 6 中观察到，即使测试的吸附剂粒度显著地大于正规的吸附剂粒子，所处理的大于正规尺寸(即>60 微米)的活性碳吸附剂对于汞的捕集也相当有效。当在中试规模 ESP 前注入更大尺寸处理的 AC 时，大约 75%的汞被捕集，而当在中试规模织物过滤器(“FF”)前注入时，大约 85%的汞被捕集。注意在图 6 中(以及通篇中)，“Macf” (及“MACF”)表示百万实际立方英尺(1 MACF 为约 0.028 百万实际立方米或“MACM”)。

现在参考图 7，可以观察到，在相同的配置下，当在中试规模 ESP(菱形记号)前注入时，更大尺寸处理的 AC 表现出的性能优于更细的标准 AC(三角形)。作为比较，当在织物过滤器(FF) 前注入时，更大尺寸处理的 AC(方形)表现出从类似到稍微更差的性能。然而，对于这种应用而言，更大尺寸处理的 AC 可以从更小的飞灰粒子中物理地分离出来，然后可以将吸附剂再生、再循环及重新使用。这将充分地改善总利用性及经济性。这些数据因而说明，大于正规尺寸的吸附剂可以提供有效的汞控制，飞灰与 AC 的分离也容易，因此可以保留飞灰的销售及有益用途的特性。相应地，由于已经成功地证明了>60 μm 的吸附剂粒子，因而使用>40 μm 的粒子可以获得优异的汞控制，依照所使用的吸附剂粒子/灰分分离系统的情况，在一些应用中使用 40 μm 的粒子是优选的。注意在图 7 中(以及通篇中)，“Macf” (及“MACF”)表示百万实际立方英尺。

实施例 7-液相(有机溶剂)卤化

将 50 g 溴小心地加入到 1 升冷的轻石油中，制备溴在轻石油中的

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5%溶液。将 1 kg 的活性碳加入到大金属罐里的溴溶液中。在加入的期间用大桨叶片搅拌浆料，经短时间后，直到红色消失表明所有的溴已经与碳反应。用布氏漏斗真空过滤浆料。将过滤器中收集到的碳饼在110℃炉中干燥若干小时，直到其显示为干燥并达到恒重。如在实施例1中那样，碳中还仍然留有一定湿度。然后使干燥的碳在旋转桶中翻转，利用金属片破碎及疏解碳。

实施例 8-促进的活性碳吸附剂

采用基于上面描述的实验室规模的步骤来测试若干促进的活性碳吸附剂的初始活性及容量，所述吸附剂使用粉状碳，包括由商业上可得到的吸附剂制备的含溴活性碳和气凝胶碳膜吸附剂，以及初始前体碳用于比较。将粉状活性碳前体浸渍于搅拌的溶液中制备溴处理的碳，所述搅拌的溶液是溴在四氯化碳或二氯甲烷或者在 HBr 水溶液中的溶液，接着在环境温度下于空气中干燥，在 100℃炉中于空气或氮气氛下干燥。还可以使气体流过活性碳前体的旋转干燥床，从而从气相中浸渍溴来制备溴处理的碳。结果表明在溶液中加入次级组分改善了吸附剂的容量。

碳的初始测试在加热床上进行，其中包含元素态汞(11 $\mu g/m^3$)的合成烟道气流通过该床。流出气体中总的及元素态 Hg 的浓度用 Sir Galahad 汞 CEM(“连续排放监测器”) (制造商 P S Analytical，Deerfield Beach，FL，USA)来确定。在测试期间粉状吸附剂负载在石英过滤器上，以三层形式测试其它吸附剂。对初始的商业级粉状碳吸附剂、与该吸附剂在用 0.1 N HBr 处理之后离心收集粉末并干燥作了比较，表明汞捕集的活性从在入口处约 50% Hg 的初始捕集效率增大至 100%捕集。吸附剂在随后用 HBr 再生的比较表明，其不仅能够以与以前同样(100% 捕集)的水平捕集汞，而且其容量还延长若干分钟，因此是增强了的。如上面所描述的那样在溶液中或在干燥床中用分子态溴处理碳膜和碳纤维吸附剂得到类似的结果。

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实施例 9-流化/沸腾床制备

通过使气体流过与碳的流化床或沸腾床串联的液体溴储槽的方式，由包含分子态溴的气体组合物来进行分子态溴的浸渍，通过如此处理碳来制备活性碳吸附剂。依照所使用的比例，每 100 g 活性碳中碳吸收的溴量范围从(在一个实施例中的)<1 至约 30 g。

实施例 10-大规模测试

在该实施例中，使用集尘室(织物过滤器)或 ESP 来收集大规模商业粉煤燃烧设备的废气中的微粒。同时使用涤气器和吸附剂床从烟道气流中将不期望的成分在被送料到烟道之前清除掉。在该实施例中，在锅炉之后将卤素/卤化物促进的碳吸附剂注入到烟道气内。然而，一般来讲，可以将本发明的吸附剂注入到期望的位置(例如，在锅炉之前、之后或之内)。

在燃烧褐煤的设备上进行的一个示范测试中，烟道气相中汞(元素态) 浓度为 10 至 11 μ g/m^3。在 350℉至 375℉(约 175-190℃)下在集尘室中收集灰分和注入的碳。以 1.0 lb/MACF 的速率("MACF"和"Macf"代表百万实际立方英尺；1.0 lb/MACF 为约 16 kg/MACM(百万实际立方米))注入商业级活性碳粉末(未处理的)，得到 3.8-4.2 μ g/m^3 的汞流出浓度结果(分别代表气体中 62%-58%的汞清除)，速率 2.0 lb/MACF(约 32 kg/MACM)时，给出 74%-71%的清除。以 1.0 lb/MACF 速率注入溴处理的碳给出 73%-69%的清除结果，速率 2.0 lb/MACF 给出 86%-84%的清除。因此，使用本发明的溴促进的碳吸附剂表现出汞捕集的显著增加。

实施例 11A-任选的碱性组分的加入—实验室规模

为了捕集可能从吸附剂中释放的任何被氧化的汞，或者捕集烟道气中可能对吸附剂容量具有不利影响的某些硫或硒的氧化物，通过使用碱性物质与活性碳的共注入可以明显地改善活性碳的汞捕集效率。

制备由 37 mg 溴化的活性碳与 113 mg 氧化钙混合组成的过滤器，

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进行实验室规模测试。如在实施例 1 中描述的那样进行测试，并与带有惰性稀释剂的相同碳吸附剂进行比较。溴化的(2%) NORIT Darco FGD 吸附剂与惰性砂的混合物的穿透曲线示于图 8 中，与 CaO 的混合物的穿透曲线示于图 9 中。可以看到，与 CaO 的混合物的 50%穿透点增至 65 分钟，而与砂的混合物仅为 48 分钟。

实施例 11B-任选的碱性组分的加入—中试规模

在参考上面实施例 6 描述的中试规模的 PTC 燃烧器上进行测试，燃烧 Texas 褐煤，通过在织物过滤器上游共注入标准活性碳(本文也称为“AC”) 和碱性物质来评价汞控制。典型结果例示在图 10 中。如图 10 所示，石灰与活性碳的共注入大大地增加了汞的清除。使用共注入吸附剂达到了大约 90%的汞清除，而即使在高得多的注入速率下，单独使用标准 AC 时只达到不到 60%的清除。类似测试的数据显示，注入类似量的碳酸钠与 AC 以及石灰与 AC，分别给出大约 80%以及 87%的汞清除结果。这些数据暗示，也可以用其它碱与 AC 共注入来改善汞的清除。其它数据显示，烟道气温度可以影响碱加入的有效性。进一步的测试数据表明，烟道气污染物、烟道气成分(SO_2、NO_x、HCl 等)、操作温度、汞的形式以及汞的浓度可以影响到碱加入的有效性。这表明理想的是能够原位地调节及定制碱与 AC 的比率，从而能在设定的原位条件下使清除最优化。

虽并不打算束缚于任何特定的理论，但可以如下地解释当两种物质共注入时在性能改善当中观察到的协同。首先，测试表明，AC 上的结合位置可以被硫物质和其它污染物所消耗。碱材料与这些物质相互作用及反应，从而使它们对于 AC 上汞结合位置的消耗最小化。其次，其它工作已经表明，即使结合位置完全被消耗，标准 AC 也将继续进行汞的氧化。然后该被氧化的汞可以与碱性物质反应，并随后被微粒控制装置捕集。因此，碱与处理的和/或未处理的 AC 的结合将协同地利用这两种机理，导致在降低的成本下的汞捕集的改善。

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实施例 12-用于气化燃料气体的溴化处理碳吸附剂 5% Br2W-AC 的制备

采用类似于实施例 3 中的步骤，制备溴在水中的 2.5 wt/vol % 溶液。将粒状的 Calgon F400 加入到溴溶液中，得到 5 wt/wt %溴化的碳产物。在加入期间及之后用大桨叶片搅拌溴溶液，直到水中的红色消失。用大布氏漏斗真空过滤悬浮液。滤饼在空气中干燥，然后在 110 ℃炉中干燥，直到获得稳定的重量，湿度减少到 15%。

5% Br2D-AC 的制备

如在实施例 7 中所描述的那样由在溶剂中加入 Br_2 制备溴化的吸附剂，不同的是，使用二氯甲烷代替轻石油作为溶剂，使用粒状的 Calgon F400。

5% PBr3-AC 的制备

采用实施例 5 中描述的方法由 PBr_3 制备磷卤化的吸附剂，不同的是，使用粒状的 Calgon F400。

氢气氛下的测试—步骤

为了模拟从煤炭气化的合成气或受热燃料气中捕集汞，采用使氮中包含 10% vol/vol 氢的气流以 500 cc/min 速率通过吸附剂来进行测试。气流中包含来自市售汞渗透源的 26.9 微克/m^3 的元素态汞。

在测试中，将吸附剂(0.5 g) 置于 0.39 英寸(1 cm, 内径)的玻璃管中，所述玻璃管配有中等熔块(medium frit)烧结玻璃滤片，从而在气流中保持吸附剂。包含吸附剂床的管与气体入口管连接，用于引入包含汞蒸汽的气流，在管连接的出口与检测器连接。检测器为 Semtech 2000 连续汞排放监测器。在环境温度下使管在氮气流(450 cc/min)中平衡 5 分钟以使系统稳定化。检测器显示在吸附剂床的流出物中汞的浓度为 0。(没有吸附剂的空白运转时的读数为 26.9 微克/m^3)。然后在选定的温度下将管置于炉中进行测试(250℃至 400℃)。收集检测器中的流出汞浓

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度数据，直到检测器显示恒定的读数有 5 分钟。然后在气流中加入氢(50 cc/min)，每 5 min 读取检测器的读数。根据温度及吸附剂的情况，在达 3 小时时段的不同时间段中，在几个炉温下进行测试。如在实施例 1 中那样，元素态汞浓度数据绘制为入口汞浓度的百分数对时间的图形。流出物中所有的汞为元素态的，因此单一检测器就足够了，无需用 $SnCl_2$ 捕集器来转化至元素态汞(如在实施例 1 中那样)。然后由穿透曲线确定 50%穿透的时间(达到 50%捕集的时间)。

结果

对于未溴化的吸附剂(Calgon F-400)、溴化的吸附剂(5% Br2W-AC 和 5% BrD-AC) 及磷溴化的吸附剂(5% PBr3-AC)，结果示于(以下)表 1 中。对于表 1 最后一栏中表示的时间段而言，每次运行在流出物中得到的最大汞浓度也记录在表 1 中。

在还原的氢条件下，未溴化的吸附剂立即穿透，仅 6.5 min 之后就耗尽。这种彻底失效的出现是因为氢在 100℃以上的任何温度下使未溴化的吸附剂中捕集的汞还原。两种溴化的吸附剂在高至至少 400℃的所有温度下均展示出极好的活性和良好的容量。磷溴化的吸附剂在高至至少 400℃的所有温度下展示出优异的活性和容量。

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表 1

50%穿透的时间

观察到的吸附剂最大 Hg 浓度

(10% 氢流)

吸附剂	温度(℃)	50%穿透(min)	最大[Hg] ($\mu g/m^3$)	时间(min)
F-400	250	6	20.3	6.5
5% Br2W-AC	250	>150	1.4	150
5% Br2W-AC	300	>180	4.3	180
5% Br2W-AC	350	160	15.1	180
5% Br2W-AC	400	60	13.9	65
5% PBr3-AC	250	>140	0.4	140
5% PBr3-AC	300	>150	0.5	150
5% PBr3-AC	350	>150	1.4	150
5% Br2D-AC	350	>180	2.1	180
5% Br2D-AC	400	>180	10.9	180

虽然已经给出和描述了本发明优选的实施方案，本领域的技术人员在不偏离本发明的实质和教导的情况下可以对其作出各种修改。本文中描述的实施方案仅为示范性的，不意味着具有限制性。文中公开的本发明的种种变化及修改也是可行的，也在本发明的范围之内。因此，保护范围不限于上面说明书给出的内容，而仅由随后的权利要求所限定，该范围包括权利要求主题的所有等同方案。

公开文本中提供的实施例仅为例示和解释的目的，不意味着对权利要求或本发明实施方案的限制。虽然已经给出和描述了本发明优选的实施方案，本领域的技术人员在不偏离本发明的实质和教导的情况下可以对其作出各种修改。基于本文的公开内容，本领域的技术人员可以很容易地确定出本发明给定实施中的方法标准、设备等。本文描述的实施方案仅为示范性的，不意味着具有限制性。文中公开的本发明的多种变化及修改也是可行的，也在本发明的范围之内。关于本发

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明中的任何要素使用的术语“任选的”意味着表明该主题要素是需要的或者不需要的。两种选择方案均意味着落于本发明的范围之内。

背景部分中对参考文献的讨论并不是承认其为本发明的在先技术，特别是公布日期可能在本申请的优先权日期之后的任何参考文献。据此将本文引用的所有专利、专利申请及出版物的公开内容全部全文引入到本文中以供参考，其引入的范围对本文中的陈述内容提供示范性的、程序性的或其它详细的补充。

虽然本文描述的本发明为吸附剂材料以及其制备和用途的相关方法，但并不意味着局限于所描述的细节，在不偏离本发明实质的情况下可以做出各种修改及结构变化，这都在权利要求的等同方案的范围之内。

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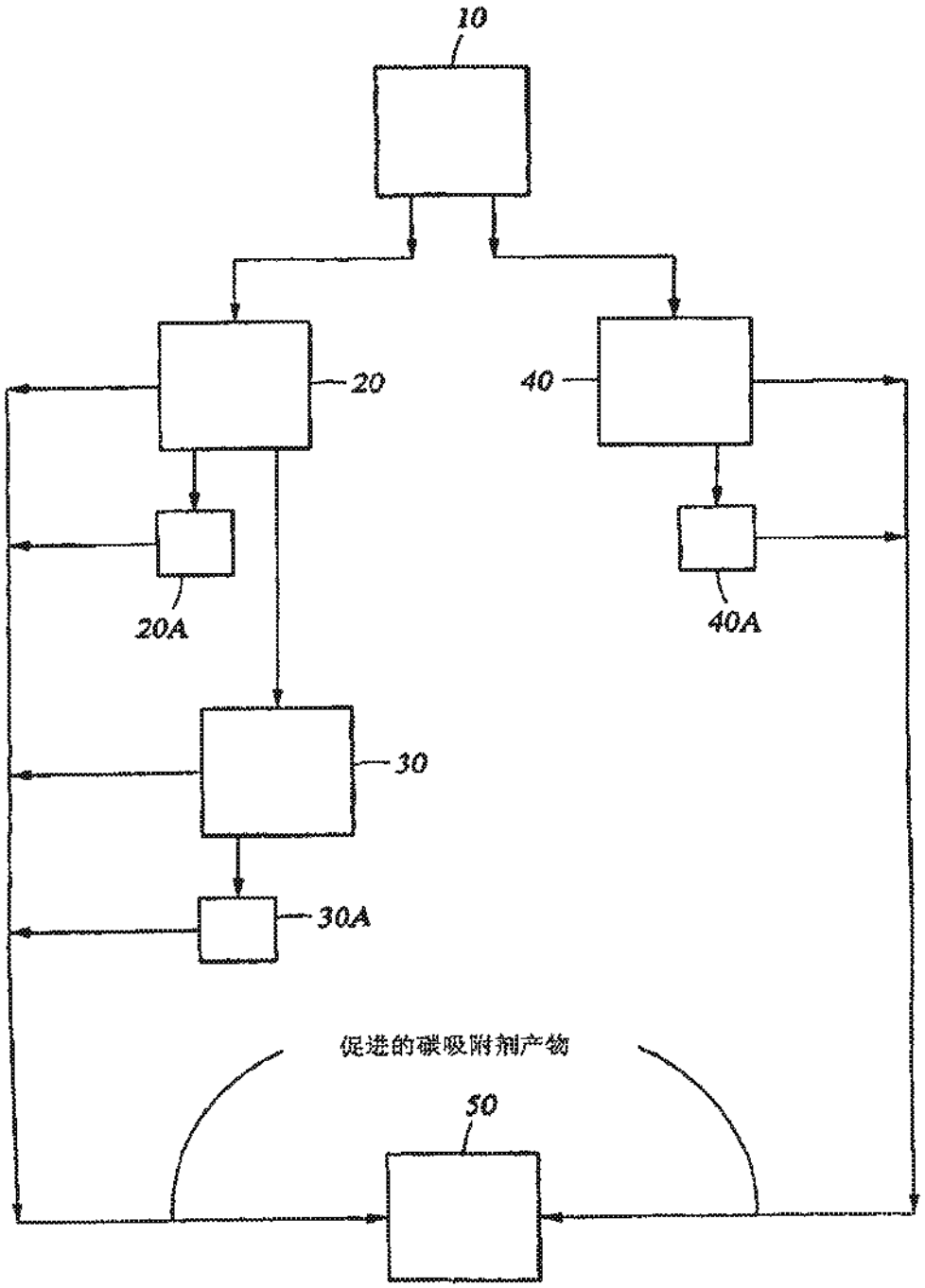


图1

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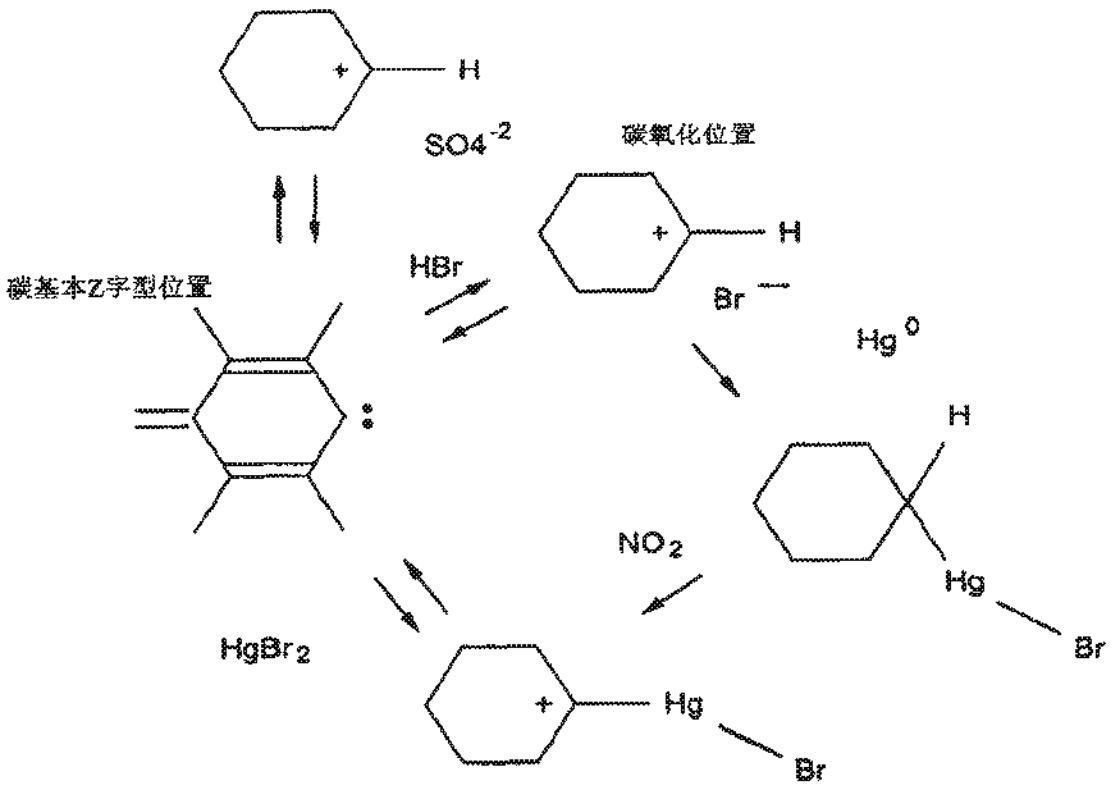


图2

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Page 543

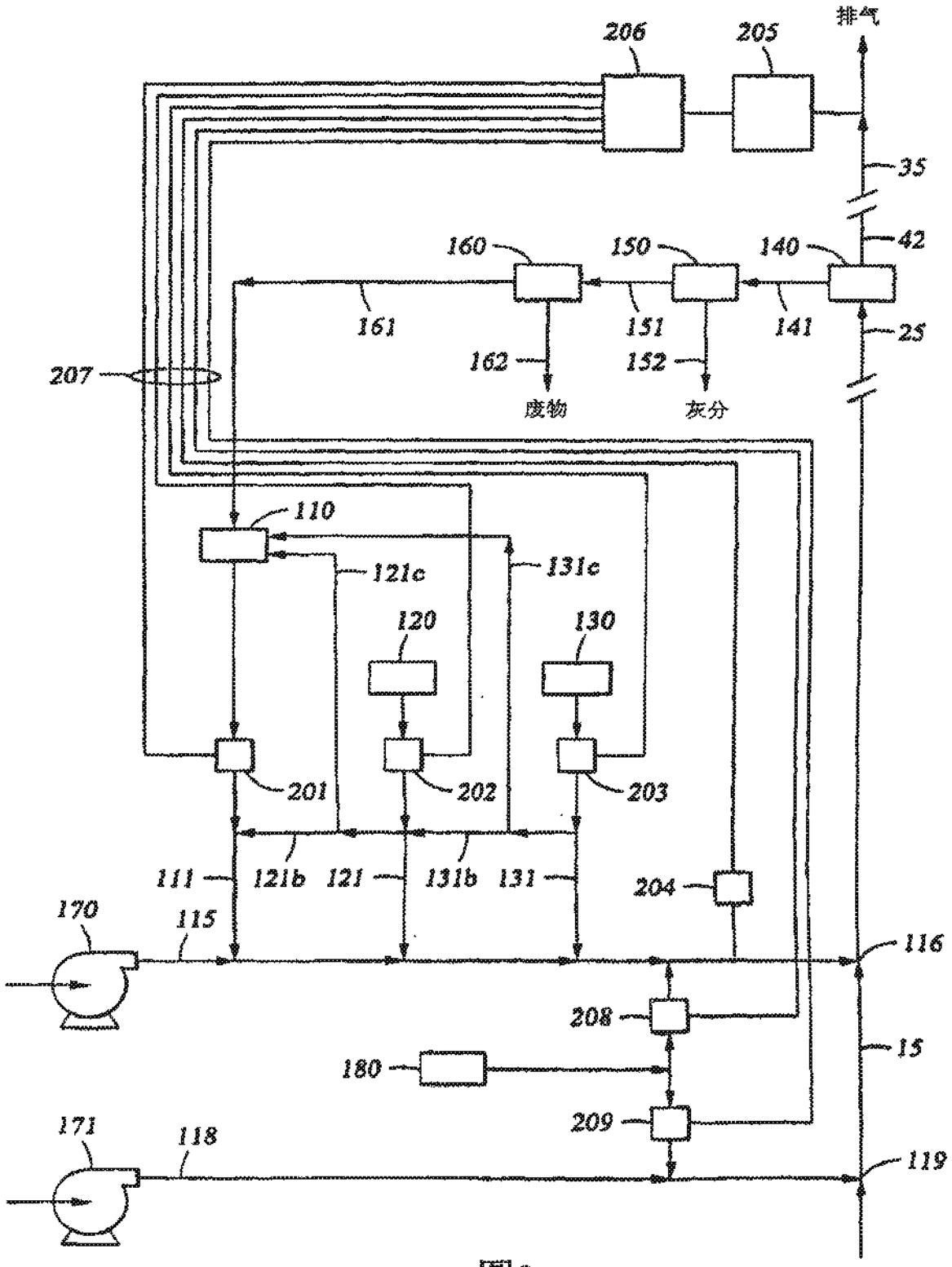


图3

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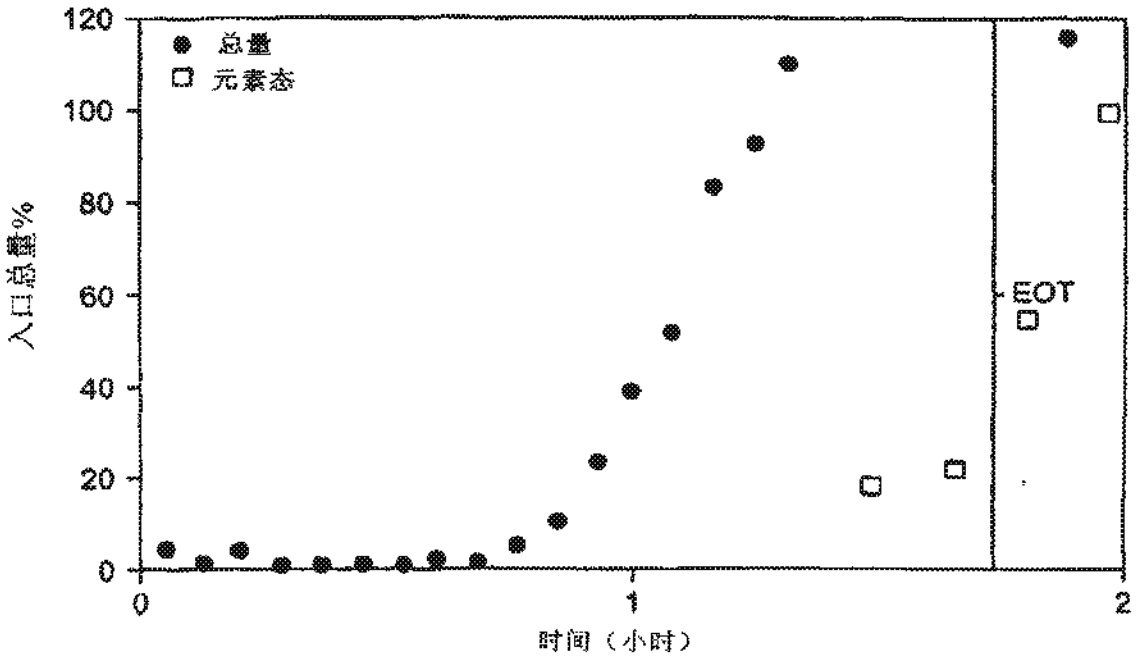


图4

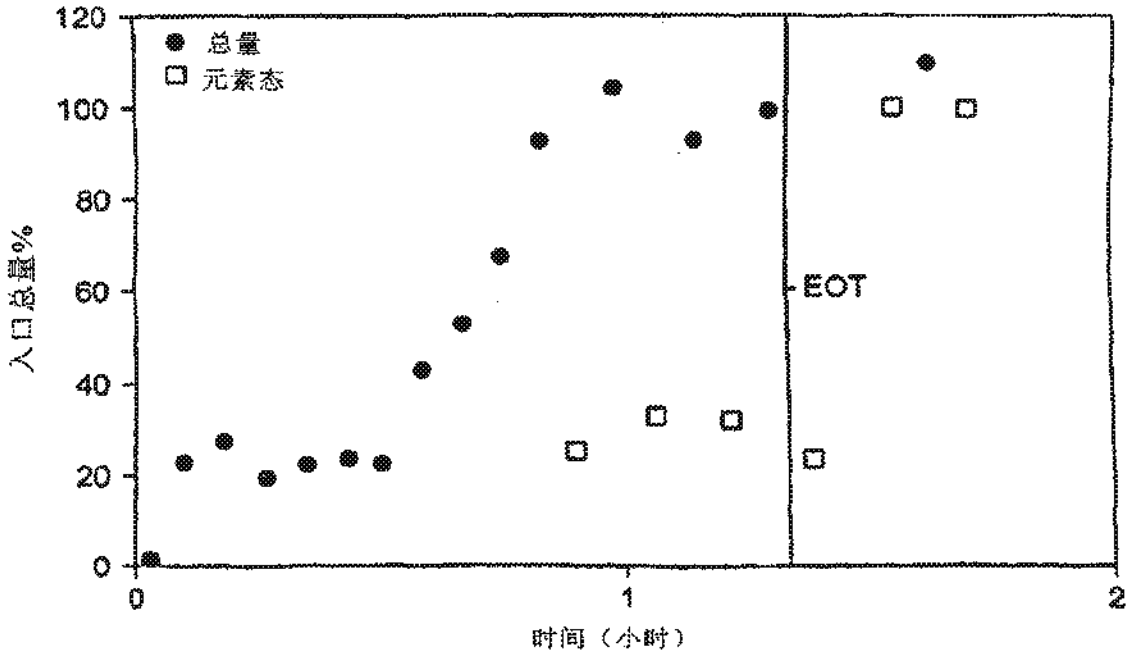


图5

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Page 545

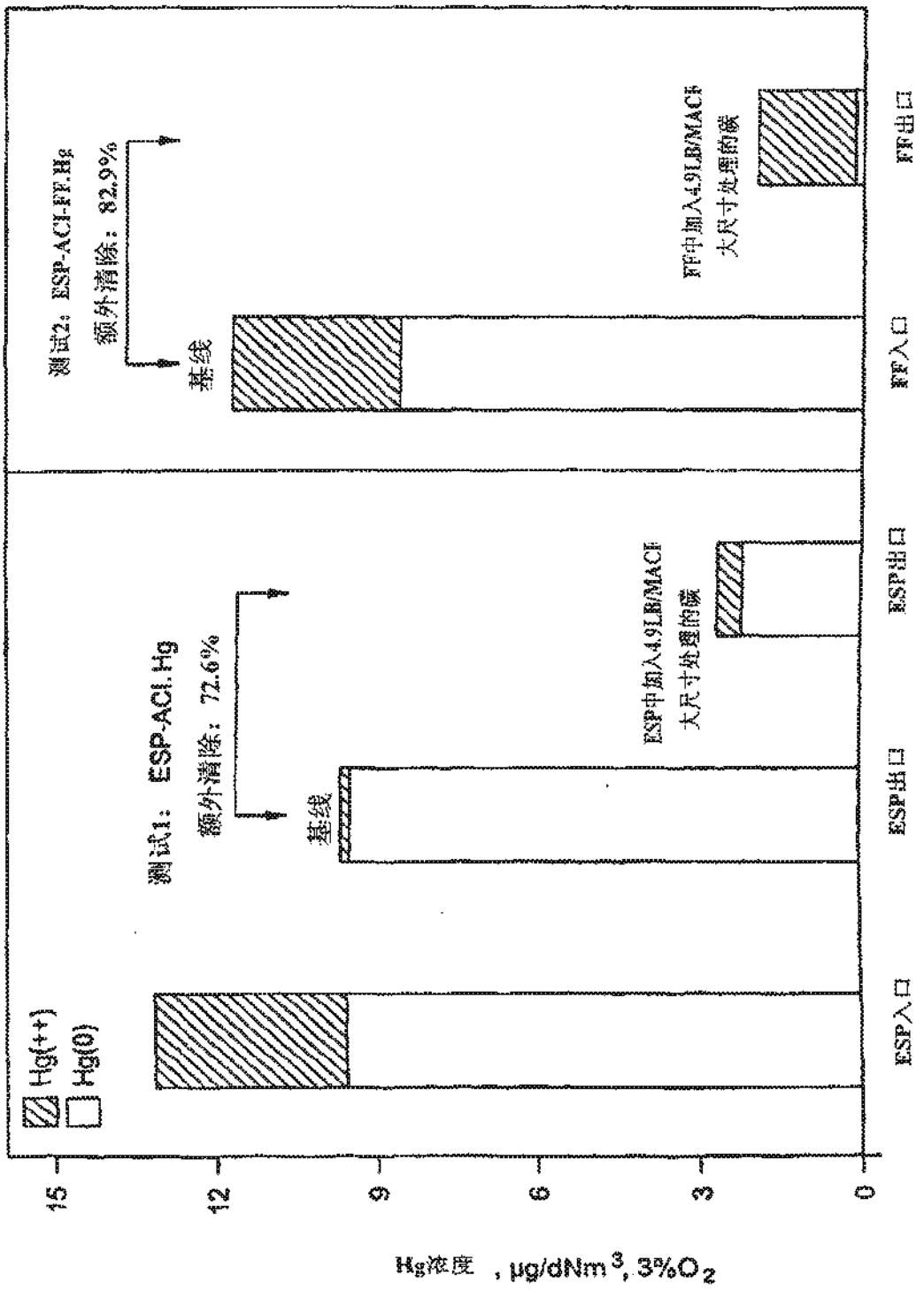


图6

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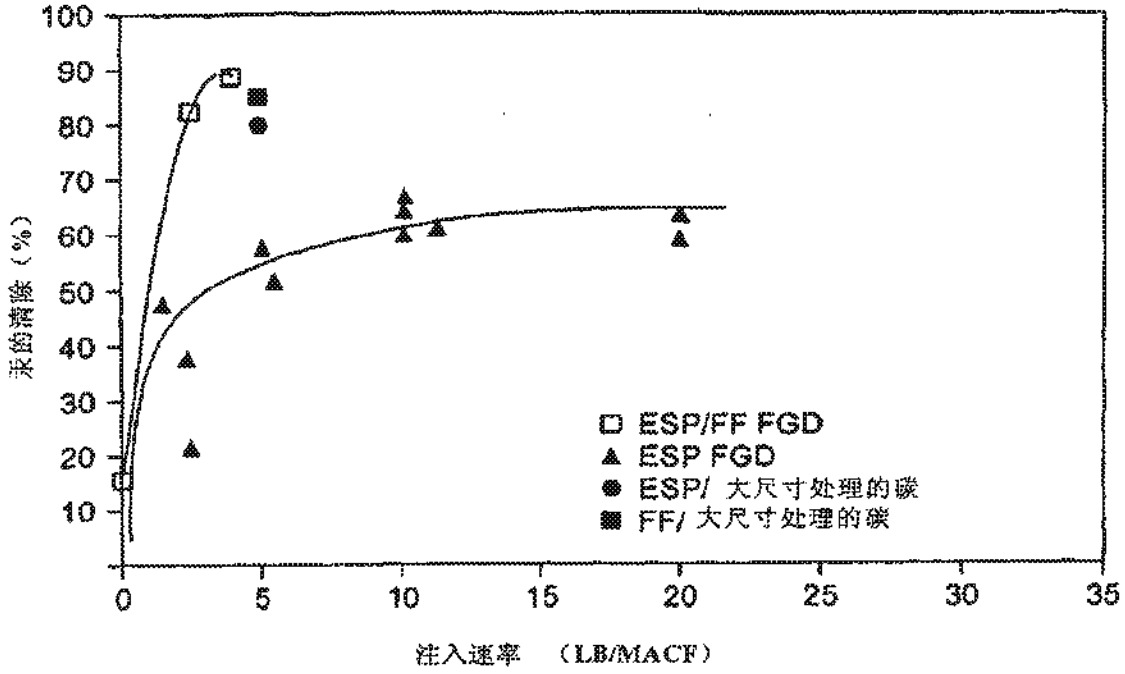


图7

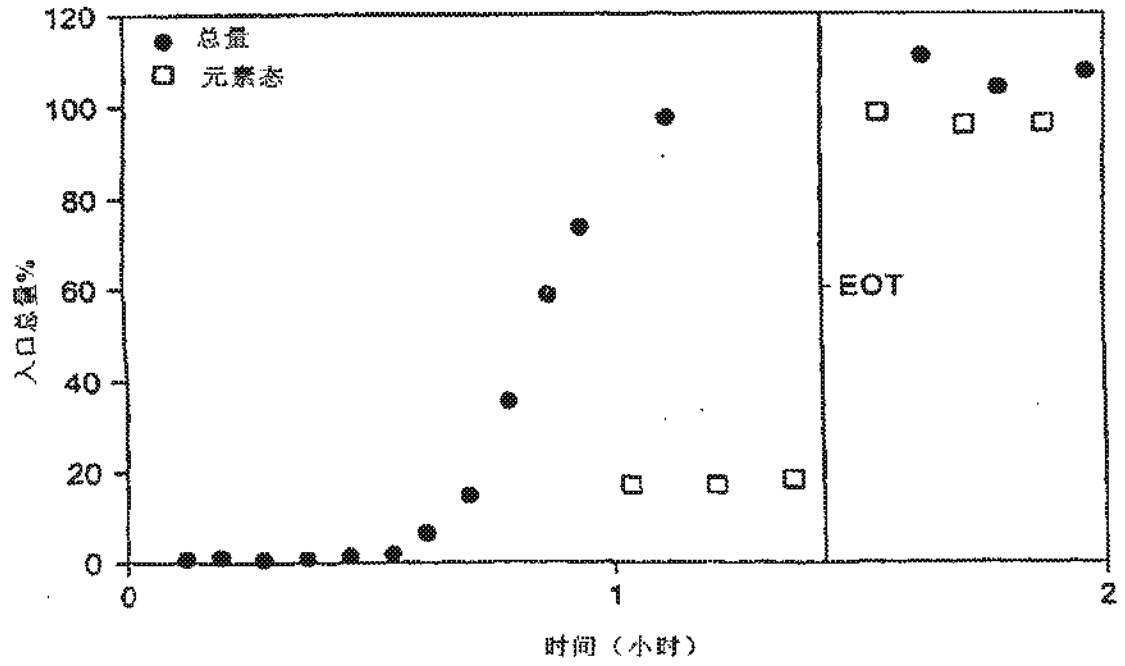


图8

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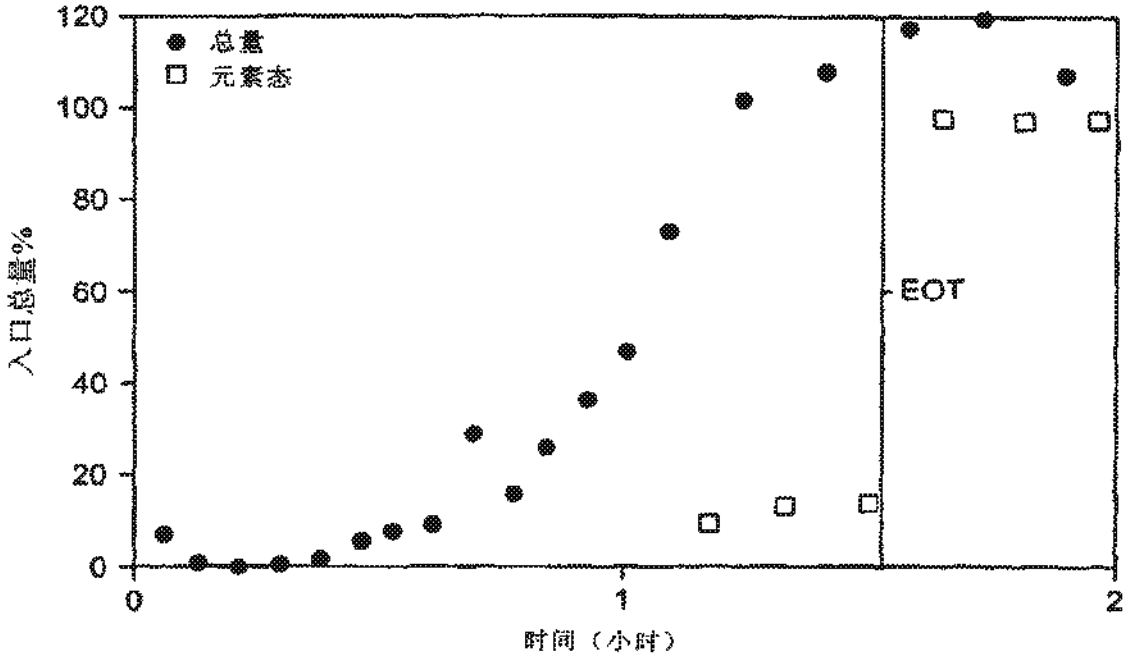


图9

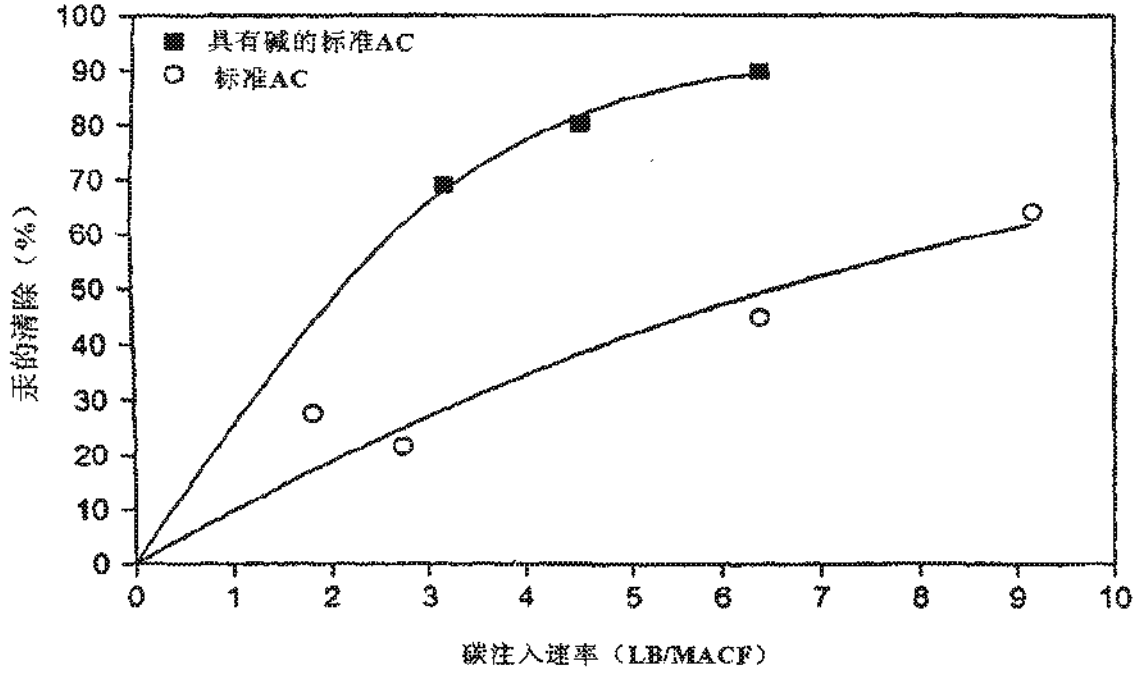


图10

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Electronic Acknowledgement Receipt

EFS ID:	34478378
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
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Time Stamp:	13:51:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
2380-01102		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2008/071986	**01 AUGUST 2008 (01.08.2008)**	01 AUGUST 2007 (01.08.2007)

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER et al

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of :
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the drawings to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ because the applicant failed to suggest a figure.
      ☐ because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/071986

A. CLASSIFICATION OF SUBJECT MATTER

F17C 5/00(2006.01)i, B01D 53/00(2006.01)i, F02C 6/14(2006.01)i, E21B 21/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F17C, F02C, C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) & keywords: "gas compressor", "gas turbine", "sulfur", "water" and "separate"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 09-256812 A (TOSHIBA CORP.) 30 September 1997 See the abstract and Claim 1.	1, 10
A	US 4,342,192 (KLAUS HEYN et al.) 3 August 1982 See the abstract and Fig. 1.	1, 10
A	US 7,017,330 B2 (JAMES C. BELLOWS) 28 March 2006 See the abstract and Fig. 1.	1, 10
A	KR 10-2002-0052209 A (JGC CORPORATION) 2 July 2002 See page 2, line 31 - page 6, line 1 and Fig. 3.	1, 10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 JANUARY 2009 (30.01.2009)	**30 JANUARY 2009 (30.01.2009)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

HAN, JAE SEOB

Telephone No. 82-42-481-5439

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2008/071986

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 09-256812 A	30.09.1997	NONE	
US 4342192	03.08.1982	CA 1134219 A1	26.10.1982
		DE 2850005 A1	29.05.1980
		DE 2931427 A1	19.02.1981
US 7017330 B2	28.03.2006	US 6804964	19.10.2004
		US 7431757	07.10.2008
		US 2004-0055309 A1	25.03.2004
		US 2005-039462 A1	24.02.2005
		US 6804964 B2	19.10.2004
KR 10-2002-0052209 A	02.07.2002	DE 60002602 D1	12.06.2003
		DE 60002602 T2	19.02.2004
		EP 1230323 B1	07.05.2003
		EP 1230323 A1	14.08.2002
		ES 2195942 T3	16.12.2003
		JP 2001-140656 A	22.05.2001
		TW 477812 B	01.03.2002
		TW 477812 A	01.03.2002
		US 6786050 B1	07.09.2004
		WO 01-36566 A1	25.05.2001

PATENT COOPERATION TREATY

PCT

RECD 29 JAN 2007
WIPO PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 2380-00201	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/US05/30018	International filing date *(day/month/year)* 23 August 2005 (23.08.2005)	Priority date *(day/month/year)* 30 August 2004 (30.08.2004)

International Patent Classification (IPC) or national classification and IPC

IPC: **B01D 53/02**(2006.01)
USPC: 95/13,107,134

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 5 sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) _____ , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25 October 2006 (25.10.2006)	27 December 2006 (27.12.2006)
Name and mailing address of the IPEA/ US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Robert A. Hopkins Telephone No. 571-272-1700

DEBORAH A. THOMAS
PARALEGAL SPECIALIST

Form PCT/IPEA/409 (cover sheet)(April 2005)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US05/30018

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:

- ☐ international search (under Rules 12.3 and 23.1(b))
- ☐ publication of the international application (under Rule 12.4(a))
- ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:
pages 1-28 as originally filed/furnished
pages* NONE received by this Authority on _____
pages* NONE received by this Authority on _____

☒ the claims:
pages NONE as originally filed/furnished
pages* NONE as amended (together with any statement) under Article 19
pages* 29-33 received by this Authority on 25 October 2006 (25.10.2006)
pages* NONE received by this Authority on _____

☒ the drawings:
pages 1-7 as originally filed/furnished
pages* NONE received by this Authority on _____
pages* NONE received by this Authority on _____

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE
- ☒ the claims, Nos. 48-54
- ☒ the drawings, sheets/figs NONE
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

** If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/US05/30018

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 34-47	YES
	Claims 1-33	NO
Inventive Step (IS)	Claims 34-47	YES
	Claims 1-33	NO
Industrial Applicability (IA)	Claims 1-47	YES
	Claims NONE	NO

2. Citations and Explanations (Rule 70.7)

Claims 1-33 lack novelty under PCT Article 33(2) as being anticipated by NISHINO ET AL. Note the base activated carbon and impregnated halide or halogen. Note also the optional secondary component including an alkaline earty salt. Note also the use of an organic solvent(ethanol). Note also the activated carbon with promoter is used for removal of mercury vapor. Note also the sorbent is either a fixed bed, moving bed, or fluidized bed sorbent. Note also the mercury content of the flue gas is monitored, and the sorbetn is recovered from the clean gas. Examiner also notes that the amendment "wherein the composition of the promoted carbon sorbent is controlled by the mercury content of the cleaned gas stream" does not have patentable weight upon a product claim(claim 1) and a method of making a product claim(claim 17)

Claims 1 and 17 lack novelty under PCT Article 33(2) as being anticipated by REVOIR ET AL. REVOIR ET AL teaches a base activated carbon and impregnated halide or halogen. Examiner also notes that the amendment "wherein the composition of the promoted carbon sorbent is controlled by the mercury content of the cleaned gas stream" does not have patentable weight upon a product claim(claim 1) and a method of making a product claim(claim 17).

Claims 1-47 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Claims 34-47 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest a step of preparing the sorbent by in-flight reaction of the base activated carbon with the at least one component within a transport line from which the reaction product is injected into the mercury containing gas stream.

---------- NEW CITATIONS ----------

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/30018

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **B01D 53/02**(2006.01)

USPC: 95/13,107,134
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 95/13,107,134

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,500,327 A (NISHINO et al) 19 February 1985, column 1 lines 66-68, column 2 lines 9-17, column 2 lines 34-38.	1-54
X	US 3,662,523A (REVOIR et al) 16 May 1972, column 1 lines 5-10, lines 62-69, column 2 lines 1-11.	1,16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 June 2006 (12.06.2006)	25 JUL 2006
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Robert A. Hopkins Telephone No. 703-872-9306

Form PCT/ISA/210 (second sheet) (April 2005)

Continuation of B. FIELDS SEARCHED Item 3:
EAST

search terms: activated adj carbon, halide, halogen, mercury, sorbent, adsorption , adsorb

PATENT COOPERATION TREATY

REC'D 28 JUL 2006
PCT

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
TIMOTHY S. WESTBY
CONLEY ROSE, P.C.
P.O. BOX 3267
HOUSTON, TX 77253-3267

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing (*day/month/year*)	25 JUL 2006
Applicant's or agent's file reference 2380-00201	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/US05/30018	23 August 2005 (23.08.2005)	30 August 2004 (30.08.2004)

International Patent Classification (IPC) or both national classification and IPC

IPC: **B01D 53/02**(2006.01)
USPC: 95/13,107,134

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

1. This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☐ Box No. II — Priority
- ☐ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI — Certain documents cited
- ☐ Box No. VII — Certain defects in the international application
- ☐ Box No. VIII — Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(*b*) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	12 June 2006 (12.06.2006)	Robert A. Hopkins Telephone No. 703-872-9306

Form PCT/ISA/237 (cover sheet) (April 2005)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US05/30018

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ on paper

☐ in electronic form

c. time of filing/furnishing

☐ contained in the international application as filed.

☐ filed together with the international application in electronic form.

☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US05/30018

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims NONE	YES
	Claims 1-54	NO
Inventive step (IS)	Claims NONE	YES
	Claims 1-54	NO
Industrial applicability (IA)	Claims 1-54	YES
	Claims NONE	NO

2. Citations and explanations:

Claims 1-54 are novelty under PCT Article 33(2) as being anticipated by NISHINO ET AL. Note the base activated carbon and impregnated halide or halogen. Note also the optional secondary component including an alkaline earty salt. Note also the use of an organic solvent(ethanol). Note also the activated carbon with promoter is used for removal of mercury vapor. Note also the sorbent is either a fixed bed, moving bed, or fluidized bed sorbent. Note also the mercury content of the flue gas is monitored, and the sorbetn is recovered from the clean gas.

Claims 1 and 16 lack novelty under PCT Article 33(2) as being anticipated by REVOIR ET AL. REVOIR ET AL teaches a base activated carbon and impregnated halide or halogen.

Claims 1-54 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING TRANSMITTAL OF COPY OF INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (CHAPTER I OF THE PATENT COOPERATION TREATY)
(PCT Rule 44bis.1(c))

To:

KOWALCHYK, Katherine, M.
Merchant & Gould P.C.
P.O. Box 2903
Minneapolis, MN 55402-0903
ETATS-UNIS D'AMERIQUE

Date of *mailing (day/month/year)*
03 November 2011 (03.11.2011)

Applicant's or agent's file reference
16291.3WO01

IMPORTANT NOTICE

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2010/022807	02 February 2010 (02.02.2010)	23 April 2009 (23.04.2009)

Applicant
ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION et al

The International Bureau transmits herewith a copy of the international preliminary report on patentability (Chapter I of the Patent Cooperation Treaty)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 82 70

Authorized officer:
Lingfei Bai

e-mail: pt02.pct@wipo.int

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 16291.3WO01	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2010/022607	International filing date *(day/month/year)* 02 February 2010 (02.02.2010)	Priority date *(day/month/year)* 23 April 2009 (23.04.2009)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 25 October 2011 (25.10.2011)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Lingfei Bai e-mail: pt02 pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
KOWALCHYK KATHERINE M

MERCHANT & GOULD P.C. P.O. BOX 2903
MINNEAPOLIS MN 55402-0903 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

	Date of mailing *(day/month/year)* **13 SEPTEMBER 2010 (13.09.2010)**
Applicant's or agent's file reference 16291.3WO11	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2010/022807	**02 FEBRUARY 2010 (02.02.2010)**	23 APRIL 2009 (23.04.2009)

International Patent Classification (IPC) or both national classification and IPC

B01D 53/02(2006.01)i, B01D 53/64(2006.01)i, F23J 15/00(2006.01)i

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION et al

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	13 SEPTEMBER 2010 (13.09.2010)	JO Soo Ik Telephone No.82-42-481-5893

Form PCT/ISA/237 (cover sheet) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/022807

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form
      ☐ furnished subsequently to this Authority for the purposes of search.

4 ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropnate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/022807

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	NONE	YES
	Claims	1-35	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-35	NO
Industrial applicability (IA)	Claims	1-35	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2009-0062119 A1 (OLSON EDWIN S. et al.) 05 March 2009
D2: US 2006-0204418 A1 (CHIEN-CHUNG CHAO et al.) 14 September 2006
D3: US 2007-0234902 A1 (DAVID FAIR et al.) 11 October 2007

1. Novelty & Inventive Step

Claims [1-35] relate to a method for separating mercury from mercury containg gas.

D1 discloses methods and materials for the removal of pollutants from flue gas or product gas from a gasification system. In particular, mercury is removed from gas streams generated during the burning or gasification of fossil fuels by highly reactive regenerable sorbents.(See the abstract, fig. 1~10, Paragraph [10] ~ Paragraph [134], whole claims)

D2 discloses a catalytic adsorbents for use in the removal of mercury from flue gas streams and methods of manufacturing such catalytic adsorbents.(See the abstract, Paragraph [33] ~ Paragraph [101])

D3 discloses a method for removing mercury from a flue gas stream of the present invention is comprised of first treating a sorbent with a metal halide, and then contacting a sufficient amount of the sorbent with a gas stream for a sufficient amount of time to bind with a desired amount of the mercury in said gas stream.(See the whole document).

1.1 Claims [1-35]

1.1.1 Concerning Claim [1]

Document D1 which is considered to represent the most relevant state of the art, disclose a method of using a sorbent, a halogen promoter, a reaction process for promted halogen sorbent, a separation process.

As all of the features of claim [1] are disclosed in D1 this claim is anticipated by D1. Therefore, claim [1] lacks novelty under PCT Article 33(2).

1.1.2 Concerning Claims [2-11]

The additional feature of claims [2-11] dependent on claim [1] such as a injection and introduction of sorbent, promoter, a rate control are disclosed in D1, this claim is anticipated by D1. Therefore, claims [2-11] lack novelty under PCT Article 33(2).

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of :

Box V

1.1.3 Concerning Claims [12-22]

The additional feature of claims [12-22] dependent on claim [1] such as a activated carbon sorbent, non carbon based sorbents, lewis base, acid group, alkaline, inorganic, sobents are disclosed in D1, this claim is anticipated by D1. Therefore, claims [12-22] lack novelty under PCT Article 33(2).

1.1.4 Concerning Claims [23-28]

The additional feature of claims [23-28] dependent on claim [1] such as carbon and non carbon promoters, a reaction process with noncarbon lewis base, acid group, alkaline, inorganic, promoted sorbent are disclosed in D1, this claim is anticipated by D1. Therefore, claims [23-28] lack novelty under PCT Article 33(2).

1.1.5 Concerning Claims [29-32]

The additional feature of claims [29-32] dependent on claim [1] such as vacuum, chmical, alkaline pretreatment process and alkaline introduction are disclosed in D1, this claim is anticipated by D1. Therefore, claims [29-32] lack novelty under PCT Article 33(2).

1.1.6 Concerning Claims [33-35]

The additional feature of claims [33-35] dependent on claim [1] such as a promoted carbon sorbent and mercury level control are disclosed in D1, this claim is anticipated by D1. Therefore, claims [33-35] lack novelty under PCT Article 33(2).

2. Industrial Applicability

The subject matter of claims [1-35] are considered to be industrially applicable under PCT Article 33(4).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
16291.3WO01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2010/022807	**02 FEBRUARY 2010 (02.02.2010)**	23 APRIL 2009 (23.04.2009)

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION et al

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of :
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a))
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 3
      ☐ as suggested by the applicant
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/022807

A. CLASSIFICATION OF SUBJECT MATTER

B01D 53/02(2006.01)i, B01D 53/64(2006.01)i, F23J 15/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B01D 53/02; C01B 31/08; B01J 8/00; B01J 20/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: sorbent, mercury, flue gas, halogen promoter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0062119 A1 (OLSON EDWIN S. et al.) 05 March 2009 See the abstract, fig. 1~10, Paragraph [10] ~ Paragraph [134], whole claims	1-35
A	US 2006-0204418 A1 (CHIEN-CHUNG CHAO et al.) 14 September 2006 See the abstract, Paragraph [33] ~ Paragraph [101]	1-35
A	US 2007-0234902 A1 (DAVID FAIR et al.) 11 October 2007 See the whole document	1-35

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 SEPTEMBER 2010 (13.09.2010)	**13 SEPTEMBER 2010 (13.09.2010)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	JO Soo Ik Telephone No. 82-42-481-5893

Form PCT/ISA/210 (second sheet) (July 2009)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009-0062119 A1	05.03.2009	None	
US 2006-0204418 A1	14.09.2006	CA 2600876-A1	21.09.2006
		CN 101175692 A0	07.05.2008
		EP 1866245 A2	19.12.2007
		KR 10-2007-0113287 A	28.11.2007
		MX 2007011233 A	06.11.2007
		US 2006-0205592 A1	14.09.2006
		WO 2006-099291 A2	21.09.2006
		WO 2006-099291 A3	21.09.2006
US 2007-0234902 A1	11.10.2007	WO 2007-112248 A2	04.10.2007
		WO 2007-112248 A3	13.12.2007
		WO 2007-112248 A3	04.10.2007

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
KOWALCHYK KATHERINE M

MERCHANT & GOULD P.C. P.O. BOX 2903
MINNEAPOLIS MN 55402-0903 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	13 SEPTEMBER 2010 (13.09.2010)
Applicant's or agent's file reference: 16291.3WO11	FOR FURTHER ACTION: See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2010/022807	02 FEBRUARY 2010 (02.02.2010)	23 APRIL 2009 (23.04.2009)

International Patent Classification (IPC) or both national classification and IPC

B01D 53/02(2006.01)i, B01D 53/64(2006.01)i, F23J 15/00(2006.01)i

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION et al

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302 -701, Republic of Korea Facsimile No. 82-42-472-7140	13 SEPTEMBER 2010 (13.09.2010)	JO Soo Ik Telephone No.82-42-481-5893

Form PCT/ISA/237 (cover sheet) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/022807

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form
      ☐ furnished subsequently to this Authority for the purposes of search.

4 ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/022807

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	NONE	YES
	Claims	1-35	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-35	NO
Industrial applicability (IA)	Claims	1-35	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2009-0062119 A1 (OLSON EDWIN S. et al.) 05 March 2009
D2: US 2006-0204418 A1 (CHIEN-CHUNG CHAO et al.) 14 September 2006
D3: US 2007-0234902 A1 (DAVID FAIR et al.) 11 October 2007

1. Novelty & Inventive Step

Claims [1-35] relate to a method for separating mercury from mercury containg gas.

D1 discloses methods and materials for the removal of pollutants from flue gas or product gas from a gasification system. In particular, mercury is removed from gas streams generated during the burning or gasification of fossil fuels by highly reactive regenerable sorbents.(See the abstract, fig. 1~10, Paragraph [10] ~ Paragraph [134], whole claims)

D2 discloses a catalytic adsorbents for use in the removal of mercury from flue gas streams and methods of manufacturing such catalytic adsorbents.(See the abstract, Paragraph [33] ~ Paragraph [101])

D3 discloses a method for removing mercury from a flue gas stream of the present invention is comprised of first treating a sorbent with a metal halide, and then contacting a sufficient amount of the sorbent with a gas stream for a sufficient amount of time to bind with a desired amount of the mercury in said gas stream.(See the whole document).

1.1 Claims [1-35]

1.1.1 Concerning Claim [1]

Document D1 which is considered to represent the most relevant state of the art, disclose a method of using a sorbent, a halogen promoter, a reaction process for promted halogen sorbent, a separation process.

As all of the features of claim [1] are disclosed in D1 this claim is anticipated by D1. Therefore, claim [1] lacks novelty under PCT Article 33(2).

1.1.2 Concerning Claims [2-11]

The additional feature of claims [2-11] dependent on claim [1] such as a injection and introduction of sorbent, promoter, a rate control are disclosed in D1, this claim is anticipated by D1. Therefore, claims [2-11] lack novelty under PCT Article 33(2).

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of :

Box V

1.1.3 Concerning Claims [12-22]

The additional feature of claims [12-22] dependent on claim [1] such as a activated carbon sorbent, non carbon based sorbents, lewis base, acid group, alkaline, inorganic, sobents are disclosed in D1, this claim is anticipated by D1. Therefore, claims [12-22] lack novelty under PCT Article 33(2).

1.1.4 Concerning Claims [23-28]

The additional feature of claims [23-28] dependent on claim [1] such as carbon and non carbon promoters, a reaction process with noncarbon lewis base, acid group, alkaline, inorganic, promoted sorbent are disclosed in D1, this claim is anticipated by D1. Therefore, claims [23-28] lack novelty under PCT Article 33(2).

1.1.5 Concerning Claims [29-32]

The additional feature of claims [29-32] dependent on claim [1] such as vacuum, chmical, alkaline pretreatment process and alkaline introduction are disclosed in D1, this claim is anticipated by D1. Therefore, claims [29-32] lack novelty under PCT Article 33(2).

1.1.6 Concerning Claims [33-35]

The additional feature of claims [33-35] dependent on claim [1] such as a promoted carbon sorbent and mercury level control are disclosed in D1, this claim is anticipated by D1. Therefore, claims [33-35] lack novelty under PCT Article 33(2).

2. Industrial Applicability

The subject matter of claims [1-35] are considered to be industrially applicable under PCT Article 33(4).

PATENT COOPERATION TREATY

Schwegman Lundberg & Woessner P.A.
JUL 24 2014
PCT RECEIVED

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	17.07.2014
Applicant's or agent's file reference	IMPORTANT NOTIFICATION
3338016WO1	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/036964	17.04.2013	23.04.2012

Applicant
Energy & Environmental Research Center Foundation

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:

European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040
Fax: +31 70 340 - 3016

Authorized Officer

Bergström, Carina

Tel. +31 70 340-2898

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 3338016WO1	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/US2013/036964	International filing date *(day/month/year)* 17.04.2013	Priority date *(day/month/year)* 23.04.2012

International Patent Classification (IPC) or national classification and IPC
INV. B01J20/12

Applicant
Energy & Environmental Research Center Foundation

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 10 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 13 sheets, as follows:
      - ☐ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).
      - ☐ sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).
      - ☒ superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3*bis* of Annex C of the Administrative Instructions).

4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
28.02.2014	17.07.2014

Name and mailing address of the international preliminary examining authority:

European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040
Fax: +31 70 340 - 3016

Authorized officer

Klemps, Christian

Telephone No. +31 70 340-8036

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

☒ the international application in the language in which it was filed

☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:

- ☐ international search (under Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (under Rule 12.4(a))
- ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-49 as originally filed

Claims, Numbers

1-42 filed with the demand for preliminary international examination

Drawings, Sheets

1/6-6/6 as originally filed

☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing *(specify)*:
- ☐ any table(s) related to sequence listing *(specify)*:

4. ☒ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):

- ☐ the description, pages
- ☒ the claims, Nos. 1,38,41
- ☐ the drawings, sheets/figs
- ☐ the sequence listing *(specify)*:

5. ☐ This report has been established:

- ☐ taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
- ☐ without taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

6. ☒ With regard to top-up searches (Rules 66.1 ter and 70.2(f)):
   - ☒ A top-up search was carried out by this Authority on 08.04.2014 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
   - ☐ No top-up search was carried out by this Authority.

7. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

   ☐ the entire international application,

   ☒ claims Nos. 6-43, 46, 47, 49

   because:

   ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination *(specify)*:

   ☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

   ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*.

   ☒ no international search report has been established for the said claims Nos. 6-43, 46, 47, 49

   ☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

      ☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Preliminary Examining Authority in a form and manner acceptable to it.

      ☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Preliminary Examining Authority in a form and manner acceptable to it.

      ☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rules 13*ter*.1(a) or (b) and 13*ter*.2.

   ☒ See separate sheet for further details

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-5, 44, 46, 48
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-5, 44, 46, 48
Industrial applicability (IA)	Yes:	Claims	1-5, 44, 46, 48
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item I

Basis of the report

1 The International Preliminary Examining Authority considers that the following amendments to the claims go beyond the disclosure in the international application as filed:

In present claims 1 and 38, the "substrate material" is defined as "comprising at least one of diatomaceous earth, a clay, a zeolite, and a mineral". In paragraph [0061] of the description of the application as filed, however, only porous minerals are disclosed. No basis in the application as filed can be found for *any* mineral as "substrate material".

Further, in present claims 1 and 38, the "heat treatment" is defined as "comprising about 500°C to about 1200°C". In paragraph [0065] of the description of the application as filed, however, only each of the temperatures 500°C and 1200°C, respectively, are disclosed in an exemplified fashion. No basis in the application as filed can be found for a *temperature range from 500°C to 1200°C* of said "heat treatment".

Further, in present claim 1, the "promotion comprising chemical reaction with at least one of a halogen and a halide promotor" is defined as taking place "after the heat treatment". However, in none of the paragraphs [0058], [0061], [0065] or [0066] - [0074] mentioned in the applicant's letter as basis for this amendment said "promotion comprising chemical reaction with at least one of a halogen and a halide promotor" is specifically disclosed as taking place *after the heat treatment*.

The present opinion therefore has been established as if such amendments had not been made (Rule 70.2(c) PCT).

2 Claim 41 has been newly introduced. Since in the accompanying letter, the basis in the application as filed for this amendment was not indicated, this report has been established as if this amendment had not been made (Rule 70.2(c-bis).

3 Consequently, the present report has been established on the application documents as originally filed.

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

4 No opinion was established with regard to novelty, inventive step and industrial applicability on the subject-matter of claims 4-37, 40 and 42 since their subject-matter relates to inventions for which no international search report has been established (Rule 66.2(e) PCT).

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 US 2011/168018 A1 (MOHAMADALIZADEH ALI [IR] ET AL) 14 July 2011 (2011-07-14)

D2 US 2009/136401 A1 (YANG XIAOLIN DAVID [US] ET AL) 28 May 2009 (2009-05-28)

D3 US 2004/076570 A1 (JIA CHARLES Q [CA]) 22 April 2004 (2004-04-22)

D4 A. Bakandritsos ET AL: "High Surface Area Montmorillonite-Carbon Composites and Derived Carbons", Chemistry of materials, vol. 16, no. 8, 16 March 2004 (2004-03-16), pages 1551-1559, XP055072551, ISSN: 0897-4756, DOI: 10.1021/cm0350030

D5 US 2008/090951 A1 (MAO DONGSHENG [US] ET AL) 17 April 2008 (2008-04-17)

5 For the reasons mentioned under item I (see above), the present reasoned statement with regard to novelty, inventive step or industrial applicability has been established on the first (group of) inventions mentioned in the claims as originally filed. The claim numbering relates to those said claims as originally filed:

6 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-5, 44, 45 and 48 is not new in the sense of Article 33(2) PCT:

7 **D1** discloses a method for separating hydrogen sulfide (a pollutant) from a gas comprising methane, helium and hydrogen sulfide, the method comprising

providing a carbon nanocomposite sorbent of multiwall carbon nanotubes (MWCNT) with average diameters of from about 2 nm to about 5 nm and mesoporous crystalline material (MCM)-41;

contacting the said carbon nanocomposite sorbent with a flow of the gas containing 5500 ppm of hydrogen sulfide;

passing the gas flow to an outlet to give a separated gas containing 600 ppm of hydrogen sulfide (paragraph [0029]; paragraph [0062]; example 2).

D1 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing MWCNT as carbon precursor;

providing MCM-41 as substrate material;

mixing MWCNTs and MCM-41 and thereby contacting them;

heating the mixture for 3 hours at 110°C (paragraph [0029]; paragraph [0062]; example 2).

D1 hence discloses the subject-matter of claims 1, 2, 44, 45 and 48.

8 **D2** discloses discloses a method for separating mercury from a flue gas comprising flue gas, fly ash and mercury, the method comprising

providing as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent;

promoting the said carbon nanocomposite sorbent by impregnating it with a sodium bromide (NaBr) solution in water;

contacting the NaBr-promoted carbon nanocomposite sorbent with a flow of the gas containing mercury for one second by injecting the carbon nanocomposite sorbent into the gas in a drop tube reactor;

separating the NaBr-promoted carbon nanocomposite sorbent from the gas for analysis of mercury content (paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2; paragraph [0048] - paragraph [0050]; table 3).

D2 further discloses as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent (paragraph [0044] - paragraph [0047]; examples 8; table 1).

D2 hence discloses the subject-matter of claims 1-5, 45 and 48.

9 D3 discloses a method of separating mercury from a desiccator atmosphere that comprises mercury, the method comprising

providing treated coke (ECOcarbon), which is considered a carbon nanocomposite comprising agglomerated carbon structures of about 30 nm;

contacting the said carbon nanocomposite sorbent with a desiccator atmosphere that comprises mercury;

separating the said carbon nanocomposite sorbent comprising mercury from the desiccator atmosphere for analysis of mercury content (paragraph [0084] - paragraph [0086]; example 1; paragraph [0095] - paragraph [0099]; example 5).

D3 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing fluid coke as carbon precursor;

providing sulfur dioxide (SO_2) as substrate material;

contacting fluid coke and SO_2 for 10 seconds;

heating the mixture at 800°C (paragraph [0087] - paragraph [0092]; example 2).

D3 hence discloses the subject-matter of claims 1-3, 44, 45 and 48.

10 D4 discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing sucrose as carbon precursor;

providing montmorillonite as substrate material;

contacting contacting sucrose and montmorillonite;

pyrolyzing and hence heating the mixture for one hour at 600°C (Section: "Sample Preparation";page 1552, right-hand column; figure 1).

D4 hence discloses the subject-matter of claims 44, 45 and 48.

11 D5 discloses a method of making a carbon nanocomposite suitable as a sorbent and the carbon nanocomposite hence made, the method comprising

providing carbon nanotubes (CNTs) as carbon precursors,

providing epoxy as substrate material,

curing and hence heating the material for two hours at 160°C .

D5 hence discloses the subject-matter of claims 44, 45 and 48 (paragraph [0015]; figure 1).

Re Item VII

Certain defects in the international application

12 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art documents mentioned in paragraphs [0005] to [0007] of the description are not cited in a way that allows their retrieval.

Re Item VIII

Certain observations on the international application

13 For the reasons mentioned under Item I (see above), the present observations have been made with regard to the first (group of) inventions mentioned in the claims as originally filed. The claim numbering relates to those said claims as originally filed:

14 The application does not meet the requirements of Article 6 PCT for the following reasons:

15 The term "carbon nanocomposite" use in the claims is unclear, because it cannot be determined without ambiguity which further technical feature is meant to be attributed to the carbon composite by defining it as a "nano"composite. The term "nano" merely indicates a prefix in the SI and other systems of units denoting a factor of 10^{-9}. For the present purposes, any carbon composite is considered to be a "carbon nanocomposite". Insofar as

the description of the application contains a clear and unambiguous definition of the tem "carbon nanocomposite", said definition would have to be included in the claims to render the subject-matter of said claim clear.

16 The term pollutant used in claim 2 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers. Specifically, whether a compound or material is considered to be polluting or not, depends on the specific circumstances in which the compound or material is found. Since theses specific circumstances are not further defined in the claim, the said claim is unclear. Insofar as the description of the application contains a clear and unambiguous definition of the tem "pollutant", said definition would have to be included in the claims to render the subject-matter of said claim clear.

17 Claim 4 is not supported by the description as required by Article 6 PCT, as its scope is broader than justified by the description and drawings. Specific support for "promoters" can only be found for "halogen and halide" promoters (see e.g. paragraph [0009] of the description), not for any "promoter".

Claim 48 tries to define the claimed carbon nanocomposite sorbent further in that it is "in contact with mercury or oxidized mercury". This wording introduces an ambiguity as to the scope of said claim 48. The expression "in contact" seeks to define a relationship between the entities "carbon nanocomposite sorbent" and "mercury or oxidized mercury", while it cannot be determined whether one of the two or both entities fall under the scope of the claim. The subject-matter of claim 48 therefore is unclear. For the present purposes of search and examination, claim 48 is considered to be solely directed to the "carbon nanocomposite sorbent" of claim 45, upon which it depends.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
3338016WO1		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2013/036964	17 April 2013 (17-04-2013)	23 April 2012 (23-04-2012)
Applicant		
ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 7 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☒ **Unity of invention is lacking** (see Box No III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant

☐ as selected by this Authority, because the applicant failed to suggest a figure

☐ as selected by this Authority, because this figure better characterizes the invention

b. ☐ none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/036964

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-5, 44, 45, 48

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/036964

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01J20/12 B01D53/02 B01J20/30 B01J20/32 B01D53/64
B01J20/20
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01J B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/168018 A1 (MOHAMADALIZADEH ALI [IR] ET AL) 14 July 2011 (2011-07-14) paragraph [0029] paragraph [0062]; example 2	1,2,44, 45,48
X	US 2009/136401 A1 (YANG XIAOLIN DAVID [US] ET AL) 28 May 2009 (2009-05-28) paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2 paragraph [0048] - paragraph [0050]; table 3	1-5,45, 48

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 July 2013	29/11/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Klemps, Christian

4

Form PCT/ISA/210 (second sheet) (April 2005)

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Page 596

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/036964

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/076570 A1 (JIA CHARLES Q [CA]) 22 April 2004 (2004-04-22) paragraph [0084] - paragraph [0086]; example 1 paragraph [0087] - paragraph [0092]; example 2 paragraph [0095] - paragraph [0099]; example 5	1-3,44, 45,48
X	A. BAKANDRITSOS ET AL: "High Surface Area Montmorillonite-Carbon Composites and Derived Carbons", CHEMISTRY OF MATERIALS, vol. 16, no. 8, 16 March 2004 (2004-03-16) , pages 1551-1559, XP055072551, ISSN: 0897-4756, DOI: 10.1021/cm0350030 Section: "Sample Preparation"; page 1552, right-hand column; figure 1	44,45,48
X	US 2008/090951 A1 (MAO DONGSHENG [US] ET AL) 17 April 2008 (2008-04-17) paragraph [0015]; figure 1	44,45,48

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

PACCAR EXHIBIT 1024
Page 597

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/036964

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011168018 A1	14-07-2011	NONE	
US 2009136401 A1	28-05-2009	US 2009136401 A1	28-05-2009
		US 2012292564 A1	22-11-2012
US 2004076570 A1	22-04-2004	AU 2003278010 A1	04-05-2004
		CA 2408858 A1	18-04-2004
		US 2004076570 A1	22-04-2004
		WO 2004035176 A1	29-04-2004
US 2008090951 A1	17-04-2008	NONE	

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 44, 45, 48

related to a method for separating a material from a gas that comprises the material, the method comprising providing or obtaining a carbon nanocomposite sorbent, contacting at least some of the material with the sorbent, to form a material-sorbent composition, and separating at least some of the material-sorbent composition from the material-containing gas, to give a separated gas; further to a method of making a such carbon nanocomposite sorbent; further to a such carbon nanocomposite

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2. claims: 6-42, 46, 49

related to a method for reducing the pollutant content of a pollutant-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent material, providing or obtaining a halogen or halide promotor, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the pollutant in the pollutant-containing gas, to form a pollutant-sorbent composition, and separating particulates from the pollutant-containing gas, the particulates comprising at least some of the pollutant-sorbent composition, to give a cleaned gas; further to a promoted corbon nanocomposite sorbent made by reacting a portion of the sorbent material with a halogen or halide promoter to form the promoted sorbent

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3. claims: 43, 47

related to a method for reducing the mercury content of a mercury-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent, the carbon nanocomposite sorbent made by steps comprising providing or obtaining a carbon precursor, providing or obtaining a substrate material, contacting the carbon precursor and the substrate material, to provide a nanocomposite starting material, and heating the nanocomposite starting material, to provide the carbon nanocomposite sorbent, providing or obtaining a halogen or halide promoter, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the mercury, to form a mercury-sorbent composition, and separating at least some of the mercury-sorbent composition from the mercury-containing gas; further to a mercury-sorbent composition made by

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

contacting a carbon nanocomposite sorbent with a mercury-containing gas

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PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
Madden, Robert B. Reg. No. 57,521
SCHWEGMAN, LUNDBERG & WOESSNER
P.O. Box 2938
Minneapolis, MN 55402-0938
ETATS-UNIS D'AMERIQUE

INVITATION TO PAY ADDITIONAL FEES AND, WHERE APPLICABLE, PROTEST FEE

(PCT Article 17(3)(a) and Rule 40.1 and 40.2(e))

Applicant's or agent's file reference 3338016WO1	Date of mailing *(day/month/year)* 2 August 2013 (02-08-2013)
International application No. PCT/US2013/036964	**PAYMENT DUE** within **ONE MONTH** from the above date of mailing
Applicant ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION	International filing date *(day/month/year)* 17 April 2013 (17-04-2013)

1. This International Searching Authority

(i) considers that there are 3 *(number of)* inventions claimed in the international application covered by the claims indicated on an extra sheet:

(ii) therefore considers that **the international application does not comply with the requirements of unity of invention** (Rules 13.1, 13.2 and 13.3) for the reasons indicated on an extra sheet:

(iii) [X] has carried out a partial international search (see Annex) [ ] will establish the international search report on those parts of the international application which relate to the invention first mentioned in claims Nos.:

see extra sheet

(iv) will establish the international search report on the other parts of the international application only if, and to the extent to which, additional fees are paid.

2. Consequently, the applicant is hereby **invited to pay**, within the time limit indicated above, the amount indicated below:

EUR 1.875,00	x	2	=	EUR 3.750,00
Fee per additional invention		number of additional inventions		currency/total amount of additional fees

3. The applicant is informed that, according to Rule 40.2(c), **the payment of any additional fee may be made under protest**, i.e., a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fee is excessive, where applicable, subject to the payment of a protest fee.

Where the applicant pays additional fees under protest, the applicant is hereby invited, within the time limit indicated above, to pay a protest fee (Rule 40.2(e)) in the amount of EUR 830,00 *(currency/amount)*

Where the applicant has not, within the time limit indicated above, paid the required protest fee, the protest will be considered not to have been made and the International Searching Authority will so declare.

4. [ ] Claim(s) Nos. _____ have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included within the opinion.

Schwegman Lundberg & Woessner P.A.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	NAMAGEMBE, Victoria Tel: +31 (0)70 340-3963 AUG 12 2013

Form PCT/ISA/206 (April 2005)
Registered Mail

PAGE 1 OF 1 EXHIBIT 1024
Page 601

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 44, 45, 48

related to a method for separating a material from a gas that comprises the material, the method comprising providing or obtaining a carbon nanocomposite sorbent, contacting at least some of the material with the sorbent, to form a material-sorbent composition, and separating at least some of the material-sorbent composition from the material-containing gas, to give a separated gas; further to a method of making a such carbon nanocomposite sorbent; further to a such carbon nanocomposite

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2. claims: 6-42, 46, 49

related to a method for reducing the pollutant content of a pollutant-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent material, providing or obtaining a halogen or halide promotor, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the pollutant in the pollutant-containing gas, to form a pollutant-sorbent composition, and separating particulates from the pollutant-containing gas, the particulates comprising at least some of the pollutant-sorbent composition, to give a cleaned gas; further to a promoted corbon nanocomposite sorbent made by reacting a portion of the sorbent material with a halogen or halide promoter to form the promoted sorbent

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3. claims: 43, 47

related to a method for reducing the mercury content of a mercury-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent, the carbon nanocomposite sorbent made by steps comprising providing or obtaining a carbon precursor, providing or obtaining a substrate material, contacting the carbon precursor and the substrate material, to provide a nanocomposite starting material, and heating the nanocomposite starting material, to provide the carbon nanocomposite sorbent, providing or obtaining a halogen or halide promoter, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the mercury, to form a mercury-sorbent composition, and separating at least some of the mercury-sorbent composition from the mercury-containing

gas; further to a mercury-sorbent composition made by contacting a carbon nanocomposite sorbent with a mercury-containing gas

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The present application lacks unity of invention (Rule 13 PCT) for the following reasons:
The present application contains the following eight independent claims: claim 1 (method claim), claim 6 (method claim), claim 43 (method claim), claim 44 (method claim), claim 45 (product claim), claim 46 (product claim), claim 47 (product claim), claim 49 (product claim).
The common same or corresponding technical features among those claims are:
carbon nanocomposite sorbent; method where said carbon nanocomposite sorbent is employed with a gas; said method comprising: the step of providing or obtaining a carbon nanocomposite sorbent; the step of contacting at least part of the sorbent; the step of separating from gas.
The common same or corresponding technical feature "carbon nanocomposite" is unclear (Article 6 PCT), because it cannot be determined which further technical feature is meant to be attributed to the carbon composite by defining it as a "nano"composite. The term "nano" merely indicates a prefix in the SI and other systems of units denoting a factor of 10^-9 . For the present purposes, any carbon composite is considered to be a "carbon nanocomposite".
The document US 2011/0168018 A1 (hereinafter D1) discloses a method for separating hydrogen sulfide from a gas comprising methane, helium and hydrogen sulfide, the method comprising
providing a carbon nanocomposite sorbent of multiwall carbon nanotubes (MWCNT) with average diameters of from about 2 nm to about 5 nm and mesoporous crystalline material (MCM)-41;
contacting the said carbon nanocomposite sorbent with a flow of the gas containing 5500 ppm of hydrogen sulfide;
passing the gas flow to an outlet to give a separated gas containing 600 ppm of hydrogen sulfide (paragraph [0029]; paragraph [0062]; example 2).
Further, the document US 2009/0136401 A1 (hereinafter D2) discloses a method for separating mercury from a flue gas comprising flue gas, fly ash and mercury, the method comprising
providing as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent;
promoting the said carbon nanocomposite sorbent by impregnating it with a sodium bromide (NaBr) solution in water;
contacting the NaBr-promoted carbon nanocomposite sorbent with a flow of the gas containing mercury for one second by injecting the carbon nanocomposite sorbent into the gas in a drop tube reactor;
separating the NaBr-promoted carbon nanocomposite sorbent from the gas for analysis of mercury content (paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2; paragraph [0048] - paragraph [0050]; table 3).
All common same or corresponding technical features are known from D1 and D2. These features therefore cannot serve as "special" technical features within the meaning of Rule 13.2 PCT.
Therefore, there is no common, same or corresponding special technical feature among all independent claims and thus the requirement of Rule 13.2 PCT is not met.
Amongst the independent claims 6, 43, 46, 47 and 49, the further common

same or corresponding technical features are:
promoter; providing a halogen or halide promoter; promoting at least a portion of the carbon nanocomposite sorbent material by chemically reacting a (the) portion of the sorbent material with the halogen or halide promoter; promoted sorbent.
All common same or corresponding technical features are known from D2. These features therefore cannot serve as "special" technical features within the meaning of Rule 13.2 PCT.
Therefore, there is no common, same or corresponding special technical feature among all independent claims 6, 43, 46, 47 and 49 and thus the requirement of Rule 13.2 PCT is not met.
The separate groups of inventions are hence as mentioned above.
The common problem underlying groups 1, 2 and 3 of inventions is seen to lie in the provision of a method for the removal of a (pollutant) component of a gas from said gas and the provision of a sorbent for a such removal.
The common problem is already known from both D1 (see e.g. abstract) and D2 (see e.g. abstract). No additional problem could be identified common to these three groups of inventions which could serve as the general inventive concept as required by Rule 13.1 PCT.
The application hence does not meet the requirements of unity of invention as defined in Rule 13.1 and 13.2 PCT.

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US2013/036964

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
see 'Invitation to pay additional fees'
2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/168018 A1 (MOHAMADALIZADEH ALI [IR] ET AL) 14 July 2011 (2011-07-14) paragraph [0029] paragraph [0062]; example 2	1,2,44, 45,48
X	US 2009/136401 A1 (YANG XIAOLIN DAVID [US] ET AL) 28 May 2009 (2009-05-28) paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2 paragraph [0048] - paragraph [0050]; table 3	1-5,45, 48
X	US 2004/076570 A1 (JIA CHARLES Q [CA]) 22 April 2004 (2004-04-22) paragraph [0084] - paragraph [0086]; example 1 paragraph [0087] - paragraph [0092]; example 2 paragraph [0095] - paragraph [0099]; example 5	1-3,44, 45,48
X	A. BAKANDRITSOS ET AL: "High Surface Area Montmorillonite-Carbon Composites and Derived Carbons", CHEMISTRY OF MATERIALS, vol. 16, no. 8, 16 March 2004 (2004-03-16) , pages 1551-1559, XP055072551, ISSN: 0897-4756, DOI: 10.1021/cm0350030 Section: "Sample Preparation"; page 1552, right-hand column; figure 1	44,45,48

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

4

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS
OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US2013/036964

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/090951 A1 (MAO DONGSHENG [US] ET AL) 17 April 2008 (2008-04-17) paragraph [0015]; figure 1	44,45,48

4

Form PCT/ISA/206 (Annex, continuation sheet) (July 1992; reprint January 2004)

Patent Family Annex

Information on patent family members

International Application No
PCT/US2013/036964

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011168018 A1	14-07-2011	NONE	
US 2009136401 A1	28-05-2009	US 2009136401 A1	28-05-2009
		US 2012292564 A1	22-11-2012
US 2004076570 A1	22-04-2004	AU 2003278010 A1	04-05-2004
		CA 2408858 A1	18-04-2004
		US 2004076570 A1	22-04-2004
		WO 2004035176 A1	29-04-2004
US 2008090951 A1	17-04-2008	NONE	

Electronic Acknowledgement Receipt

EFS ID:	34478626
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
Receipt Date:	04-DEC-2018
Filing Date:	04-JUN-2018
Time Stamp:	14:02:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	0237_2014800257019aarmisc_092017_20170915.pdf	1388126 c16b3e2b05d2f16d5a6ab20205158a8c691a03e6	no	21

Warnings:

Information:					
2	Non Patent Literature	0238_norit_darco_fgd_product_sheet.pdf	6905 23c9e66e629af5dbeaa4d853f83f3d18a126cb2d	no	2
Warnings:					
Information:					
3	Non Patent Literature	0239_jp_49_53593.pdf	1452768 d158c4e5c30809590125 6b4c8c491fc840e0a0fd	no	4
Warnings:					
Information:					
4	Non Patent Literature	0240_ep_reply_09_09_11.pdf	4824191 4ed08a519154055e10bce2a6c585b4950bbf482b	no	20
Warnings:					
Information:					
5	Non Patent Literature	0241_4820001ep1_e2001_110509.pdf	365416 fa5fdb310d571c2ec5028e8c6de5fb4d072bc77b	no	4
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Information:					
6	Non Patent Literature	0242_4820001ep1_decisiontograrant_060812.pdf	241648 4374ff57e7c3a101ea773c1ad9730083b9becd0a	no	2
Warnings:					
Information:					
7	Non Patent Literature	0243_4820001ep1_eesr_041409.pdf	1295558 4e6468b3b404a84fb2290738e9d7246937de7f4e	no	13
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Information:					
8	Non Patent Literature	0244_ep_oa_01_25_08.pdf	334290 beb37d9908c9ed57614e2f3a14dabe24199b9853	no	2
Warnings:					
Information:					

9	Non Patent Literature	0245_4820001ep1_e2001_013112.pdf	340216 4900ccc30ce17dca2d010be728f58e05adefa70a	no	4
Warnings:					
Information:					
10	Non Patent Literature	0246_4820001ep1_oarmisc_042712.pdf	599698 7f5396f7c40138136e819374f70735ac0e7e2512	no	6
Warnings:					
Information:					
11	Non Patent Literature	0247_ep_oa_11_05_09.pdf	995182 25d26614269a1171a3710add60fe5605167434d9	no	4
Warnings:					
Information:					
12	Non Patent Literature	0248_ep_search_report_04_14_09.pdf	3337669 563612d656c7d14f0f490090106bf4665f0cdcd9	no	13
Warnings:					
Information:					
13	Non Patent Literature	0249_4820001ep1_e2001ar_022812.pdf	4591107 9ad7d77e638f4e99221fdc89273878971cf9f0b7	no	30
Warnings:					
Information:					
14	Non Patent Literature	0250_ep_response_04_18_08.pdf	2807314 78831d96e7048deab8a30461518a0be7e8c4929a	no	7
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Information:					
15	Non Patent Literature	0251_4820001ep1_e2001ar_051110.pdf	596371 7f90a00a2e6a2081c65847772195fc52c8fe1f1e	no	11
Warnings:					
Information:					

16	Non Patent Literature	0252_ep_response_05_11_10.pdf	596450 067d4c74bea8265f8d1d0c21f81067d9adb08c33	no	11
Warnings:					
Information:					
17	Non Patent Literature	0253_4820001ep1_eesrr_090911.pdf	2247240 d24f825968160efd7e2ddc2c5f95858dcea7b960	no	20
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Information:					
18	Non Patent Literature	0254_third_party_observations.pdf	674454 941db7cc392242d065b87e8beb629ea27d9e87f4	no	7
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Information:					
19	Non Patent Literature	0255_third_party_comment_12_04_07.pdf	1423810 ef4ce956c8cb360b2742eba1086f03e0c410fe14	no	5
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Information:					
20	Non Patent Literature	0256_4820007ep1_decisiontograntt_041714.pdf	239269 1edd92128219fccf291320e68697f9c3b08faf76	no	2
Warnings:					
Information:					
21	Non Patent Literature	0257_4820007ep1_eesr_120612.pdf	509966 730e600dd4de13c0bf6cbe5ede91453582fdaf4b	no	5
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Information:					
22	Non Patent Literature	0258_4820007ep1_e2000c_031714.pdf	7019813 0568b8508a2a22867b0bdf35a97ef811de177230	no	44
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Information:					

23	Non Patent Literature	0259_4820007ep1_e2000c_093013.pdf	6729751 87381eef5b34c76bda492d399c62ef16419706aa	no	44
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24	Non Patent Literature	0260_4820007ep1_aarmisc_020314.pdf	1209447 ef3e585800b143e417c3a43d75bc0704acc568c5	no	11
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Information:					
25	Non Patent Literature	0261_4820007ep1_eesrr_062013.pdf	2165813 ce496c3bb4ca2276fd35934d1c1596701355be7e	no	18
Warnings:					
Information:					
26	Non Patent Literature	0262_supp_eu_search_rpt_1262012.pdf	222511 0b9fad02fb7426d7ad5db7a8b18ba58a94622f04	no	2
Warnings:					
Information:					
27	Non Patent Literature	0263_3_4820001ep3_e2001_112612.pdf	325591 c59fb0dd0e91652ea49d22f6bae0c1ea3f1a15b9	no	4
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Information:					
28	Non Patent Literature	0264_7_4820001ep3_decision_121913.pdf	1394786 2b0fdf1fa3ea7007a590b9fa042fd28624f00775	no	18
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Information:					
29	Non Patent Literature	0265_1_4820001ep3_eesr_020112.pdf	741357 c6fa499fe4996949d3a903d4cc93104fcc0d9400	no	7
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Information:					

30	Non Patent Literature	0266_6_4820001ep3_oar_misc_110413.pdf	260210 d2b5d791d73d83ea67e4cb4a91eea23107ef17d7	no	4
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31	Non Patent Literature	0267_4_4820001ep3_e2001r4_020413.pdf	926261 39a8ad99785d751e8ea2f3b5355cb70d26a41cbb	no	9
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Information:					
32	Non Patent Literature	0268_2_4820001ep3_eesrr_082812.pdf	1062658 201c5e6a347925fae40ac26ba4b4ffc5e09c42a1	no	9
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Information:					
33	Non Patent Literature	0269_5_4820001ep3_oarmisc_041513.pdf	632129 a2eb158b834e8d6f0018bb3e906920d7fc0a084a	no	7
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34	Non Patent Literature	0270_4820001ep2_e2001_010913.pdf	351110 9968b5b7f86bb39bf149d0f33aebf8d35ea0e9cd	no	4
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Information:					
35	Non Patent Literature	0271_4820001ep2_decisiontograrant_050214.pdf	240468 b7dd86cfc5ad4d78989f64f78a4bbebafde5b0e6	no	2
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36	Non Patent Literature	0272_4820001ep2_eesr_012312.pdf	571436 4542a078b5760387c96666e8f9d3ec88042c712e	no	6
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37	Non Patent Literature	0273_4820001ep2_eesr_050912.pdf	1199398 badcd4513cf0d87f8babecf5e12260155d50808f	no	12
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Information:					
38	Non Patent Literature	0274_4820001ep2_e2001_103013.pdf	250916 1fc019f9bb4e76589e160b1a2fd64884f7799bdc	no	4
Warnings:					
Information:					
39	Non Patent Literature	0275_4820001ep2_oarmisc_121113.pdf	609183 5a8e8e2ce2e9dd232c7e823fabea59d94038989b	no	6
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40	Non Patent Literature	0276_4820001ep2_e2001ar_021113.pdf	706120 bacdd854bedeae23173d100af23fc105fc9636fb	no	5
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Information:					
41	Non Patent Literature	0277_4820001ep2_aarmisc_101013.pdf	2039055 c483de725fbeccb30dc4f9e75f1e694215d2da46	no	18
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42	Non Patent Literature	0278_4820001ep2_eesrr_112212.pdf	1553524 ddaf5a01d7781103afc685d46282f9a0a5132ca8	no	13
Warnings:					
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43	Non Patent Literature	0279_4820001ep2_oarmisc_041513.pdf	598635 2205336b5265e490a1421e8582929e8c3fba76a5	no	6
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Information:					

44	Non Patent Literature	0280_4820006ep1_oarmisc_04 2417.pdf	655151 6ef0d04185064 71c0e41cb390594 2b7bd69 db4cc	no	8
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Information:					
45	Non Patent Literature	0281_3338016ep1_oarmisc_05 1217.pdf	702332 8c783715814 3cede8bbaa7c1ae20b32a6bc a2d3d	no	6
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46	Non Patent Literature	0282_ep_oa_12_19_2014.pdf	338900 4b7af8da61bc4ddb139d0dd11763dd2a26 2713c6	no	2
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Information:					
47	Non Patent Literature	0283_ep_response_06_29_201 5.pdf	5327099 169a376959820b41f203e8eb848820263ed c03f1	no	19
Warnings:					
Information:					
48	Non Patent Literature	0284_137193389aarmisc_0905 17_201709042.pdf	109442 f2c12282f6b16ee7669de437bcbcb4cb914 4cf85	no	7
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Information:					
49	Non Patent Literature	0285_3338021ep1_e2001_022 217.pdf	655001 886a5121f4aef72210027567ed977d2a12e d9f95	no	6
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Information:					
50	Non Patent Literature	0286_147111066e2001r4_0817 17_20170222.pdf	146560 af0ab987dc47b3b7532cecc41f5788d9626e 018c	no	10
Warnings:					
Information:					

51	Non Patent Literature	0287_2008071986_pct_13009.pdf	330236 c28a7f370f71a73f09d144557fd4de949615703d	no	3
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Information:					
52	Non Patent Literature	0288_4820001wo1_p326_122706.pdf	462868 a50f857442b3977b33e372d15f82a73e36ecc655	no	3
Warnings:					
Information:					
53	Non Patent Literature	0289_4820001wo1_p210_072506.pdf	174185 73b39d0683c329ea9521cf9829a880219160347a	no	2
Warnings:					
Information:					
54	Non Patent Literature	0290_4820001wo1_p237_072506.pdf	351881 604244b4304f1ffc027ae4773658d9d5dd88d85d	no	3
Warnings:					
Information:					
55	Non Patent Literature	0291_4820007wo1_p326_110311.pdf	623895 8797748221832226b63e8dddbfc5454c81e76d9a	no	6
Warnings:					
Information:					
56	Non Patent Literature	0292_4820007wo1_p210_091310.pdf	350307 666a0887f0b961eeb8482cc71856ac9b15342c1d	no	3
Warnings:					
Information:					
57	Non Patent Literature	0293_4820007wo1_p237_091310.pdf	453772 cec982a40334fe46a3f4f8bcfe19fb4559cca012	no	4
Warnings:					
Information:					

58	Non Patent Literature	0294_3338016wo1_p326_071714.pdf	1867110 f181ba709734de3c73911d9f8b34eec0d1e2bf00	no	11
Warnings:					
Information:					
59	Non Patent Literature	0295_3338016wo1_p210_112913.pdf	804642 61d7258040784f816ce15704d77663dc6c464d5e	no	7
Warnings:					
Information:					
60	Non Patent Literature	0296_3338016wo1_p206_080213.pdf	1096404 85cdda14c271b07af5a323680be8d73f025ed10d	no	7
Warnings:					
Information:					
			Total Files Size (in bytes):	74127605	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
ETATS-UNIS D'AMERIQUE

PCT

WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rule 66)

Date of mailing *(day/month/year)*	15.04.2014
Applicant's or agent's file reference: 3338016WO1	**REPLY DUE** within 1 month(s) and 15 days from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/036964	17.04.2013	23.04.2012

International Patent Classification (IPC) or both national classification and IPC
INV. B01J20/12

Applicant
Energy & Environmental Research Center Foundation

1. ☒ The written opinion established by the International Searching Authority:
   ☒ is ☐ is not
   considered to be a written opinion of the International Preliminary Examining Authority.

2. This second opinion contains indications relating to the following items:
   - ☒ Box No. I Basis of the opinion
   - ☐ Box No. II Priority
   - ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

   When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(e).
   How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 55.3 and 66.8.
   Also: For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4*bis*. For an informal communication with the examiner, see Rule 66.6. For an additional opportunity to submit amendments, see Rule 66.4.
   If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary report on patentability (Chapter II of the PCT) must be established according to Rule 69.2 is: 23.06.2014

Schwegman Lundberg & Woessner P.A.
APR 29 2014

Name and mailing address of the international preliminary examining authority:
European Patent Office P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040
Fax: +31 70 340 - 3016

Authorized Officer
Klemps, Christian
Telephone No. +31 70 340-8036

RECEIVED

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into ,
   which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))

2. With regard to the elements of the international application, this opinion has been established on the basis of *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed")*:

   Description, Pages

   1-49 as originally filed

   Claims, Numbers

   1-42 filed with the demand for preliminary international examination

   Drawings, Sheets

   1/6-6/6 as originally filed

   ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

4. ☒ This opinion has been established as if (some of) the amendments listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
   - ☐ the description, pages
   - ☒ the claims, Nos. 1-3, 38,39,41
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

5. ☐ This opinion has been established:
   - ☐ taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 66.1(d-bis)).
   - ☐ without taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 66.4bis).

6. ☐ Supplementary international search report(s) from Authority(ies) have been received and taken into account in drawing up this opinion (Rule 45bis.8(b) and (c)).

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non- obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application

☒ claims Nos. 4-37, 40, 42

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*:

☒ no international search opinion has been established for the said claims Nos. 4-37, 40, 42

☐ a meaningful opinion could not be formed without sequence listing; the applicant did not, within the prescribed time limit:

☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Preliminary Examining Authority in a form and manner acceptable to it.

☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Preliminary Examining Authority in a form and manner acceptable to it.

☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rules 13*ter*.1(a) or (b) and 13*ter*.2.

☒ See supplemental sheet for further details

Box No. V Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	No:	Claims 1-5, 44, 45, 48
Inventive step (IS)	No:	Claims 1-5, 44, 45, 48
Industrial applicability (IA)	No:	Claims

2. Citations and explanations:

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item I

Basis of the report

1 The International Preliminary Examining Authority considers that the following amendments to the claims go beyond the disclosure in the international application as filed:

In present claims 1 and 38, the "substrate material" is defined as "comprising at least one of diatomaceous earth, a clay, a zeolite, and a mineral". In paragraph [0061] of the description of the application as filed, however, only porous minerals are disclosed. No basis in the application as filed can be found for *any* mineral as "substrate material".

Further, in present claims 1 and 38, the "heat treatment" is defined as "comprising about 500°C to about 1200°C". In paragraph [0065] of the description of the application as filed, however, only each of the temperatures 500°C and 1200°C, respectively, are disclosed in an exemplified fashion. No basis in the application as filed can be found for a *temperature range from 500°C to 1200°C* of said "heat treatment".

Further, in present claim 1, the "promotion comprising chemical reaction with at least one of a halogen and a halide promotor" is defined as taking place "after the heat treatment". However, in none of the paragraphs [0058], [0061], [0065] or [0066] - [0074] mentioned in the applicant's letter as basis for this amendment said "promotion comprising chemical reaction with at least one of a halogen and a halide promotor" is specifically disclosed as taking place *after the heat treatment*.

The present opinion therefore has been established as if such amendments had not been made (Rule 70.2(c) PCT).

2 Claim 41 has been newly introduced. Since in the accompanying letter, the basis in the application as filed for this amendment was not indicated, this opinion has been established as if this amendment had not been made (Rule 70.2(c-bis).

3 Consequently, the present opinion has been established on the application documents as originally filed.

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

4 No opinion was established with regard to novelty, inventive step and industrial applicability on the subject-matter of claims 4-37, 40 and 42 since their subject-matter relates to inventions for which no international search report has been established (Rule 66.2(e) PCT).

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 US 2011/168018 A1 (MOHAMADALIZADEH ALI [IR] ET AL) 14 July 2011 (2011-07-14)

D2 US 2009/136401 A1 (YANG XIAOLIN DAVID [US] ET AL) 28 May 2009 (2009-05-28)

D3 US 2004/076570 A1 (JIA CHARLES Q [CA]) 22 April 2004 (2004-04-22)

D4 A. Bakandritsos ET AL: "High Surface Area Montmorillonite-Carbon Composites and Derived Carbons", Chemistry of materials, vol. 16, no. 8, 16 March 2004 (2004-03-16), pages 1551-1559, XP055072551, ISSN: 0897-4756, DOI: 10.1021/cm0350030

D5 US 2008/090951 A1 (MAO DONGSHENG [US] ET AL) 17 April 2008 (2008-04-17)

5 For the reasons mentioned under Item I (see above), the present reasoned statement with regard to novelty, inventive step or industrial applicability has been established on the first (group of) inventions mentioned in the claims as originally filed. The claim numbering relates to those said claims as originally filed:

6 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-5, 44, 45 and 48 is not new in the sense of Article 33(2) PCT:

7 **D1** discloses a method for separating hydrogen sulfide (a pollutant) from a gas comprising methane, helium and hydrogen sulfide, the method comprising

providing a carbon nanocomposite sorbent of multiwall carbon nanotubes (MWCNT) with average diameters of from about 2 nm to about 5 nm and mesoporous crystalline material (MCM)-41;

contacting the said carbon nanocomposite sorbent with a flow of the gas containing 5500 ppm of hydrogen sulfide;

passing the gas flow to an outlet to give a separated gas containing 600 ppm of hydrogen sulfide (paragraph [0029]; paragraph [0062]; example 2).

D1 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing MWCNT as carbon precursor;

providing MCM-41 as substrate material;

mixing MWCNTs and MCM-41 and thereby contacting them;

heating the mixture for 3 hours at 110°C (paragraph [0029]; paragraph [0062]; example 2).

D1 hence discloses the subject-matter of claims 1, 2, 44, 45 and 48.

8 **D2** discloses discloses a method for separating mercury from a flue gas comprising flue gas, fly ash and mercury, the method comprising

providing as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent;

promoting the said carbon nanocomposite sorbent by impregnating it with a sodium bromide (NaBr) solution in water;

contacting the NaBr-promoted carbon nanocomposite sorbent with a flow of the gas containing mercury for one second by injecting the carbon nanocomposite sorbent into the gas in a drop tube reactor;

separating the NaBr-promoted carbon nanocomposite sorbent from the gas for analysis of mercury content (paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2; paragraph [0048] - paragraph [0050]; table 3).

D2 further discloses as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent (paragraph [0044] - paragraph [0047]; examples 8; table 1).

D2 hence discloses the subject-matter of claims 1-5, 45 and 48.

9 **D3** discloses a method of separating mercury from a desiccator atmosphere that comprises mercury, the method comprising

providing treated coke (ECOcarbon), which is considered a carbon nanocomposite comprising agglomerated carbon structures of about 30 nm;

contacting the said carbon nanocomposite sorbent with a desiccator atmosphere that comprises mercury;

separating the said carbon nanocomposite sorbent comprising mercury from the desiccator atmosphere for analysis of mercury content (paragraph [0084] - paragraph [0086]; example 1; paragraph [0095] - paragraph [0099]; example 5).

D3 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing fluid coke as carbon precursor;

providing sulfur dioxide (SO_2) as substrate material;

contacting fluid coke and SO_2 for 10 seconds;

heating the mixture at 800°C (paragraph [0087] - paragraph [0092]; example 2).

D3 hence discloses the subject-matter of claims 1-3, 44, 45 and 48.

10 **D4** discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing sucrose as carbon precursor;

providing montmorillonite as substrate material;

contacting contacting sucrose and montmorillonite;

pyrolyzing and hence heating the mixture for one hour at 600 °C (Section: "Sample Preparation";page 1552, right-hand column; figure 1).

D4 hence discloses the subject-matter of claims 44, 45 and 48.

11 D5 discloses a method of making a carbon nanocomposite suitable as a sorbent and the carbon nanocomposite hence made, the method comprising

providing carbon nanotubes (CNTs) as carbon precursors,

providing epoxy as substrate material,

curing and hence heating the material for two hours at 160 °C .

D5 hence discloses the subject-matter of claims 44, 45 and 48 (paragraph [0015]; figure 1).

Re Item VII

Certain defects in the international application

12 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art documents mentioned in paragraphs [0005] to [0007] of the description are not cited in a way that allows their retrieval.

Re Item VIII

Certain observations on the international application

13 For the reasons mentioned under item I (see above), the present observations have been made with regard to the first (group of) inventions mentioned in the claims as originally filed. The claim numbering relates to those said claims as originally filed:

14 The application does not meet the requirements of Article 6 PCT for the following reasons:

15 The term "carbon nanocomposite" use in the claims is unclear, because it cannot be determined without ambiguity which further technical feature is meant to be attributed to the carbon composite by defining it as a "nano"composite. The term "nano" merely indicates a prefix in the SI and other systems of units denoting a factor of 10^{-9}. For the present purposes, any carbon composite is considered to be a "carbon nanocomposite". Insofar as

the description of the application contains a clear and unambiguous definition of the tem "carbon nanocomposite", said definition would have to be included in the claims to render the subject-matter of said claim clear.

16 The term pollutant used in claim 2 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers. Specifically, whether a compound or material is considered to be polluting or not, depends on the specific circumstances in which the compound or material is found. Since theses specific circumstances are not further defined in the claim, the said claim is unclear. Insofar as the description of the application contains a clear and unambiguous definition of the tem "pollutant", said definition would have to be included in the claims to render the subject-matter of said claim clear.

17 Claim 4 is not supported by the description as required by Article 6 PCT, as its scope is broader than justified by the description and drawings. Specific support for "promoters" can only be found for "halogen and halide" promoters (see e.g. paragraph [0009] of the description), not for any "promoter".

Claim 48 tries to define the claimed carbon nanocomposite sorbent further in that it is "in contact with mercury or oxidized mercury". This wording introduces an ambiguity as to the scope of said claim 48. The expression "in contact" seeks to define a relationship between the entities "carbon nanocomposite sorbent" and "mercury or oxidized mercury", while it cannot be determined whether one of the two or both entities fall under the scope of the claim. The subject-matter of claim 48 therefore is unclear. For the present purposes of search and examination, claim 48 is considered to be solely directed to the "carbon nanocomposite sorbent" of claim 45, upon which it depends.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/036964	17.04.2013	23.04.2012

International Patent Classification (IPC) or both national classification and IPC
INV. B01J20/12 B01D53/02 B01J20/30 B01J20/32 B01D53/64 B01J20/20

Applicant
ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016	see form PCT/ISA/210	Klemps, Christian Telephone No. +31 70 340-8036

Form PCT/ISA/237 (Cover Sheet) (July 2009)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of

☐ the entire international application

☒ claims Nos. 6-43, 46, 47, 49

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international search *(specify)*:

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*:

☒ no international search report has been established for the whole application or for said claims Nos. 6-43, 46, 47, 49

☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

- ☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rules 13*ter*.1(a) or (b).

☐ See Supplemental Box for further details

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has, within the applicable time limit:

   ☐ paid additional fees

   ☐ paid additional fees under protest and, where applicable, the protest fee

   ☐ paid additional fees under protest but the applicable protest fee was not paid

   ☒ not paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-5, 44, 45, 48

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-5, 44, 45, 48
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-5, 44, 45, 48
Industrial applicability (IA)	Yes:	Claims	1-5, 44, 45, 48
	No:	Claims	

2. Citations and explanations

   see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Reference is made to the following documents:

D1 US 2011/168018 A1 (MOHAMADALIZADEH ALI [IR] ET AL) 14 July 2011 (2011-07-14)

D2 US 2009/136401 A1 (YANG XIAOLIN DAVID [US] ET AL) 28 May 2009 (2009-05-28)

D3 US 2004/076570 A1 (JIA CHARLES Q [CA]) 22 April 2004 (2004-04-22)

D4 A. Bakandritsos ET AL: "High Surface Area Montmorillonite-Carbon Composites and Derived Carbons", Chemistry of materials, vol. 16, no. 8, 16 March 2004 (2004-03-16), pages 1551-1559, XP055072551, ISSN: 0897-4756, DOI: 10.1021/cm0350030

D5 US 2008/090951 A1 (MAO DONGSHENG [US] ET AL) 17 April 2008 (2008-04-17)

Re Item IV

Lack of unity of invention

1 The present application lacks unity of invention (Rule 13 PCT) for the following reasons:

The present application contains the following eight independent claims: claim 1 (method claim), claim 6 (method claim), claim 43 (method claim), claim 44 (method claim), claim 45 (product claim), claim 46 (product claim), claim 47 (product claim), claim 49 (product claim).

The common same or corresponding technical features among those claims are:

carbon nanocomposite sorbent; method where said carbon nanocomposite sorbent is employed with a gas; said method comprising: the step of providing or obtaining a carbon nanocomposite sorbent; the step of contacting at least part of the sorbent; the step of separating from gas.

The common same or corresponding technical feature "carbon nanocomposite" is unclear (Article 6 PCT), because it cannot be determined which further technical feature is meant to be attributed to the carbon composite by defining it as a "nano"composite. The term "nano" merely

indicates a prefix in the SI and other systems of units denoting a factor of 10^{-9}. For the present purposes, any carbon composite is considered to be a "carbon nanocomposite".

The document US 2011/0168018 A1 (**D1**) discloses a method for separating hydrogen sulfide from a gas comprising methane, helium and hydrogen sulfide, the method comprising

providing a carbon nanocomposite sorbent of multiwall carbon nanotubes (MWCNT) with average diameters of from about 2 nm to about 5 nm and mesoporous crystalline material (MCM)-41;

contacting the said carbon nanocomposite sorbent with a flow of the gas containing 5500 ppm of hydrogen sulfide;

passing the gas flow to an outlet to give a separated gas containing 600 ppm of hydrogen sulfide (paragraph [0029]; paragraph [0062]; example 2).

Further, the document US 2009/0136401 A1 (**D2**) discloses a method for separating mercury from a flue gas comprising flue gas, fly ash and mercury, the method comprising

providing as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent;

promoting the said carbon nanocomposite sorbent by impregnating it with a sodium bromide (NaBr) solution in water;

contacting the NaBr-promoted carbon nanocomposite sorbent with a flow of the gas containing mercury for one second by injecting the carbon nanocomposite sorbent into the gas in a drop tube reactor;

separating the NaBr-promoted carbon nanocomposite sorbent from the gas for analysis of mercury content (paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2; paragraph [0048] - paragraph [0050]; table 3).

All common same or corresponding technical features are known from **D1** and **D2**. These features therefore cannot serve as "special" technical features within the meaning of Rule 13.2 PCT.

Therefore, there is no common, same or corresponding special technical feature among all independent claims and thus the requirement of Rule 13.2 PCT is not met.

Amongst the independent claims 6, 43, 46, 47 and 49, the further common same or corresponding technical features are:

promoter; providing a halogen or halide promoter; promoting at least a portion of the carbon nanocomposite sorbent material by chemically reacting a (the) portion of the sorbent material with the halogen or halide promoter; promoted sorbent.

All common same or corresponding technical features are known from **D2**. These features therefore cannot serve as "special" technical features within the meaning of Rule 13.2 PCT.

Therefore, there is no common, same or corresponding special technical feature among all independent claims 6, 43, 46, 47 and 49 and thus the requirement of Rule 13.2 PCT is not met.

The separate groups of inventions are:

Group 1: claims: 1-5, 44, 45, 48 related to a method for separating a material from a gas that comprises the material, the method comprising providing or obtaining a carbon nanocomposite sorbent, contacting at least some of the material with the sorbent, to form a material-sorbent composition, and separating at least some of the material-sorbent composition from the material-containing gas, to give a separated gas; further to a method of making a such carbon nanocomposite sorbent; further to a such carbon nanocomposite.

Group 2: claims: 6-42, 46, 49 related to a method for reducing the pollutant content of a pollutant-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent material, providing or obtaining a halogen or halide promotor, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the pollutant in the pollutant-containing gas, to form a pollutant-sorbent composition, and separating particulates from the pollutant-containing gas, the particulates comprising at least some of the pollutant-sorbent composition, to give a cleaned gas; further to a promoted corbon nanocomposite sorbent made by reacting a portion of the sorbent material with a halogen or halide promoter to form the promoted sorbent.

Group 3: claims: 43, 47 related to a method for reducing the mercury content of a mercury-containing gas, the method comprising providing or obtaining a carbon nanocomposite sorbent, the carbon nanocomposite sorbent made by steps comprising providing or obtaining a carbon precursor,

providing or obtaining a substrate material, contacting the carbon precursor and the substrate material, to provide a nanocomposite starting material, and heating the nanocomposite starting material, to provide the carbon nanocomposite sorbent, providing or obtaining a halogen or halide promoter, promoting at least a portion of the sorbent material by chemically reacting the portion of the sorbent material with the halogen or halide promoter to form a promoted sorbent, contacting at least part of the promoted sorbent with the mercury, to form a mercury-sorbent composition, and separating at least some of the mercury-sorbent composition from the mercury-containing gas; further to a mercury-sorbent composition made by contacting a carbon nanocomposite sorbent with a mercury-containing gas.

The common problem underlying groups 1, 2 and 3 of inventions is seen to lie in the provision of a method for the removal of a (pollutant) component of a gas from said gas and the provision of a sorbent for a such removal.

The common problem is already known from both **D1** (see e.g. abstract) and **D2** (see e.g. abstract). No additional problem could be identified common to these three groups of inventions which could serve as the general inventive concept as required by Rule 13.1 PCT.

The application hence does not meet the requirements of unity of invention as defined in Rule 13.1 and 13.2 PCT.

In accordance with Article 17(3) PCT the international search report is established on those parts of the international application which relate to the invention first mentioned in the claims, i.e. the above mentioned Group 1.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

2 The present application further does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-5, 44, 45 and 48 is not new in the sense of Article 33(2) PCT:

3 **D1** discloses a method for separating hydrogen sulfide (a pollutant) from a gas comprising methane, helium and hydrogen sulfide, the method comprising

providing a carbon nanocomposite sorbent of multiwall carbon nanotubes (MWCNT) with average diameters of from about 2 nm to about 5 nm and mesoporous crystalline material (MCM)-41;

contacting the said carbon nanocomposite sorbent with a flow of the gas containing 5500 ppm of hydrogen sulfide;

passing the gas flow to an outlet to give a separated gas containing 600 ppm of hydrogen sulfide (paragraph [0029]; paragraph [0062]; example 2).

D1 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing MWCNT as carbon precursor;

providing MCM-41 as substrate material;

mixing MWCNTs and MCM-41 and thereby contacting them;

heating the mixture for 3 hours at 110°C (paragraph [0029]; paragraph [0062]; example 2).

D1 hence discloses the subject-matter of claims 1, 2, 44, 45 and 48.

4 **D2** discloses discloses a method for separating mercury from a flue gas comprising flue gas, fly ash and mercury, the method comprising

providing as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent;

promoting the said carbon nanocomposite sorbent by impregnating it with a sodium bromide (NaBr) solution in water;

contacting the NaBr-promoted carbon nanocomposite sorbent with a flow of the gas containing mercury for one second by injecting the carbon nanocomposite sorbent into the gas in a drop tube reactor;

separating the NaBr-promoted carbon nanocomposite sorbent from the gas for analysis of mercury content (paragraph [0044] - paragraph [0047]; examples 8, 16; tables 1, 2; paragraph [0048] - paragraph [0050]; table 3).

D2 further discloses as-mined kaolin containing about 2% naturally intercalated carbon (Kaolin-1), which is considered as a carbon nanocomposite sorbent (paragraph [0044] - paragraph [0047]; examples 8; table 1).

D2 hence discloses the subject-matter of claims 1-5, 45 and 48.

5 **D3** discloses a method of separating mercury from a desiccator atmosphere that comprises mercury, the method comprising

providing treated coke (ECOcarbon), which is considered a carbon nanocomposite comprising agglomerated carbon structures of about 30 nm;

contacting the said carbon nanocomposite sorbent with a desiccator atmosphere that comprises mercury;

separating the said carbon nanocomposite sorbent comprising mercury from the desiccator atmosphere for analysis of mercury content (paragraph [0084] - paragraph [0086]; example 1; paragraph [0095] - paragraph [0099]; example 5).

D3 further discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing fluid coke as carbon precursor;

providing sulfur dioxide (SO_2) as substrate material;

contacting fluid coke and SO_2 for 10 seconds;

heating the mixture at 800°C (paragraph [0087] - paragraph [0092]; example 2).

D3 hence discloses the subject-matter of claims 1-3, 44, 45 and 48.

6 **D4** discloses a method of making a carbon nanocomposite sorbent and the carbon nanocomposite sorbent hence made, the method comprising

providing sucrose as carbon precursor;

providing montmorillonite as substrate material;

contacting contacting sucrose and montmorillonite;

pyrolyzing and hence heating the mixture for one hour at 600°C (Section: "Sample Preparation"; page 1552, right-hand column; figure 1).

D4 hence discloses the subject-matter of claims 44, 45 and 48.

7 **D5** discloses a method of making a carbon nanocomposite suitable as a sorbent and the carbon nanocomposite hence made, the method comprising

providing carbon nanotubes (CNTs) as carbon precursors,

providing epoxy as substrate material,

curing and hence heating the material for two hours at 160°C .

D5 hence discloses the subject-matter of claims 44, 45 and 48 (paragraph [0015]; figure 1).

Re Item VII

Certain defects in the international application

8 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art documents mentioned in paragraphs [0005] to [0007] of the description are not cited in a way that allows their retrieval.

Re Item VIII

Certain observations on the international application

9 The application does not meet the requirements of Article 6 PCT for the following reasons:

10 The term "carbon nanocomposite" use in the claims is unclear, because it cannot be determined without ambiguity which further technical feature is meant to be attributed to the carbon composite by defining it as a "nano"composite. The term "nano" merely indicates a prefix in the SI and other systems of units denoting a factor of 10^9. For the present purposes, any carbon composite is considered to be a "carbon nanocomposite".

11 The term pollutant used in claim 2 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers. Specifically, whether a compound or material is considered to be polluting or not, depends on the specific circumstances in which the compound or material is found. Since theses specific circumstances are not further defined in the claim, the said claim is unclear.

12 Claim 4 is not supported by the description as required by Article 6 PCT, as its scope is broader than justified by the description and drawings. Specific support for "promoters" can only be found for "halogen and halide" promoters (see e.g. paragraph [0009] of the description), not for any "promoter".

13 Claim 48 tries to define the claimed carbon nanocomposite sorbent further in that it is "in contact with mercury or oxidized mercury". This wording introduces an ambiguity as to the scope of said claim 48. The expression "in

contact" seeks to define a relationship between the entities "carbon nanocomposite sorbent" and "mercury or oxidized mercury", while it cannot be determined whether one of the two or both entities fall under the scope of the claim. The subject-matter of claim 48 therefore is unclear. For the present purposes of search and examination, claim 48 is considered to be solely directed to the "carbon nanocomposite sorbent" of claim 45, upon which it depends.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
3338021WO1		
International application No.	International filing date (day/month/year)	(Earliest) Priority Date (day/month/year)
PCT/US2014/019316	3 March 2014 (03-03-2014)	6 March 2013 (06-03-2013)

Applicant

ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 8 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the language, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (See Box No. II)

3. ☒ Unity of invention is lacking (see Box No III)

4. With regard to the title,

☒ the text is approved as submitted by the applicant

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the drawings,

a. the figure of the drawings to be published with the abstract is Figure No. _____

☐ as suggested by the applicant

☐ as selected by this Authority, because the applicant failed to suggest a figure

☐ as selected by this Authority, because this figure better characterizes the invention

b. ☐ none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/019916

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-49(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/019916

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01J20/20 B01D53/02 B01D53/10 B01J20/32 C01B31/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01J C01B B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YUANJING ZHENG ET AL: "Review of technologies for mercury removal from flue gas from cement production processes", PROGRESS IN ENERGY AND COMBUSTION SCIENCE, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 38, no. 5, 26 April 2012 (2012-04-26), pages 599-629, XP028415255, ISSN: 0360-1285, DOI: 10.1016/J.PECS.2012.05.001 [retrieved on 2012-05-25]	1-9, 16-25, 38,39, 48,49
Y	page 600, paragraph 1 page 615, paragraph 4.2.5.1 page 615, right-hand column, line 1 - line 4 "...by impregnation of nitrogen-containing polymers or pitches ..."; page 616, left-hand column 2nd paragraph;	5-9, 16-25, 38,39, 48,49

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2014	13/10/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pöhlmann, Robert

Form PCT/ISA/210 (second sheet) (April 2005)

PACKET AL. EXHIBIT 1024
Page 643

(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	page 616, right-hand column page 622; figure 20 paragraph before 4.2.23; page 612, left-hand column	
X	DE 20 2012 003747 U1 (BLUECHER GMBH [DE]) 15 November 2012 (2012-11-15)	1-4
Y	claims 1, 25 paragraphs [0106], [0142], [0143]	5-9, 16-25, 38,39, 48,49

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/019916

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 202012003747 U1	15-11-2012	DE 102012007392 A1	08-05-2013
		DE 202012003747 U1	15-11-2012
		EP 2776153 A1	17-09-2014
		WO 2013068060 A1	16-05-2013

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and applying the method for gases with a sulfur(VI) concentration of more than 3 ppm by mole

---

2. claims: 50-67(completely); 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and obtaining or providing the activated carbon sorbent comprises promoting an unpromoted carbon sorbent and/or obtaining the unpromoted carbon sorbent from a carbon precursor comprising nitrogen and/or the activated carbon sorbent comprising a stabilizing agent

---

3. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and adding an alkaline component into the pollutant containing gas

---

4. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and regenerating the activated carbon sorbent

---

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
Madden, Robert B. Reg. No. 57,521
SCHWEGMAN, LUNDBERG & WOESSNER
P.O. Box 2938
Minneapolis, MN 55402-0938
ETATS-UNIS D'AMERIQUE

INVITATION TO PAY ADDITIONAL FEES AND, WHERE APPLICABLE, PROTEST FEE

(PCT Article 17(3)(a) and Rule 40.1 and 40.2(e))

Applicant's or agent's file reference 3338021WO1	Date of mailing *(day/month/year)* 30 May 2014 (30-05-2014)
International application No. PCT/US2014/019916	**PAYMENT DUE** within **ONE MONTH** from the above date of mailing
Applicant ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION	International filing date *(day/month/year)* 3 March 2014 (03-03-2014)

1. This International Searching Authority

(i) considers that there are 4 *(number of)* inventions claimed in the international application covered by the claims indicated on an extra sheet:

(ii) therefore considers that the international application does not comply with the requirements of unity of invention (Rules 13.1, 13.2 and 13.3) for the reasons indicated on an extra sheet:

(iii) [X] has carried out a partial international search (see Annex) [ ] will establish the international search report on those parts of the international application which relate to the invention first mentioned in claims Nos.:

see extra sheet

(iv) will establish the international search report on the other parts of the international application only if, and to the extent to which, additional fees are paid.

2. Consequently, the applicant is hereby invited to pay, within the time limit indicated above, the amount indicated below:

EUR 1.875,00 (Fee per additional invention) x 3 (number of additional inventions) = EUR 5.625,00 (currency/total amount of additional fees)

3. The applicant is informed that, according to Rule 40.2(a), the payment of any additional fee may be made under protest, i.e., a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fee is excessive, where applicable, subject to the payment of a protest fee.

Where the applicant pays additional fees under protest, the applicant is hereby invited, within the time limit indicated above, to pay a protest fee (Rule 40.2(e)) in the amount of EUR 865,00 *(currency/amount)*

Where the applicant has not, within the time limit indicated above, paid the required protest fee, the protest will be considered not to have been made and the International Searching Authority will so declare.

4. [ ] Claim(s) Nos. _____ have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	SLOAN, Mary Tel: +49 (0)89 2399-2608

Schwegman Lundberg & Woessner P.A.
JUN 09 2014

Form PCT/ISA/206 (April 2005)
Registered Mail

RECEIVED

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and applying the method for gases with a sulfur(VI) concentration of more than 3 ppm by mole

---

2. claims: 50-67(completely); 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and obtaining or providing the activated carbon sorbent comprises promoting an unpromoted carbon sorbent and/or obtaining the unpromoted carbon sorbent from a carbon precursor comprising nitrogen and/or the activated carbon sorbent comprising a stabilizing agent

---

3. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and adding an alkaline component into the pollutant containing gas

---

4. claims: 1-49(partially)

Pollutant removal from a gas by contacting with an activated carbon sorbent comprising nitrogen and regenerating the activated carbon sorbent

---

The common concept linking together the groups is the subject-matter of claim 1 . This common concept is not new over D1.
D1 discloses a method of reducing the mercury content in a mercury-containing gas (see abstract), the method comprising obtaining or providing an activated carbon sorbent comprising activated carbon sorbent particles comprising nitrogen in a surface layer of the sorbent particles (see page 615, para. 4.2.5.1 and page 616, left column, "...by impregnation of nitrogen-containing polymers or pitches ..."), contacting a pollutant-containing gas with the activated carbon sorbent to form a pollutant-sorbent composition (implicitly disclosed as for a sorbent based removal process the pollutant has to be contacted with the sorbent, the pollutant thereby always forms a pollutant-sorbent composition), and separating at least some of the pollutant-sorbent composition from the pollutant-containing gas, to give a separated gas (see page 622, figure 20).
Hence, D1 discloses all the features of claim 1.

D1 further discloses

PAC ET AL. EXHIBIT 1024
Page 648

- claim 3: the concentration of nitrogen in the surface layer of the sorbent particles to be higher than in a core of the particles (see page 615, right column, lines 1-4, nitrogenated function introduced on carbon surface, therefrom following a lower nitrogenous concentration in the core of the particles)
- claim 5, 6: the mercury-containing gas to comprise a sulfur(VI) concentration, like SO 3 (see page 616, right column, 2nd paragraph)

The differentiating features are
- Group 1: applying the method for gases with a sulfur(VI) concentration of more than 3 ppm by mole
- Group 2: obtaining or providing the activated carbon sorbent comprises promoting an unpromoted carbon sorbent and/or providing or obtaining the unpromoted carbon sorbent from a carbon precursor comprising nitrogen and/or the activated carbon sorbent comprising a stabilizing agent
- Group 3: adding an alkaline component into the pollutant containing gas
- Group 4: regenerating the activated carbon sorbent

with following resulting technical effects:
- Group 1: no surprising and unexpected technical effect distinguishable
- Group 2: further enhancement of the mercury sorption efficiency of the activated carbon sorbent comprising nitrogen
- Group 3: reduction of sulfuric compounds in the pollutant containing gas
- Group 4: saving financial means for sorbent

Thus the problems solved may be regarded as
- Group 1: finding an alternative mercury containing gas for which the method can be applied.
- Group 2: how to modify the method of D1 in order to further enhance the mercury sorption efficiency of the activated carbon sorbent comprising nitrogen
- Group 3: how to modify the method of D1 in order to reduce the sulfuric compounds in the pollutant containing gas
- Group 4: how to modify the method of D1 in order to save financial means for sorbent

The special technical features (R. 13.2 PCT) are
- Group 1: no special technical feature A as the alternative gas is considered to be obvious for the skilled person.
- Group 2: differentiating feature = special technical feature B as the feature is neither disclosed nor rendered obvious by D1 and therefore is considered to make a contribution over D1.
- Group 3: differentiating feature = special technical feature C as the feature is neither disclosed nor rendered obvious by D1 and therefore is considered to make a contribution over D1.
- Group 4: no special technical feature D as the regeneration and reuse of the sorbent is disclosed by D1 (see page 612, left column, paragraph before 4.2.2.3).

Groups of (alleged) Inventions
The groups of technical features do not solve any common technical problem. Thus the groups of claims are neither linked by the same nor by corresponding special technical features and define different inventions not linked by a single general inventive concept (Rule 13.1 and 13.2 PCT)

and therefore the requirement for unity of invention referred to in Rule 13 PCT is not fulfilled .

PAC ET AL. EXHIBIT 1024
Page 650

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US2014/019916

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
see 'Invitation to pay additional fees'.
2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YUANJING ZHENG ET AL: "Review of technologies for mercury removal from flue gas from cement production processes", PROGRESS IN ENERGY AND COMBUSTION SCIENCE, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 38, no. 5, 26 April 2012 (2012-04-26) , pages 599-629, XP028415255, ISSN: 0360-1285, DOI: 10.1016/J.PECS.2012.05.001 [retrieved on 2012-05-25]	1-9, 16-25, 38,39, 48,49
Y	page 600, paragraph 1 page 615, paragraph 4.2.5.1 page 615, right-hand column, line 1 - line 4 "...by impregnation of nitrogen-containing polymers or pitches ..."; page 616, left-hand column 2nd paragraph; page 616, right-hand column page 622; figure 20 paragraph before 4.2.23; page 612, left-hand column	5-9, 16-25, 38,39, 48,49
X	DE 20 2012 003747 U1 (BLUECHER GMBH [DE]) 15 November 2012 (2012-11-15)	1-4
Y	claims 1, 25 paragraphs [0106], [0142], [0143]	5-9, 16-25, 38,39, 48,49

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

4

Patent Family Annex

Information on patent family members

International Application No
PCT/US2014/019916

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 202012003747 U1	15-11-2012	DE 102012007392 A1	08-05-2013
		DE 202012003747 U1	15-11-2012
		WO 2013068060 A1	16-05-2013

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2014/019916	03.03.2014	06.03.2013

International Patent Classification (IPC) or both national classification and IPC
INV. B01J20/20 B01D53/02 B01D63/10 B01J20/32 C01B31/08

Applicant
ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Pöhlmann, Robert Telephone No. +49 89 2399-2089

Form PCT/ISA/237 (Cover Sheet) (July 2009)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of

☐ the entire international application

☒ claims Nos. 50-67(completely); 1-49(partially)

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international search *(specify)*:

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*:

☒ no international search report has been established for the whole application or for said claims Nos. 50-67(completely); 1-49(partially)

☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

- ☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rules 13*ter*.1(a) or (b).

☐ See Supplemental Box for further details

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has, within the applicable time limit:

   ☐ paid additional fees

   ☐ paid additional fees under protest and, where applicable, the protest fee

   ☐ paid additional fees under protest but the applicable protest fee was not paid

   ☒ not paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-49(partially)

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	5-49(partially)
	No:	Claims	1-4(partially)
Inventive step (IS)	Yes:	Claims	10-15, 26-37, 40-47(all partially)
	No:	Claims	1-9, 16-25, 38, 39, 48, 49(all partially)
Industrial applicability (IA)	Yes:	Claims	1-49(partially)
	No:	Claims	

2. Citations and explanations

   see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item VIII

Certain observations on the international application

1 Clarity, Article 6 PCT)

1.1 General

The terms "about" (used in claims 4-6, 18-24, 34, 50, 58, 64), "substantially" (used in claims 5, 7-9, 50, 61-64, 67) and "core" (used in claims 3, 7, 18, 19, 51, 56, 61) are vague and unclear and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of said claims unclear, Art. 6 PCT.

1.2 Claim 4

Claim 4 does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved (combines with at least 70 wt%), which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result (like but not limited to volume flows, distribution of sorbent, injection of sorbent, contact times, temperatures, other components in the mercury-containing gas).

1.3 Claim 7

It is unclear (Art. 6 PCT) how the nitrogen can be homogeneously distributed in the core of the particles and how at the same time there can be a concentration profile from the surface to the core (when referring to claim 3).

1.4 Claims 8, 9

Claims 8 and 9 do not meet the requirements of Art. 6 PCT because the matter for which protection is sought is not clearly defined. The claims attempt to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

1.5 Claim 18

It is unclear in claim 18 how a core of an activated carbon sorbent particle can comprise 99 wt% nitrogen (Art. 6 PCT). The core practically would consist of nitrogen only in this case.

1.6 Claim 20

It is unclear in claim 20 how a surface layer of an activated carbon sorbent particle can comprise 99 wt% nitrogen (Art. 6 PCT). The surface would consist of nitrogen only in this cas. Also it is unclear if the technical effect related to nitrogen being present at 0.001 wt% in the surface layer is still existing (Art.6 PCT).

1.7 Claim 22

The definition of the surface layer is unclear as a thickness of 99% of the radius of the particles is in fact the complete particle and not only a "surface layer" (Art. 6 PCT).

Re Item IV

2 **Lack of unity of invention**

Notwithstanding the objections under Article 6 PCT above, the application lacks unity within the meaning of Rule 13.1 PCT.

2.1 Reference is made to the following document:

D1 YUANJING ZHENG ET AL: "Review of technologies for mercury removal from flue gas from cement production processes",PROGRESS IN ENERGY AND COMBUSTION SCIENCE, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL,vol. 38, no. 5, 26 April 2012 (2012-04-26), pages 599-629, XP028415255,ISSN: 0360-1285, DOI: 10.1016/J.PECS.2012.05.001[retrieved on 2012-05-25]

D2 DE 20 2012 003747 U1 (BLUECHER GMBH [DE]) 15 November 2012 (2012-11-15)

2.2 **There are several groups of claims:**

- Group 1: Claims 1-49 (partially), in particular claims 2-9, 16-25, 38, 39, 48, 49
- Group 2: Claims 1-49 (partially), in particular claims 10-15, 26-37, 40, 41, 44, 45, claims 50-67 (completely)
- Group 3: Claims 1-49 (partially), in particular claims 42, 43
- Group 4: Claims 1-49 (partially), in particular claims claims 46, 47

2.3 **The common concept linking together the groups is the subject-matter of claim 1.** This common concept is not new over D1.

2.3.1 D1 discloses a method of reducing the mercury content in a mercury-containing gas (see page 600, para. 1.), the method comprising obtaining or providing an activated carbon sorbent comprising activated carbon sorbent particles comprising nitrogen in a surface layer of the sorbent particles (see page 615, para. 4.2.5.1 and page 616, left column, "...by impregnation of nitrogen-containing polymers or pitches ..."), contacting a pollutant-containing gas with the activated carbon sorbent to form a pollutant-sorbent composition (implicitly disclosed as for a sorbent based removal process the pollutant has to be contacted with the sorbent, the pollutant thereby always forms a pollutant-sorbent composition), and separating at least some of the pollutant-sorbent composition from the pollutant-containing gas, to give a separated gas (see page 622, figure 20).

Hence, D1 discloses all the features of claim 1.

2.3.2 D1 further discloses

- claim 3: the concentration of nitrogen in the surface layer of the sorbent particles to be higher than in a core of the particles (see page 615, right column, lines 1-4, nitrogenated function introduced on carbon surface, therefrom following a lower nitrogenous concentration in the core of the particles)

- claim 5, 6: the mercury-containing gas to comprise a sulfur(VI) concentration, like SO_3 (see page 616, right column, 2nd paragraph)

2.4 **The differentiating features are**

- Group 1: applying the method for gases with a sulfur(VI) concentration of more than 3 ppm by mole
- Group 2: obtaining or providing the activated carbon sorbent comprises promoting an unpromoted carbon sorbent and/or providing or obtaining the unpromoted carbon sorbent from a carbon precursor comprising nitrogen and/or the activated carbon sorbent comprising a stabilizing agent
- Group 3: adding an alkaline component into the pollutant containing gas
- Group 4: regenerating the activated carbon sorbent

2.5 **with following resulting technical effects:**

- Group 1: no surprising and unexpected technical effect distinguishable

- Group 2: further enhancement of the mercury sorption efficiency of the activated carbon sorbent comprising nitrogen
- Group 3: reduction of sulfuric compounds in the pollutant containing gas
- Group 4: saving financial means for sorbent

2.6 **Thus the problems solved may be regarded as**

- Group 1: finding an alternative mercury containing gas for which the method can be applied.
- Group 2: how to modify the method of D1 in order to further enhance the mercury sorption efficiency of the activated carbon sorbent comprising nitrogen
- Group 3: how to modify the method of D1 in order to reduce the sulfuric compounds in the pollutant containing gas
- Group 4: how to modify the method of D1 in order to save financial means for sorbent

2.7 **The special technical features (R. 13.2 PCT) are**

- Group 1: no special technical feature A as the alternative gas is considered to be obvious for the skilled person.
- Group 2: differentiating feature = special technical feature B as the feature is neither disclosed nor rendered obvious by D1 and therefore is considered to make a contribution over D1.
- Group 3: differentiating feature = special technical feature C as the feature is neither disclosed nor rendered obvious by D1 and therefore is considered to make a contribution over D1.
- Group 4: no special technical feature D as the regeneration and reuse of the sorbent is disclosed by D1 (see page 612, left column, paragraph before 4.2.2.3).

2.8 **Groups of (alleged) inventions**

The groups of technical features do not solve any common technical problem. Thus the groups of claims are neither linked by the same nor by corresponding special technical features and define different inventions not linked by a single general inventive concept (Rule 13.1 and 13.2 PCT) and therefore **the requirement for unity of invention referred to in Rule 13 PCT is not fulfilled**.

2.9 **Consequence**

A search has been performed for the invention first mentioned in the claims, here the subject-matter of the claims forming group 1. Correspondingly, in the following this written opinion is restricted to group 1.

Group 1 : Claims 1-9, 16-25, 38, 39, 48, 49 (partially)

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

3 Novelty Claim 1

3.1 As already shown under point 2.3.1 above the subject-matter of claim 1 is not new (Article 33(2) PCT).

4 Inventive Step Claim 1

Besides D1, which is considered to be the closest prior art to the subject-matter of claim 1, also D2 could be regarded as the closest prior art the subject-matter of claim 1.

4.1.1 D2 discloses

A method of reducing the pollutant content in a pollutant-containing gas (see §0142 and 0143), the method comprising:

obtaining or providing an activated carbon sorbent comprising activated carbon sorbent particles comprising nitrogen in a surface layer of the sorbent particles (see claim 1);

4.1.2 The subject-matter of claim 1 therefore differs from this known D2 in that

a pollutant-containing gas is contacted with the activated carbon sorbent, to form a pollutant-sorbent composition; and in that at least some of the pollutant-sorbent composition is separated from the pollutant-containing gas, to give a separated gas.

4.1.3 There is no unexpected technical effect related to that difference.

4.1.4 The problem to be solved by the present invention may therefore be regarded as how to to apply the method of D2 for reducing the pollutant content in a pollutant-containing gas.

4.1.5 The solution proposed in claim 1 of the present application cannot be considered to involve an inventive step (Article 33(3) PCT) for the following reasons:

It is common general knowledge for the skilled person to contact the sorbent with the gas to form a pollutant-sorbent composition and to separate the pollutant-sorbent composition from the gas to give a separated gas. Also, amongst many other documents he finds in D1 an indication (see cited passages) with which he would contact the sorbent with the gas, thereby forming a pollutant sorbent composition and separate this composition from the gas to give a separated gas, thereby arriving at the subject-matter of claim 1 without being inventive.

5 Dependent claims

Dependent claims 2-9, 16-25, 38, 39, 48, 49 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step.

5.1 Claims 2, 3

The subject-matter of said claims is neither new (see points 2.3.1 and 2.3.2 above), nor inventive (see D2, claim 1 and §0143, mercury being an obvious toxic substance whose removal from gas streams with activated carbon is widely known in industry).

5.2 Claims 5, 6

D1 discloses a sulfur(VI) concentration in the mercury-containing gas (see 2.3.2 above) and the claimed ranges for said concentration are considered to be merely an arbitrary selection out of a variety of possible mercury containing gases without showing an unexpected technical effect. The properties of the activated carbon sorbent of D1 are considered to achieve the results claimed in claim 5 with regard to corresponding activated carbon sorbents.

5.3 Claims 16, 17, 38, 39, 48, 49

It is well-known in the art to add the sorbent into the mercury-containing gas and to remove it after a certain distance by various means like bag houses, electrostatic precipitators, cyclones or the like. As well, it is common general knowledge to contact the gas with the sorbent in a fixed bed, a dry or aqueous scrubber, a filter or a moving bed.

Claim 19, 21

D2 discloses a wide variety of possible nitrogen concentrations of the activated carbon (see claim 25), which is also considered to be applicable either to the surface and/or to the core of carbon particles. Therefore, the claimed ranges are not inventive.

Claim 24, 25

The claimed range of particle diameters is considered an arbitrary selection and activated carbon particles in this range are known to the skilled person (see for reference D2, §0106). Furthermore, every surface is considered to be continuous and therefore also a surface layer.

Re Item VII

Certain defects in the international application

6 The requirements of Rule 6.3(b) PCT (two-part form of independent claims) and Rule 5.1(a)(ii) and (iii) PCT (acknowledgement of prior art D1) are not met.

Electronic Acknowledgement Receipt

EFS ID:	34478796
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Jordan Rivard Golomb/Jamie Johnson
Filer Authorized By:	Jordan Rivard Golomb
Attorney Docket Number:	4820.001US10
Receipt Date:	04-DEC-2018
Filing Date:	04-JUN-2018
Time Stamp:	14:10:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	0297_3338016wo1_p237_041514.pdf	1414324 7ad26b355a4dccb9ede7dcf29c4d72c663c079fa	no	10

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5	Non Patent Literature	0301_written_opinion_10_13_2014.pdf	3453405 f287156761 1f94d1504ae776d2d265cdcc208ea5	no	12
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6	Non Patent Literature	0302_powdered_activated_carbon___cabot_corporation.pdf	469745 875a46fc34381d4e8ebcfb65af70b98f9e178db0	no	3
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7	Non Patent Literature	0303_14195360_co2_removal_potential_of_carbons_prepared.pdf	1515182 48a4ea5c697b582ea1e67e88f7c37c50c8ae4adb	no	9
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23	Non Patent Literature	0319_gomez_aviles_darder_2010.pdf	11669394 9976031e9cfbf2be9697a066f86af3f81548a5c0	no	13
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43	Non Patent Literature	0339_141953603.pdf	1170251 3348e4972cbdea95606ca4fc2d5c086e1a3b123d	no	7
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44	Non Patent Literature	0340_14195360_structural_characterization_of__n_taining.pdf	1883421 d6a05f4f1633a87986973cdc0da48b2481291d45	no	12
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45	Non Patent Literature	0341_alternatives_to_activated_carbon_for_mercury_trol__power_engineering.pdf	2220405 e04bcf17c0fa836d0f22956ddb0816c0f2f2f465	no	10
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46	Non Patent Literature	0342_3338013us1_streng_toxics_111808.pdf	3793209 da508b28d3cb27d5bfce926dfb8faa07b057d548	no	14
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47	Non Patent Literature	0343_3338013us1_tsuji_coke_process_111808.pdf	4198252 ff286ebb5263fcb67006074e551b58417eb00bd9	no	27
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52	Non Patent Literature	0348_qi_2010.pdf	6661547 bb0ee05d9dcf5263438b788b4592e0aae37c0afb	no	6
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53	Non Patent Literature	0349_wang_smith.pdf	949889 6798dbcbaf028d0d74cb126f27ecdcac05b0e01a	no	8
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54	Non Patent Literature	0350_zhang_2009.pdf	6581725 ebace4c97a889e2ca79f1e652dea1b91cab5da33	no	6
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55	Non Patent Literature	0351_zhao_2006.pdf	3949197 3027be4f23da88e1a6fada3016acb029e1453caf	no	8
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58	Non Patent Literature	0354_3338016US2_PAMD_12-10-14_1.pdf	421845 b4512085c9153cf2a2035e157647717f7036bcb1	no	6
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60	Non Patent Literature	0356_olson_2001.pdf	2329142 9dcc564891aa507f2c1d9ebe266a85fc4c97f348	no	19
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			Total Files Size (in bytes):	202719298	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/997,091 Group Art Unit: 1776
Filed: June 4, 2018 Docket No.: 4820.001U10
Confirmation No.: 5161
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant has received the Non-Final Office Action dated November 2, 2018. Please enter the following.

IN THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A method for reducing mercury in a mercury-containing gas, the method comprising:

~~injecting a sorbent into the mercury-containing gas;~~

combusting coal that comprises an additive comprising Br_2, HBr, Br^-, or a combination thereof, to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site;

collecting mercury in the mercury-containing gas on [[the]]a sorbent to produce a cleaned gas, wherein the sorbent [[is]]comprises a promoted activated carbon that is promoted in-flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter ~~that is~~comprising [[Br_2,]]HBr, Br^-, or a combination thereof~~, wherein the mercury-containing gas is a coal-combustion gas~~.

2-3. (Canceled)

4. (Currently Amended) The method of claim 1, wherein ~~the promoted~~an activated carbon is promoted with the promoter while the promoter is in [[the]]a gas phase or is a vapor.

5. (Canceled)

6. (Original) The method of claim 1, wherein the promoted activated carbon comprises active sites, comprising halide anions bound to the activated carbon.

7. (Original) The method of claim 1, wherein the promoted activated carbon comprises active sites comprising carbocations bound to halide anions.

8. (Currently Amended) The method of claim 1, wherein collecting the mercury comprises ~~chemically~~ reacting carbene species edge sites in the activated carbon with the mercury.

9. (Original) The method of claim 1, further comprising injecting an alkaline sorbent into the mercury-containing gas stream.

10. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

11. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

12. (Original) The method of claim 1, wherein the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof.

13. (Original) The method of claim 1, wherein the promoter is HBr or Br^-.

14. (Original) The method of claim 1, wherein the mercury-containing gas is a flue gas stream downstream of a boiler furnace.

15. (Currently Amended) The method of claim 1, wherein monitoring [[the]]mercury content of the cleaned gas is performed substantially continuously.

16. (Currently Amended) The method of claim 1, wherein the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 ~~grains~~grams of activated carbon.

17. (Currently Amended) The method of claim 1, further comprising injecting a sorbent comprising activated carbon into the mercury-containing gas stream to form the promoted activated carbon.

18. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas.

19. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent.

20. (Currently Amended) The method of claim 1, wherein the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method further comprising:

monitoring [[the]]mercury content of the cleaned gas; and

controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting a [[the]]sorbent comprising activated carbon into the mercury-containing gas, a rate at which the promoter is added to the sorbent comprising activated carbon~~the sorbent composition~~, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level.

REMARKS

This responds to the Non-Final Office Action dated November 2, 2018.

Claims 1, 4, 8, 15, 16, 17, and 20 are presently amended. Claims 2-3 and 5 are presently canceled, and no claims were canceled previously. No new claims are presently added. As a result, claims 1, 4, and 6-20 are now pending in this application.

Independent claim 1 is amended to recite "…combusting coal that comprises an additive comprising Br_2, HBr, Br^-, or a combination thereof, to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site…." Support can be found in the present published application at paragraphs [0042] (promoter can be bromide, Br^-), [0054] and [0072] (bromine, bromide, or HBr can be promoter), paragraphs [0077]-[0086] ("additive" can mean promoter), and FIG. 11 (the additive can be added to the coal).

Independent claim 1 is amended to recite "…wherein the sorbent [[is]]comprises a promoted activated carbon that is promoted in-flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter ~~that is~~comprising [[Br_2,]]HBr, Br^-, or a combination thereof~~, wherein the mercury-containing gas is a coal combustion gas~~…." Support can be found in the present published application at paragraph [0076]-[0086].

Claim 20 is amended to recite "…controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting a [[the]]sorbent comprising activated carbon into the mercury-containing gas, a rate at which the promoter is added to the sorbent comprising activated carbon~~the sorbent composition~~, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level." Support can be found in the present published application at paragraph [0025].

No new matter is added via the amendments herein.

The Rejection of Claims Under §112

I. The Office Action rejected claims 2-6, 12, 15 and 20 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as allegedly being indefinite.

This rejection is respectfully traversed.

The Office Action states that claim 2 recites "the coal" in line 1, which is lacking sufficient antecedent basis.

Claim 2 is presently canceled.

The Office Action states that claim 3 recites the limitation "the coal" in line 1, which is lacking sufficient antecedent basis.

Claim 3 is presently canceled.

The Office Action states that claim 3 recites the limitation "the precursor" in line 2, which is lacking sufficient antecedent basis.

Claim 3 is presently canceled.

The Office Action states that claim 4 recites the limitation "the gas phase" in line 2, which is lacking sufficient antecedent basis.

Claim 4 is presently amended to recite "...wherein ~~the promoted~~an activated carbon is promoted with the promoter while the promoter is in [[the]]a gas phase or is a vapor."

The Office Action states that claim 5 recites the limitation "the activated carbon" in line 1, which is lacking sufficient antecedent basis.

Claim 1 is presently amended to recite "...wherein the sorbent [[is]]comprises a promoted activated carbon that is promoted in-flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter..." In view of the amendments to claim 1, claim 5's recitation of "the activated carbon" has antecedent basis in claim 1 from which it depends.

The Office Action states that claim 6 recites the limitation "the activated carbon" in line 2, which is lacking sufficient antecedent basis.

In view of the amendments to claim 1, claim 6's recitation of "the activated carbon" has antecedent basis in claim 1 from which it depends.

The Office Action states that claim 12 recites the limitation "the activated carbon" in line 1, which is lacking sufficient antecedent basis.

In view of the amendments to claim 1, claim 12's recitation of "the activated carbon" has antecedent basis in claim 1 from which it depends.

The Office Action states that claim 15 recites the limitation "the mercury content" in line 1, which is lacking sufficient antecedent basis.

Claim 15 is presently amended to recite "...wherein monitoring [[the]]mercury content of the cleaned gas is performed substantially continuously."

The Office Action states that claim 15 recites the limitation "the cleaned gas" in lines 1-2, which is lacking sufficient antecedent basis.

Claim 1 recites "...collecting mercury in the mercury-containing gas on [[the]]a sorbent to produce a cleaned gas...." Claim 15's recitation of "the cleaned gas" has antecedent basis in claim 1 from which it depends.

The Office Action states that claim 20 recites the limitation "the mercury content" in lines 3 and 6, which is lacking sufficient antecedent basis.

Claim 20 is presently amended to recite "...monitoring [[the]]mercury content of the cleaned gas...."

The Office Action states that claim 20 recites the limitation "the cleaned gas" in lines 3, 4 and 6, which is lacking sufficient antecedent basis.

Claim 15's recitation of "the cleaned gas" has antecedent basis in claim 1 from which it depends.

The Office Action states that claim 20 recites the limitation "the sorbent composition" in line 5, which is lacking sufficient antecedent basis.

Claim 20 is presently amended to recite "...a rate at which the promoter is added to the sorbent comprising activated carbon~~the sorbent composition~~...."

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 2-6, 12, 15 and 20 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph.

The Rejection of Claims Under §102

II. The Office Action rejected claims 1, 4-14, and 16-19 under 35 U.S.C. § 102(e) over U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed.

Independent claim 1 is amended to recite "…combusting coal that comprises an additive comprising Br_2, HBr, Br^-, or a combination thereof, to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site…."

Nelson fails to describe or suggest combusting coal that includes an additive that includes Br_2, HBr, Br^-, or a combination thereof. Nelson fails to describe or suggest all the features of independent claim 1; therefore, this claim cannot be anticipated by Nelson.

Dependent claims 4-14 and 16-19 are directly or indirectly dependent on independent claim 1. As such, these dependent claims incorporate all the features of claim 1. Accordingly, dependent claims 4-14 and 16-19 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 1, 4-14, and 16-19 under 35 U.S.C. § 102(e) over Nelson.

The Rejection of Claims Under §103

III. The Office Action rejected claims 2-3, 5, 15, and 20 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed.

As explained herein at **IV**, independent claim 1 is patentable over Nelson in view of Felsvang.

Dependent claims 2-3, 5, 15, and 20 are dependent on independent claim 1. As such, these dependent claims incorporate all the features of claim 1. Accordingly, dependent claims 2-3, 5, 15, and 20 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 2-3, 5, 15, and 20 under 35 U.S.C. § 103(a) over Nelson in view of Felsvang.

IV. The Office Action rejected claims 1-20 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed.

Independent claim 1 is amended to recite "…combusting coal that comprises an additive comprising Br_2, HBr, Br^-, or a combination thereof, to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site; collecting mercury in the mercury-containing gas on [[the]]a sorbent to produce a cleaned gas, wherein the sorbent [[is]]comprises a promoted activated carbon that is promoted in-flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter ~~that is~~comprising [[Br_2,]]HBr, Br^-, or a combination thereof~~, wherein the mercury-containing gas is a coal-combustion gas~~."

As amended, any process encompassed by independent claim 1 includes in-flight promotion of activated carbon in the flue gas. Whether the activated carbon is untreated at the time of addition to the mercury-containing gas or the activated carbon is treated with an additive prior to addition to the mercury containing gas, the injected activated carbon encounters promoters in the flue gas formed from the combustion of the coal comprising the additive including Br_2, HBr, Br^-, or a combination thereof, and is thereby promoted in-flight in the flue gas.

As explained herein at **IV(A)**, there would be no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process. As explained herein at **IV(B)(1)**, in-flight promotion with bromide promoters is more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas, and as explained herein at **IV(B)(2)**, there would be no way for a person of ordinary skill in the art to predict this advantage from the cited references. As explained herein at **IV(C)(1)**, in-flight promotion with bromide promoters is more effective for mercury removal than in-flight promotion with chloride-

promoters, and as explained herein at **IV(C)(2)**, there would be no way for a person of ordinary skill in the art to predict this advantage from the cited references. As explained herein at **IV(D)**, even if a person of ordinary skill in the art compared the mercury removal of Felsvang's activated carbons promoted with chloride in the flue gas to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties. As explained herein at **IV(E)(1)**, activated carbon treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide promoters for in-flight promotion results in greater mercury removal than using activated carbon only treated with bromide additives outside the flue gas or activated carbon only treated with bromide promoters in-flight in the flue gas, and as explained herein at **IV(E)(2)**, there would be no way for a person of ordinary skill in the art to predict this advantage from the cited references.

IV(A). There would be no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process.

Independent claim 1 is amended to recite "…combusting coal that comprises an additive comprising Br_2, HBr, Br^-, or a combination thereof, to form the mercury-containing gas, wherein the combusting of the coal is performed at a coal combustion facility site; collecting mercury in the mercury-containing gas on [[the]]a sorbent to produce a cleaned gas, wherein the sorbent [[is]]comprises a promoted activated carbon that is promoted in-flight in a gas stream at the coal combustion facility site comprising contacting activated carbon dispersed in the gas stream with at least one promoter ~~that is~~comprising [[Br_2,]]HBr, Br^-, or a combination thereof~~, wherein the mercury-containing gas is a coal-combustion gas~~."

The Office Action admits that Felsvang fails to describe or suggest a halogen or halide promoter that is Br_2, HBr, or Br^-. Nelson fails to describe or suggest in-flight promotion of activated carbon with a halide in the flue gas. The Office Action alleges that one of ordinary skill in the art would combine Nelson's additive with Felsvang's method to accomplish the presently claimed method, stating that such a modification of Felsvang would be made "…to promote activated carbon (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury." (Office Action, page 9, last sentence of fourth full paragraph). Applicant respectfully

disagrees. As explained below, a person of ordinary skill in the art would not be motivated to use Nelson's bromide additives in Felsvang's process.

Felsvang is directed to adding chlorine (Cl_2) or chloride (Cl^-) materials to the coal or combustion products. Felsvang makes clear that addition of chlorine or chloride material increases the amount of chloride supplied to the flue gas, or to the drying-absorption zone, see, Abstract and col. 3, lines 40-44. When Felsvang mentions activated carbon, the interaction between activated carbon and chloride is the focus: "[i]t has been experienced that the increase of the Hg-removing effect of chloride addition to the drying-absorption zone in a process treating flue gases of low chloride content is especially remarkable when activated carbon is present…." Col. 3, line 67 bridging to col. 4, line 4. For a person of ordinary skill in the art to be motivated to replace Felsvang's chloride-treatment with treatment by another material to provide an effective carbon sorbent for mercury, that person would need to think that the material they are using to replace the chloride would result in the same or better mercury-removal efficiency. However, not only does Felsvang fail to describe or suggest that in-flight promotion of activated carbon with chloride provides better mercury removal than treatment of activated carbon outside the flue gas with chloride; further, as shown herein at **IV(D)**, treatment of activated carbon outside the flue gas with chloride actually provides better mercury removal than in-flight promotion of activated carbon with chloride, which would lead one of ordinary skill in the art away from using in-flight promotion.

Nelson's Background paragraph [0017] states that "[t]he particular advantages of using bromine rather than iodine or iodides, or chlorine or chlorides, with activated carbons for mercury control have not been previously appreciated." The paragraph then goes on to describe various accomplishments in the prior art, stating that prior art processes fail to use bromine as a sequestration agent on carbon, and concludes with "[r]ather, it serves as a catalyst, taking part in a repeated series of desired chemical reactions, but not becoming permanently consumed by any of them. Perhaps it is understandable that the tenacity of carbon-bromine-mercury complexes could be overlooked." Importantly, paragraph [0017] states that bromine (Br_2) is superior to I_2 or I^-, or Cl_2 or Cl^-, with activated carbons for sequestration, and never states that the claimed promoters HBr or Br^- are more effective with activated carbons than chlorides.

Nelson's paragraph [0041] states:

> **[0041]** I have discovered that the simple act of exposing a carbonaceous material, preferably powdered activated carbon (PAC), to gaseous bromine, $Br_2(g)$, or to gaseous hydrogen bromide, HBr(g), significantly increases the carbonaceous material's ability to remove mercury species when injected into high-temperature coal-fired flue-gas compositions. Surprisingly, gaseous bromine produces a much more effective and appropriate carbon sorbent for mercury in hot combustion gases than do iodine or iodide species, or chlorine or chloride species, in contrast to what has been taught in the prior art.

Paragraph [0041] begins by stating that bromine, defined as Br_2, or hydrogen bromide, defined as HBr, increases the mercury absorption capacity of activated carbon. Then, paragraph [0041] states specifically that bromine (Br_2) produces a more effective mercury-absorbing carbon sorbent than iodine (I_2), or iodide (I^-), or chlorine (Cl_2), or chloride (Cl^-). With the precise definitions given for bromine and hydrogen bromide, and then reference only to bromine, Nelson makes clear that the comparison of efficacy is only with respect to bromine and not hydrogen bromide. Like paragraph [0017], paragraph [0041] also fails to state that HBr or Br^- are more effective with activated carbons than chlorides.

The majority of Nelson's Examples (1-4 and 8) focus only on Br_2. Nelson's Examples 5-7 demonstrate the use of HBr-treated sorbent; however, none of these Examples or any other parts of Nelson compare the mercury-absorption performance of HBr-treated activated carbon to chloride-treated activated carbon such as HCl-treated activated carbon. Although figures 14 and 15 illustrate HBr-treated activated carbon and Cl_2-treated activated carbon, Cl_2-treated activated carbon is not chloride-treated carbon and these figures fail to show any examples of chloride-treated activated carbon.

Nelson's paragraph [0049] states:

> **[0049]** A critical element in the process is that a bromine-containing gas **3** is used to treat the carbonaceous substrate. Preferably this gas comprises elemental bromine, $Br_2(g)$, although other bromine-containing gases, such as hydrogen bromide, HBr, will also have the advantageous effect of the invention.

Paragraph [0049] says that using Br_2 is a critical element of the process. It states that HBr can also have the "advantageous effect of the invention"; however, it is not clear what advantage this is

referring to. The very next paragraph, [0050], states "[i]n the liquid form at ambient temperatures, elemental bromine is dense and compact, with advantages in transport and storage." These statements also hold true for HBr in the form of a gas. No Example is given in Nelson comparing the mercury-absorption performance of activated carbons treated with bromides such as HBr to the mercury-absorption performance of chlorides such as HCl. In every statement comparing to other halogens or halides, Nelson states with great particularity, even giving the chemical formula, that bromine (Br_2) has advantageous effects over other halogens and halides but fails to mention bromides in these statements. One of ordinary skill in the art would not interpret paragraph [0049] or any other part of Nelson as describing or suggesting that bromides even have the same effectiveness for mercury sequestration when used to treat activated carbons as chlorides, let alone that bromides are more effective for mercury sequestration when used to treat activated carbons than chlorides or chlorine.

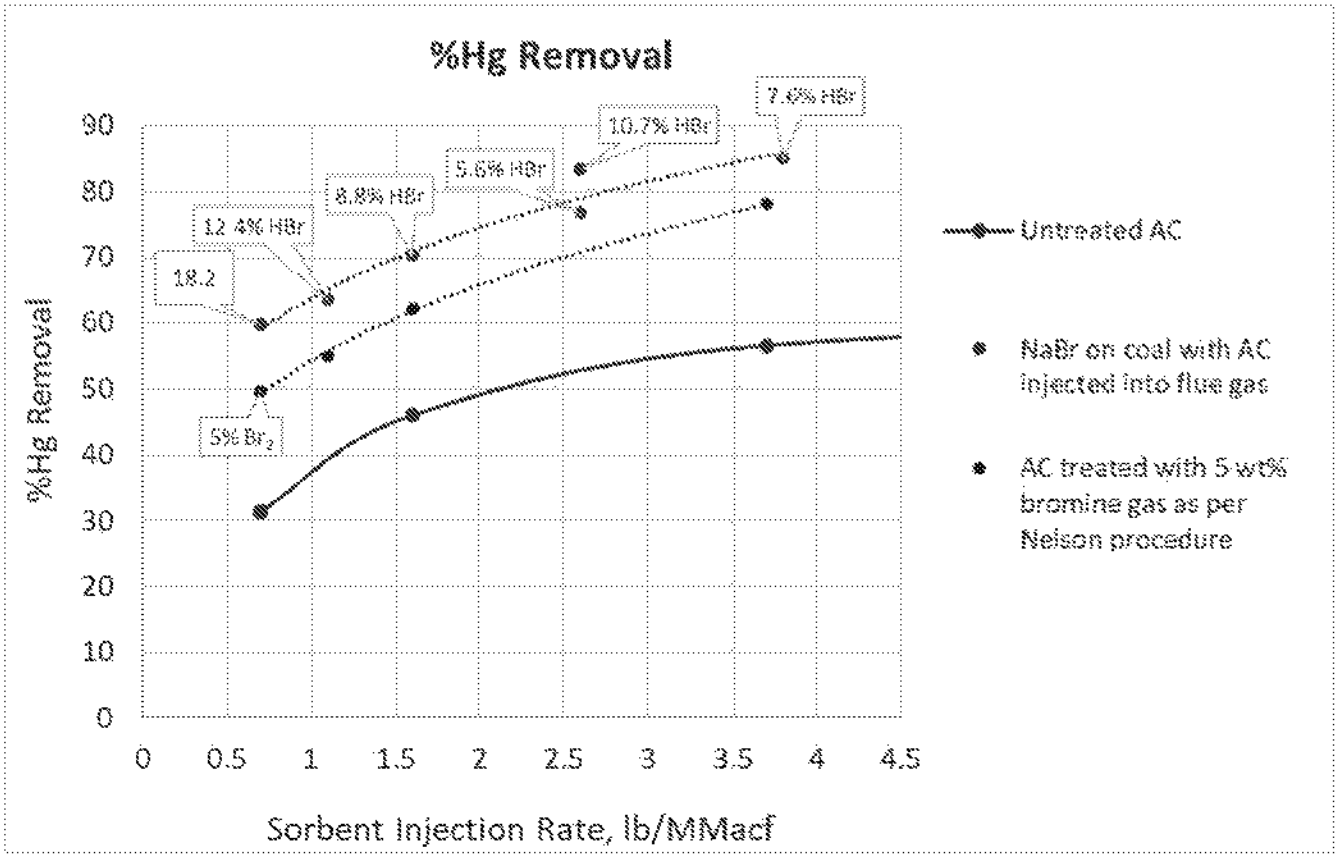
Nelson fails to describe or suggest that treatment of activated carbon with bromides such as HBr could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to activated carbons treated with chlorides. Not only does Felsvang fail to describe or suggest that in-flight promotion of activated carbon with chloride provides better mercury removal than treatment of activated carbon outside the flue gas with chloride; further, as shown herein at **IV(D)**, treatment of activated carbon outside the flue gas with chloride actually provides better mercury removal than in-flight promotion of activated carbon with chloride, which would lead one of ordinary skill in the art away from using in-flight promotion. A person of ordinary skill in the art would have no reason to modify Felsvang's chloride process with a different promoter to form an effective carbon sorbent for mercury if the resulting mercury-removal efficiency could not be reasonably predicted to be the same or greater as that of Felsvang's original process. Therefore, a person of ordinary skill in the art would not be motivated to combine Nelson's bromide additive with Felsvang's chloride method. Independent claim 1 is patentable for at least this reason.

IV(B)(1). In-flight promotion with bromide promoters is more effective for mercury removal than treating the sorbent with bromide or bromine additives outside the mercury-containing gas.

The inventors of the present application have discovered that by combusting coal in the presence of a bromide promoter, and by placing an activated carbon sorbent in the mercury-

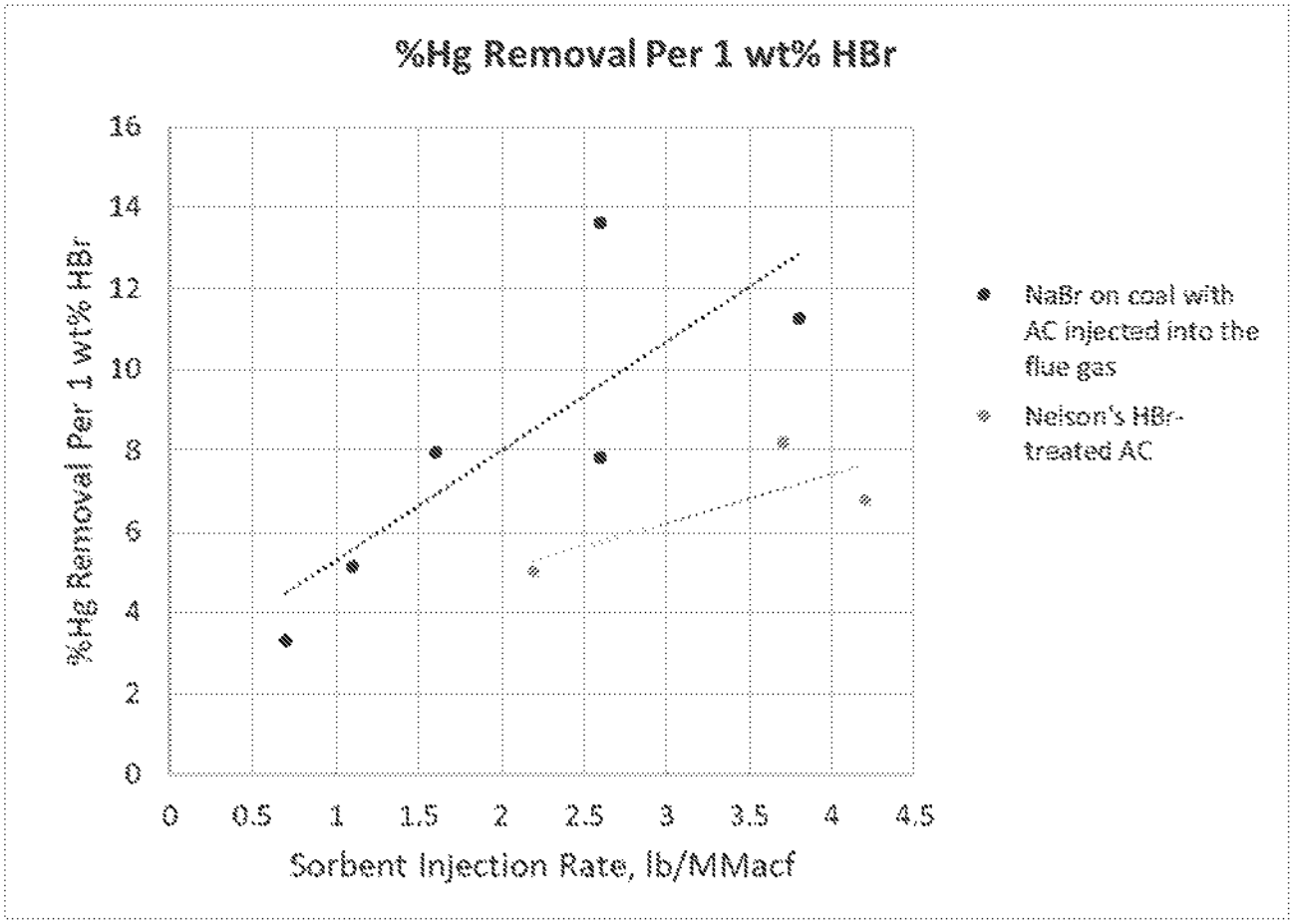
containing gas, as presently claimed, the activated carbon can be promoted by the promoter in-flight in the mercury-containing gas, and further, that in-flight bromide promotion of the activated carbon is more effective for mercury removal than use of an activated carbon that is treated with bromides or bromine outside the flue gas.

As explained in the 37 CFR § 1.132 declaration by John Pavlish filed with the Non-Final Office Action Response for Application No. 15/978,760 on December 3, 2018 ("first 132 Declaration"), pilot-scale testing was performed with activated carbon alone (untreated) injected into the flue gas, the activated carbon treated with Br_2 outside the flue gas as per the Nelson procedure (see, first 132 Declaration at item 6), and with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, the first 132 Declaration at items 8-11. The plot given in the first 132 Declaration at item 11 is reproduced below.



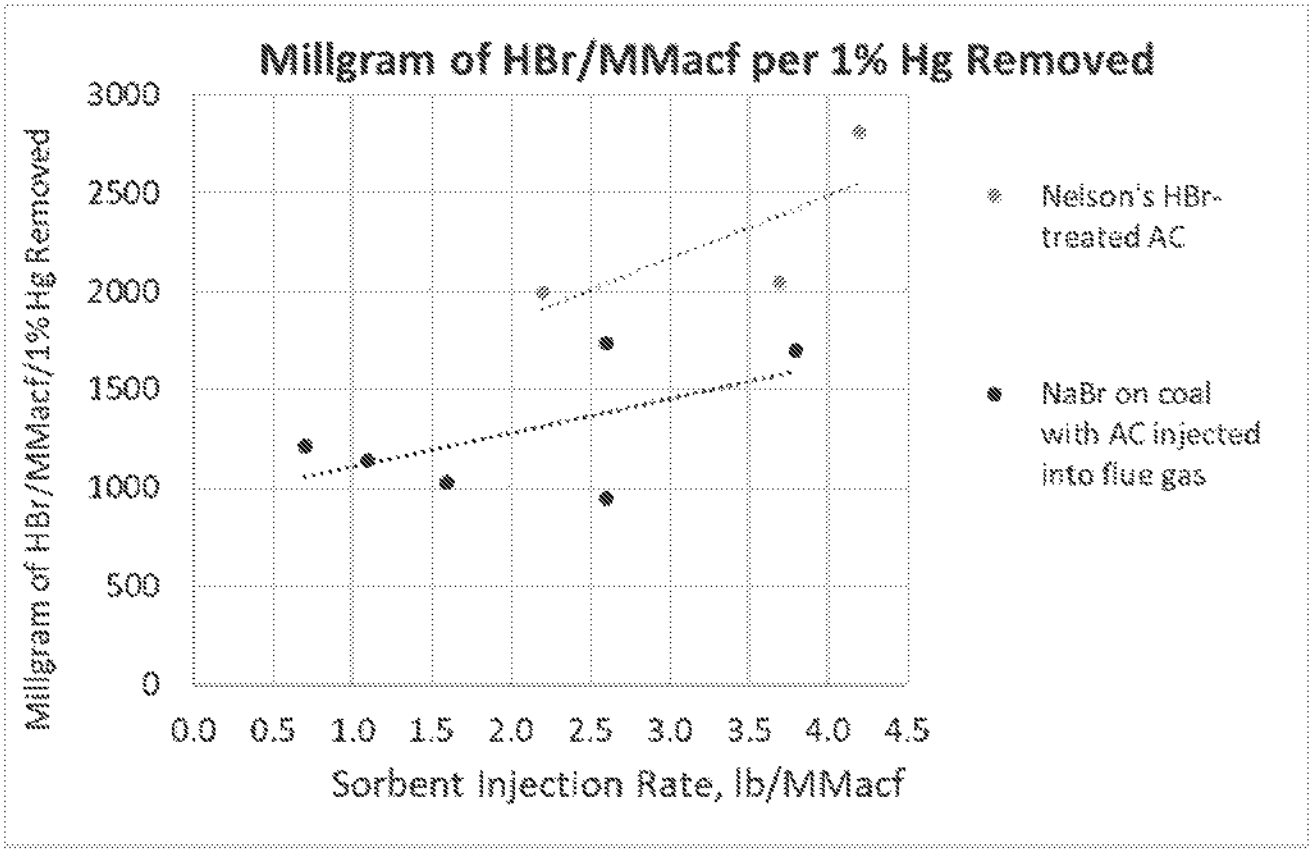
The data in the plot above from item 11 of the first 132 Declaration show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas (in-flight promotion with Br^-) provided a higher percent of mercury removal at all tested sorbent injection rates as compared to the activated carbon alone (untreated) and compared to the activated carbon treated with Br_2 outside the flue gas described herein at item 6 as per the Nelson procedure. With NaBr added to the coal and activated carbon injected into the flue gas, there was a significant reduction in the amount of sorbent required to acheive similar mercury removal compared to the activated carbon treated with Br_2 outside the flue gas. For example, to acheive 70% mercury removal, 2.5 lb/MMacf of Br_2-treated carbon was required, as compared to 1.6 lb/MMacf with NaBr added to the coal and activated carbon injected into the flue gas; an additional (2.5-1.6/1.6)*100% or 56% treated sorbent was required to achieve the same leval of mercury removal. See, first 132 Declaration at items 2-5 and 12.

The percent mercury removal per 1 wt% HBr versus the sorbent injection rate was compared with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas using the pilot-scale plant, and with Nelson's activated carbon treated with HBr outside the flue gas. The data for Nelson's activated carbon treated with HBr outside the flue gas was taken directly from Nelson. The first plot given in the first 132 Declaration at item 13 is reproduced below, but only showing the bromide data.



The data in the plot above, derived from the first plot at item 13 of the first 132 Declaration, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 2x) percent mercury removal per 1 wt% HBr at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas. See, first 132 Declaration at item 14.

The data from the pilot-scale plant was also plotted to show the milligrams of HBr/MMacf per 1% mercury removal versus the sorbent injection rate with NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for Nelson's activated carbon treated with HBr outside the flue gas. The second plot given in the first 132 Declaration at item 13 is reproduced below.



The data in the plot above, derived from the second plot at item 13 of the first 132 Declaration, show that NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly lower milligrams of HBr/MMacf per 1% mercury removal at all tested sorbent injection rates as compared to Nelson's activated carbon treated with HBr outside the flue gas, indicating more efficient (approximately 2x) use of HBr for mercury removal during in-flight promotion of activated carbon than treatment of activated carbon outside the flue gas. See, first 132 Declaration at item 14.

IV(B)(2). There is no way a person of ordinary skill in the art could predict from the cited references that in-flight promotion of a sorbent with bromide promoters is more effective for mercury removal than use of a sorbent that is treated with the same promoters outside the flue gas.

The M.P.E.P. at the beginning of § 2143.02 states (emphasis added) "[a] rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in

the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, *and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.*"

As admitted by the Office Action, Felsvang fails to describe or suggest bromide promoters. Felsvang also fails to describe or suggest that treatment of an activated carbon with a chloride additive outside of flue gas has any advantages over in-flight promotion of an activated carbon with a chloride promoter. Further, as shown herein at **IV(D)**, treatment of activated carbon outside the flue gas with chloride provides better mercury removal than in-flight promotion of activated carbon with chloride. Therefore, a person of ordinary skill in the art hypothetically having Felsvang in-hand would have no clue that in-flight promotion of activated carbon with a halide could give the same or better percent mercury removal over halide treatment outside of the flue gas, and would be led away from Felsvang's in-flight process if they investigated the relative mercury removal of treatment of the activated carbon with chloride outside the flue gas versus in-flight treatment with chloride in the flue gas.

Nelson mentions treating activated carbon outside of flue gas, and then adding the activated carbon to flue gas. Nelson fails to describe or suggest in-flight promotion of an activated carbon with a halide in the flue gas. Therefore, a person of ordinary skill in the art hypothetically having Nelson in-hand would *also* have no idea that in-flight promotion of activated carbon with a halide could have any advantages over halide treatment outside of the flue gas.

There is no way to predict from the presently cited references the superior mercury capture discovered by the present inventors that occurs when activated carbon is promoted with bromide promoters in-flight in the mercury-containing gas, as occurs when following the present claims. The Office Action states at the end of the fourth full paragraph on page 4 that Nelson's additives would be combined with Felsvang's in-flight promotion "...so as to provide an effective carbon sorbent for mercury." However, a person of ordinary skill in the art would have no idea that in-flight promotion with bromide promoters could work better than Nelson's bromide-treatment outside the flue gas. Felsvang fails to describe or suggest that in-flight promotion provides a sorbent with even the same (let alone superior) properties as a sorbent treated outside the flue gas, and, as explained herein at **IV(D)**, treatment of activated carbon outside the flue gas with chloride actually provides better mercury removal than in-flight promotion of activated carbon with chloride;

similarly, Nelson fails to describe in-flight promotion, let alone that in-flight promotion provides the same or superior mercury removal ability as compared to treatment outside the flue gas.

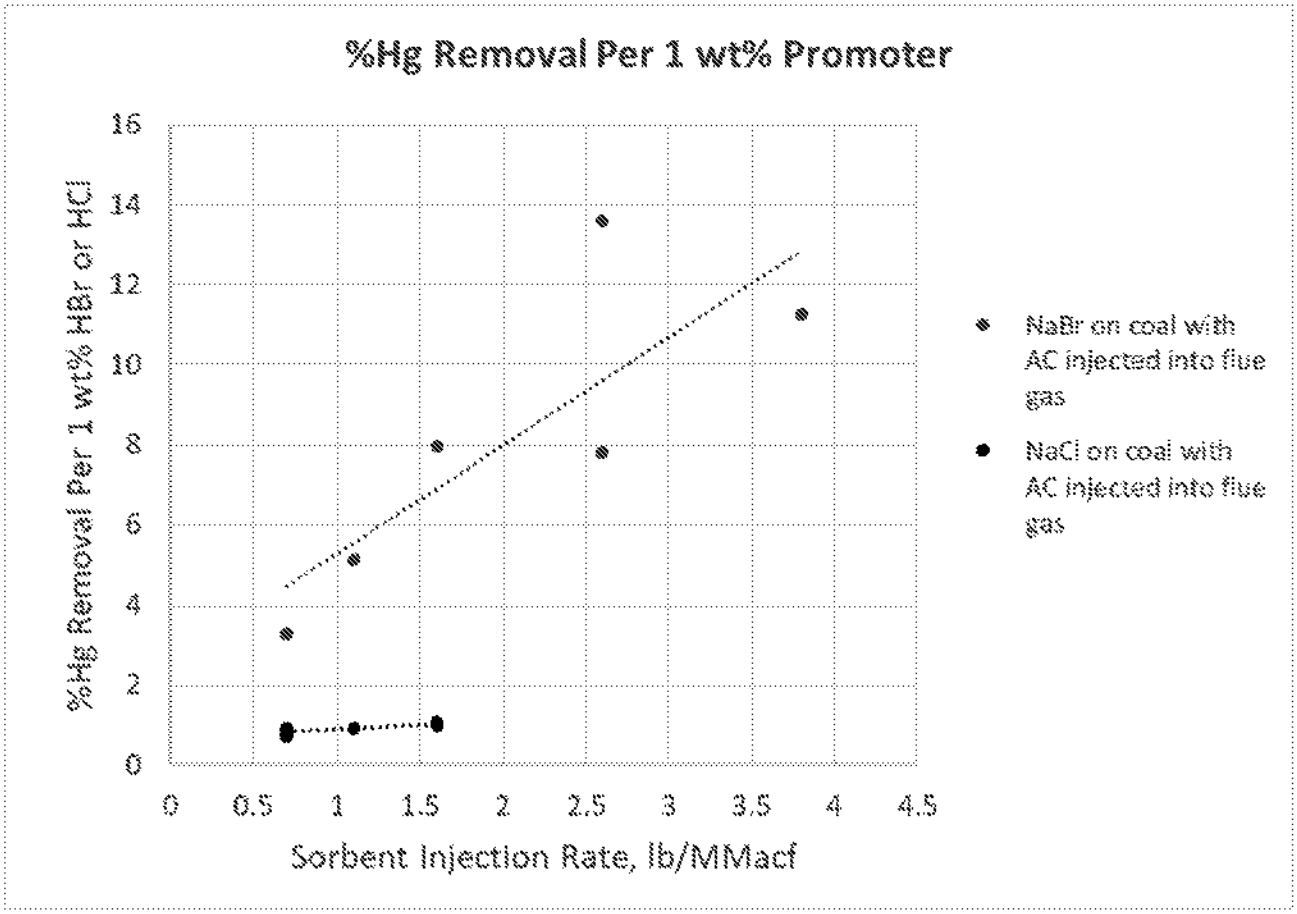
The only way that a person of ordinary skill in the art could discover that in-flight promotion of activated carbon with bromide promoters is more effective for mercury removal than bromide treatment outside the flue gas would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then to compare the mercury removal of Felsvang's modified process to Nelson's sorbent treated outside the flue gas.[1] However, the person of ordinary skill carrying out such a combination would be surprised to find that in-flight promotion with bromide is more effective for mercury removal than bromide treatment of the sorbent outside the flue gas. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claim 1 is patentable over Felsvang in view of Nelson for at least this additional reason.

IV(C)(1). In-flight promotion with bromide promoters is more effective for mercury removal than in-flight promotion with chloride-promoters.

The inventors of the present application have discovered that that in-flight bromide promotion of an activated carbon in a mercury-containing flue gas is significantly more effective for mercury removal than in-flight chloride promotion of an activated carbon.

As explained in the first 132 Declaration, pilot-scale testing was performed with NaBr or NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, the first 132 Declaration at items 8-10. The first plot given in the first 132 Declaration at item 13 is reproduced below, but not showing the data from Nelson's HBr-treated AC.

[1] In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).



The data in the plot above, derived from the first plot at item 13 of the first 132 Declaration, show that the NaBr added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas provided a significantly higher (about 6-8x) percent mercruy removal per 1 wt% HBr or HCl at all tested sorbent injection rates compared to the NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, first 132 Declaration at item 14.

IV(C)(2). There would be no way for a person of ordinary skill in the art to predict this advantage from the from the cited references.

As explained herein at **IV(A)**, Nelson fails to describe or suggest that treatment of activated carbon with bromides such as HBr could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang's activated carbons promoted with chlorides.

The only way that a person of ordinary skill in the art could discover that in-flight promotion with bromide promoters is more effective for mercury removal than in-flight promotion with chloride promoters would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and then to compare the mercury removal of Felsvang's modified process to Felsvang's original process.[2] However, the person of ordinary skill carrying out such a combination would be surprised to find that promotion of activated carbon with bromides such as HBr could provide any mercury-removal improvement, or even the same mercury-removal activity, compared to Felsvang's activated carbons promoted with chlorides. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claim 1 is patentable over Felsvang in view of Nelson for at least this additional reason.

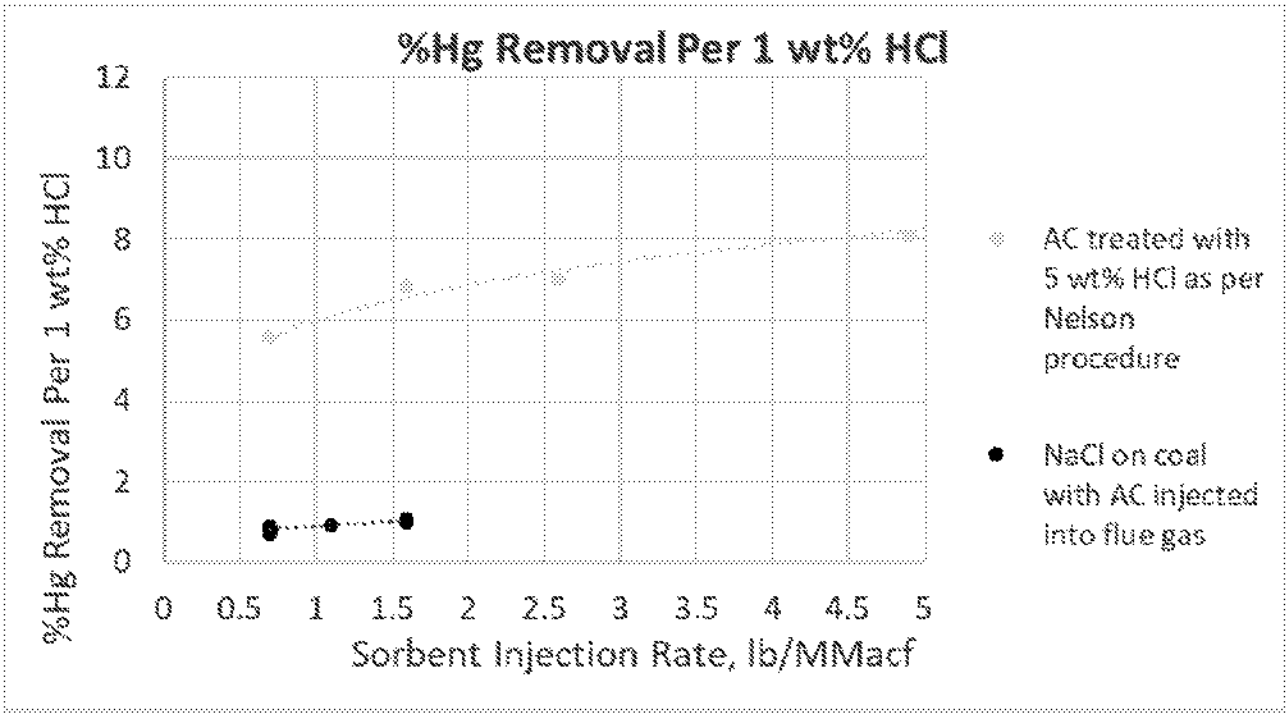
IV(D). Even if a person of ordinary skill in the art compared the mercury removal of Felsvang's activated carbons promoted with chloride in the flue gas to activated carbons treated with HCl outside of the flue gas, they would not determine that in-flight promotion provides the same or better mercury removal properties.

As explained herein at **IV(A)**, Felsvang fails to describe or suggest that in-flight promotion of activated carbon with chloride provides better mercury removal than treatment of activated carbon outside of the flue gas. For the sake of argument, even if a person of ordinary skill in the art were to compare mercury removal of Felsvang's activated carbons promoted with chloride in the flue gas to activated carbons treated with HCl outside of the flue gas, they would not find that in-flight promotion provides the same or better mercury-removal properties.

As explained in the first 132 Declaration, pilot-scale testing was performed with activated carbon treated with HCl outside the flue gas as per the Nelson procedure (see, first 132 Declaration

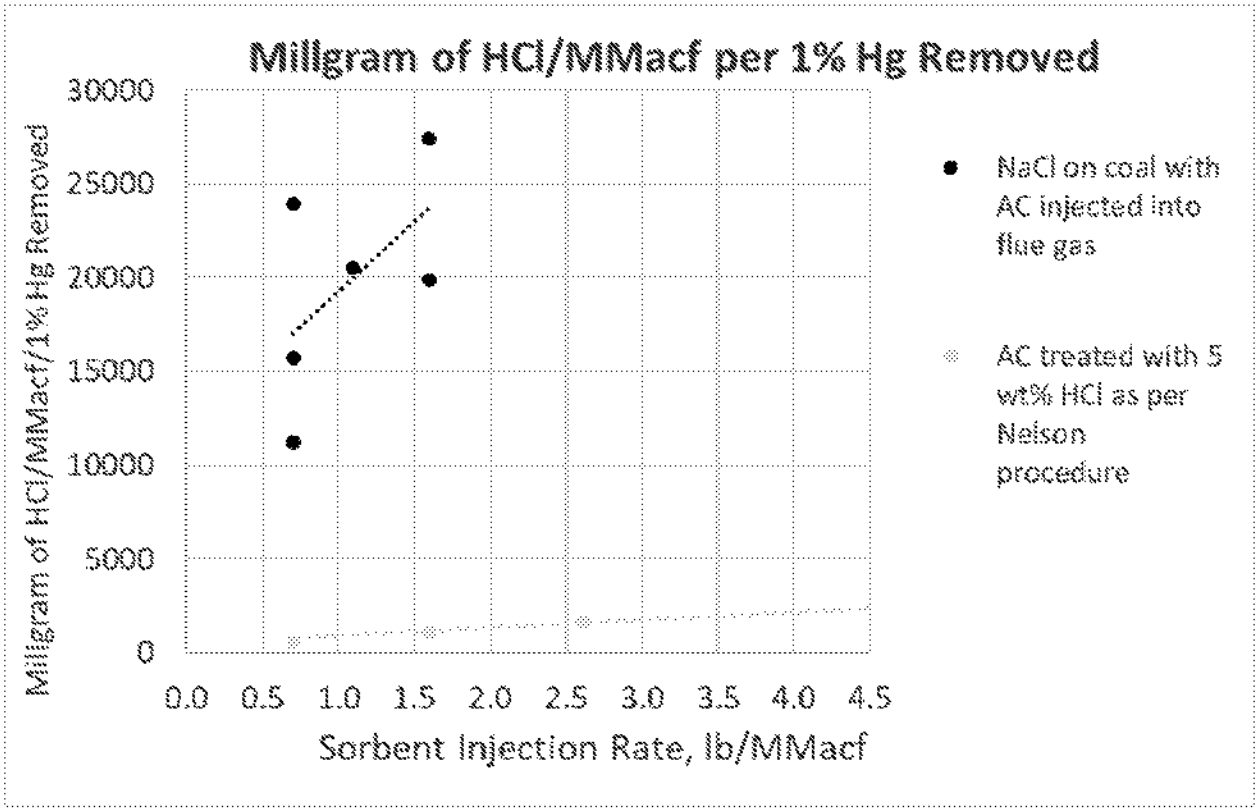
[2] In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

at item 7), and with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. The same activated carbon was used for each sample. See, the first 132 Declaration at items 8-10. The first plot given in the first 132 Declaration at item 15 is reproduced below.



The data in the plot above from the item 15 of the first 132 Declaration show that activated carbon treated with HCl outside the flue gas as per the Nelson procedure provided a much higher percent of mercury removal per 1 wt% HCl at all tested sorbent injection rates as compared to NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas. See, first 132 Declaration at item 16.

The pilot-scale data was also plotted to show the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas, and for the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure. The second plot given in the first 132 Declaration at item 15 is reproduced below.



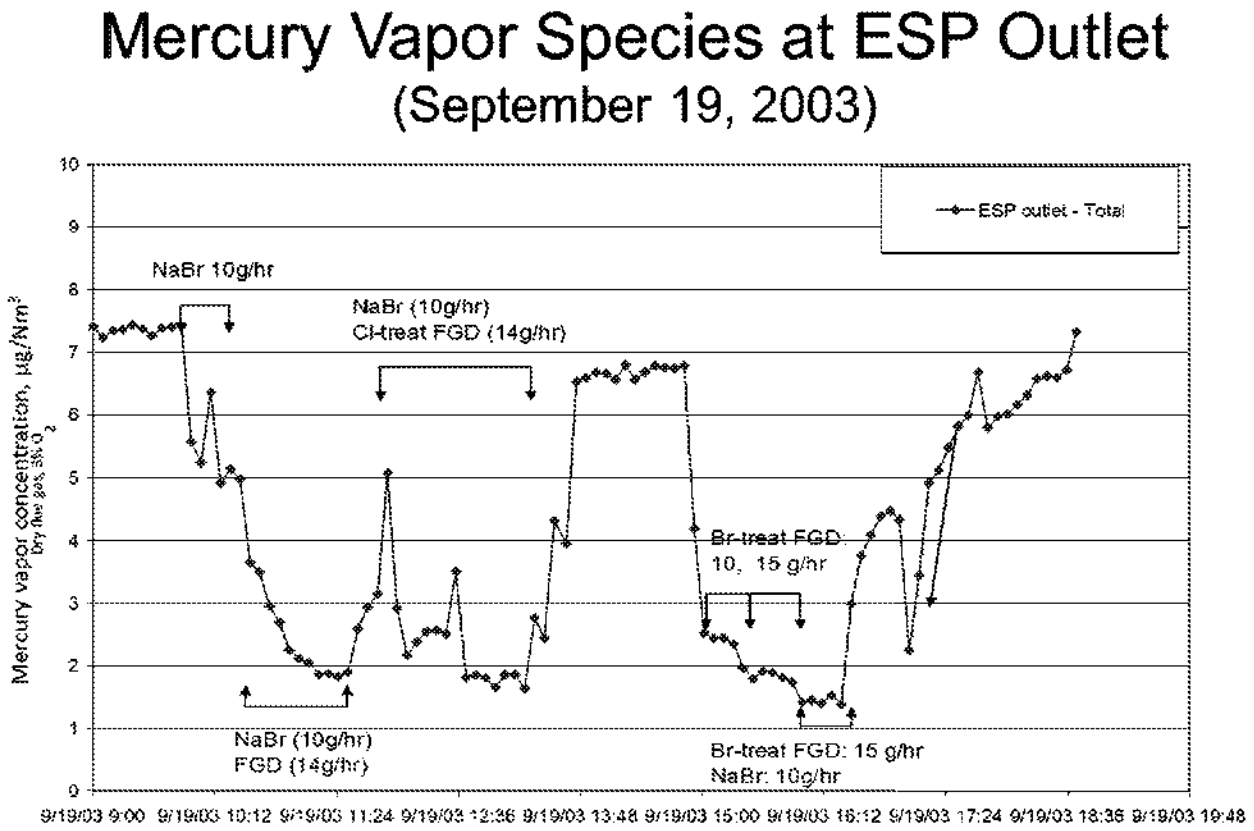
The data in the second plot above from item 15 of the Declaration show that the milligrams of HCl/MMacf per 1% mercury removal versus the sorbent injection rate with NaCl added to coal prior to introduction to the furnace with injection of untreated activated carbon into the flue gas was significantly higher as compared to the activated carbon treated with HCl outside the flue gas described herein at item 7 as per the Nelson procedure, indicating more efficient use of HCl for mercury removal by treatment of activated carbon outside the flue gas than by promotion in-flight.

IV(E)(1). Activated carbon treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide promoters for in-flight promotion results in greater mercury removal than using activated carbon only treated with bromide additives outside the flue gas or activated carbon only treated with bromide promoters in-flight in the flue gas.

As explained in the 37 CFR § 1.132 declaration by John Pavlish filed with the Non-Final Office Action Response for Application No. 15/974,343 on December 3, 2018 ("second 132 Declaration"), the following data show trends that provide evidence that using activated carbon

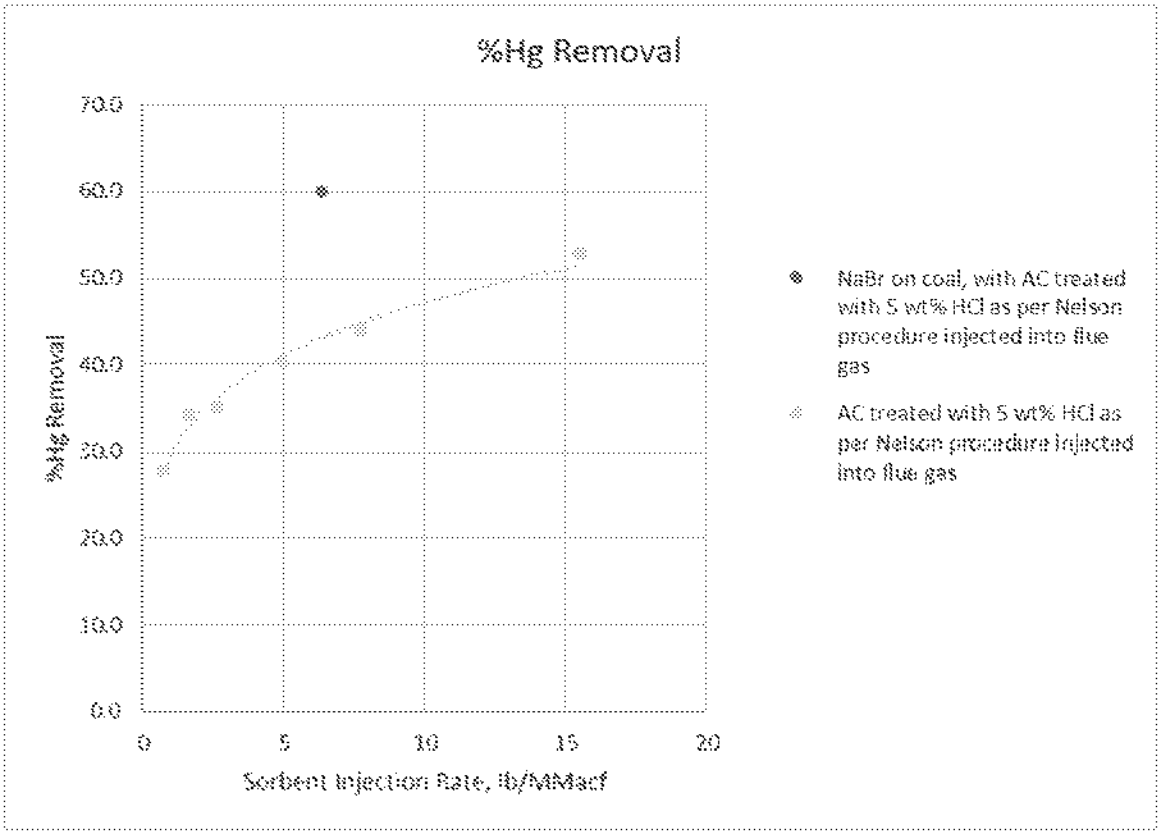
treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide promoters for in-flight promotion results in greater mercury removal than using activated carbon only treated with bromide additives outside the flue gas or activated carbon only treated with bromide promoters in-flight in the flue gas. Although the additives used to treat injected activated carbon in this section are HCl or Br_2, the trends shown would be expected to occur also with bromide-treated activated carbon. See, second 132 Declaration at item 18.

Pilot-scale testing was performed, using lignite coal and Norit DARCO® FGD, and the mercury content at the ESP outlet was measured with NaBr on coal, with NaBr on coal with injection of untreated activated carbon into the flue gas, with NaBr on coal with injection of 5 wt% HCl-treated activated carbon, with injection of 5 wt% Br_2-treated activated carbon without additives on the coal, and with NaBr on the coal with injection of 5 wt% Br_2-treated activated carbon. See, the second 132 Declaration at items 2-4. The plot given in the second 132 Declaration at item 5 is reproduced below.



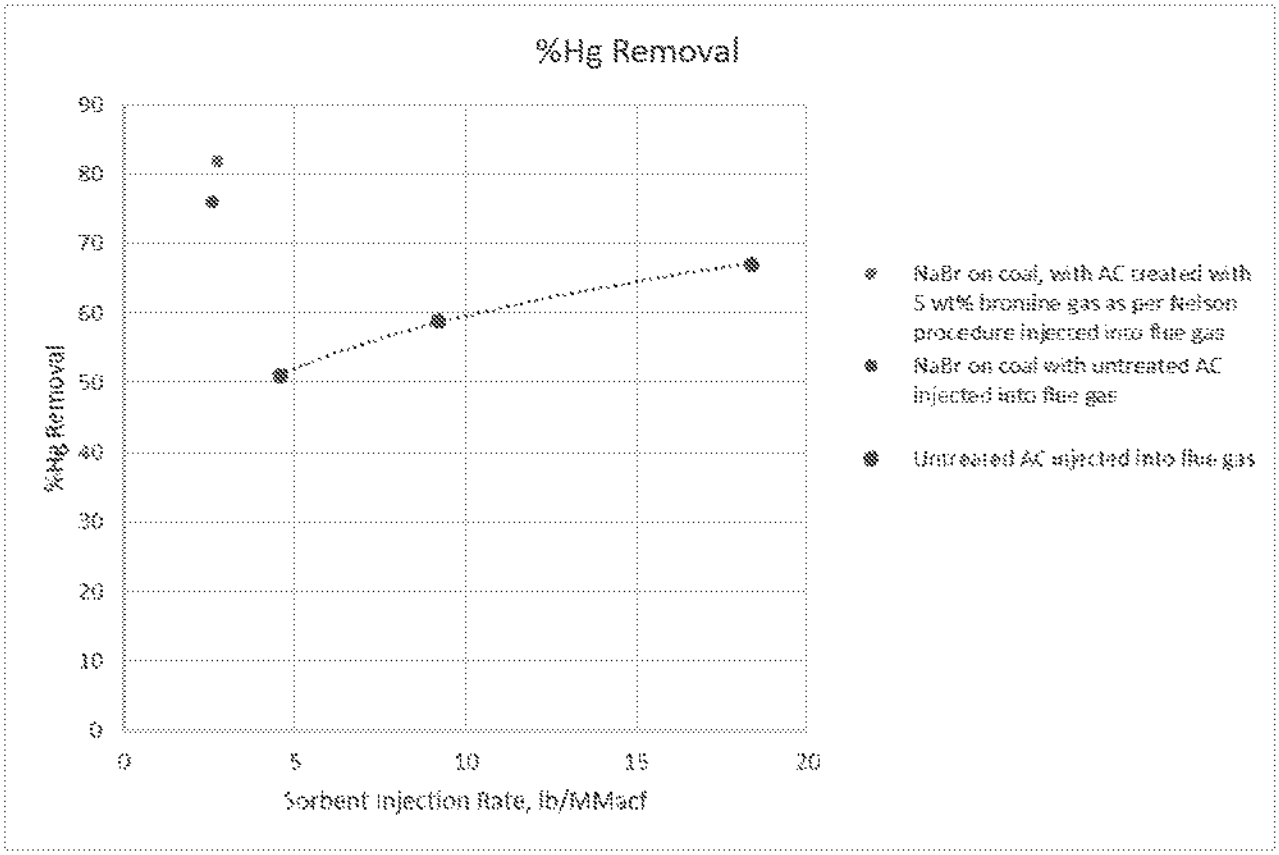
The data in the plot above from item 5 of the second 132 Declaration shows that, compared to placing NaBr on the coal and injecting untreated activated carbon into the flue gas, placing NaBr on the coal and injecting activated carbon into the flue gas treated with 5 wt% HCl outside the flue gas provided greater mercury removal. The data in the plot above also shows that, compared to injecting activated carbon into the flue gas treated with 5 wt% Br_2 outside the flue gas, and compared to placing NaBr on the coal and injecting untreated activated carbon into the flue gas, placing NaBr on the coal and injecting activated carbon into the flue gas treated with 5 wt% Br_2 outside the flue gas provided greater mercury removal. Therefore, in-flight promotion of activated carbon with bromide in the flue gas provides even greater mercury removal if the activated carbon has already been treated with Br_2 or HCl outside the flue gas prior to injection. In-flight bromide promotion in the flue gas of activated carbon treated with Br_2 outside the flue gas also provides greater mercury removal than injecting activated carbon treated with Br_2 outside the flue gas with no in-flight bromide promotion. See, second 132 Declaration at item 6.

The pilot-scale testing was repeated, using lignite coal and Norit DARCO® FGD, with NaBr on coal with injection of 5 wt% HCl-treated activated carbon, and with injection of 5 wt% HCl-treated activated carbon without NaBr on coal. See, second 132 Declaration at item 7. The plot given in the second 132 Declaration at item 8 is reproduced below.



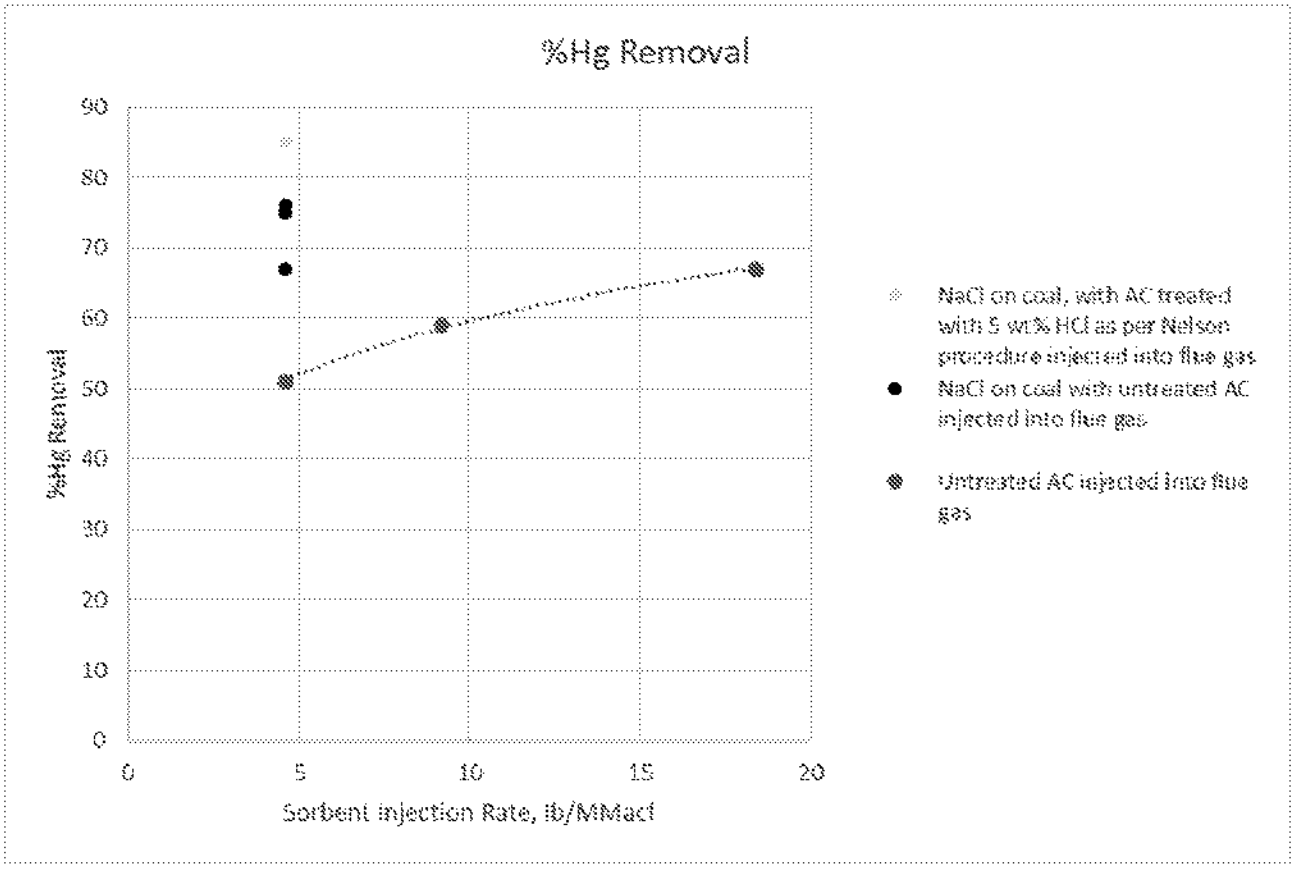
The data in the plot above from item 8 of the second 132 Declaration shows that, compared to injecting activated carbon into the flue gas treated with 5 wt% HCl outside the flue gas, placing NaBr on the coal and injecting activated carbon into the flue gas treated with 5 wt% HCl outside the flue gas provided greater mercury removal. Therefore, in-flight bromide promotion in the flue gas of activated carbon treated with HCl outside the flue gas provides greater mercury removal than injecting activated carbon treated with HCl outside the flue gas with no in-flight bromide promotion. See, second 132 Declaration at item 9.

The pilot-scale testing was repeated, using subbituminous coal and Norit DARCO® Hg, with injection of untreated activated carbon into the flue gas, NaBr on coal with injection of untreated activated carbon into the flue gas, and with NaBr on coal with injection of 5 wt% Br_2-treated activated carbon into the flue gas. See, second 132 Declaration at items 10-12. The plot given in the second 132 Declaration at item 13 is reproduced below.



The data in the plot at item 13 shows that, compared to placing NaBr on the coal and injecting untreated activated carbon into the flue gas, placing NaBr on the coal and injecting activated carbon into the flue gas treated with 5 wt% Br_2 outside the flue gas provided greater mercury removal. Therefore, in-flight promotion of activated carbon with bromide in the flue gas provides even greater mercury removal if the activated carbon has already been treated with Br_2 outside the flue gas prior to injection. See, second 132 Declaration at item 14.

The pilot-scale testing was repeated, using subbituminous coal and Norit DARCO® Hg, with injection of untreated activated carbon into the flue gas, NaCl on coal with injection of untreated activated carbon into the flue gas, and with NaCl on coal with injection of 5 wt% HCl-treated activated carbon into the flue gas. See, second 132 Declaration at item 15. The plot given in the second 132 Declaration at item 16 is given below.



The data in the plot above from item 16 of the second 132 Declaration shows that, compared to placing NaCl on the coal and injecting untreated activated carbon into the flue gas, placing NaCl on the coal and injecting activated carbon into the flue gas treated with 5 wt% HCl outside the flue gas provided greater mercury removal. Therefore, in-flight promotion of activated carbon with chloride in the flue gas provides even greater mercury removal if the activated carbon has already been treated with chloride outside the flue gas prior to injection. See, second 132 Declaration at item 17.

IV(E)(2). There would be no way for a person of ordinary skill in the art to predict this advantage from the cited references.

Neither Felsvang nor Nelson describes or suggests that activated carbon treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide promoters for in-flight promotion results in greater mercury removal than using activated

carbon only treated with bromide additives outside the flue gas or activated carbon only treated with bromide promoters in-flight in the flue gas. The only way that a person of ordinary skill in the art could discover that that activated carbon treated with bromide additives outside the flue gas and subsequently injected into the flue gas containing bromide promoters for in-flight promotion results in greater mercury removal than using activated carbon only treated with bromide additives outside the flue gas or activated carbon only treated with bromide promoters in-flight in the flue gas would not be from the cited references alone; instead, the person of ordinary skill would need to actually modify Felsvang with Nelson as alleged, and would need to make a further modification of Felsvang that also includes injection of sorbents treated with bromide additives outside the flue gas.[3] As explained herein at **IV(A)**, there would be no motivation for a person of ordinary skill in the art to use Nelson's bromide additives in Felsvang's process in the first place; therefore, one of ordinary skill in the art would not use bromide compounds on the coal of Felsvang's process, let alone combine bromide compounds on coal with injection of activated carbon treated with bromide additives outside the flue gas. Even if the person of ordinary skill hypothetically placed Nelson's additives on Felsvang's coal, they would be surprised to find that in-flight promotion with bromide is more effective for mercury removal than bromide treatment of the sorbent outside the flue gas, as explained herein at **IV(B)**; similarly, such a person of ordinary skill in the art carrying out the further modification of using Nelson's activated carbon treated with bromide outside the flue gas for injection into the flue gas formed from combustion of coal including Nelson's bromide additives would also be surprised that the further modification results in even greater mercury removal. The process giving rise to these surprising results was discovered by the inventors of the present application. Surprising results are a hallmark of patentability; only by having the present application in-hand could such results be predicted, and a need to resort to hindsight analysis to predict the advantages of the combination asserted by the Office Action is indicative that the presently claimed invention is not obvious over the cited references. Accordingly, independent claim 1 is patentable over Felsvang in view of Nelson for at least this additional reason.

[3] In the event the Examiner intends to argue that such advantages are inherent in the cited art, Applicant notes that the claimed invention is not specifically disclosed in the prior art. The Examiner cannot reason inherency in a §103 context based on a mere proposed or hypothetical combination of features from cited references. Such reasoning would merely reflect the Examiner's reliance on impermissible hindsight. See, M.P.E.P. § 2112(IV).

Dependent claims 2-20 are directly or indirectly dependent on independent claim 1. As such, these claims incorporate all the features of claim 1. Accordingly, dependent claims 2-20 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 1-20 under 35 U.S.C. § 103(a) over Nelson in view of Felsvang.

Double Patenting Rejection

V(A). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 7,435,286.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-30 of U.S. patent no. 7,435,286.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(B). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 7,435,286 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 7,435,286 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(C). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-25 of patent no. 8,168,147.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-25 of U.S. patent no. 8,168,147.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(D). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-25 of U.S. patent no. 8,168,147 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-25 of U.S. patent no. 8,168,147 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(E). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,512,655 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-60 of U.S. patent no. 8,512,655 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(F). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,512,655 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 8,512,655 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time

inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(G). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-60 of U.S. patent no. 8,821,819.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-60 of U.S. patent no. 8,821,819.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(H). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,821,819 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 8,821,819 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(I). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-33 of U.S. patent no. 9,757,689.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-33 of U.S. patent no. 9,757,689.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(J). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 9,757,689 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 9,757,689 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(K). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-20 of U.S. patent no. 9,468,886.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-20 of U.S. patent no. 9,468,886.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(L). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 9,468,886 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 9,468,886 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(M). The Office Action rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,652,235.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-30 of U.S. patent no. 8,652,235.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(N). The Office Action rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-30 of U.S. patent no. 8,652,235 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-30 of U.S. patent no. 8,652,235 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(O). The Office Action provisionally rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/295,594.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-16 of copending application no. 15/295,594.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(P). The Office Action provisionally rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/295,594 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-16 of copending application no. 15/295,594 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(Q). The Office Action provisionally rejected claims 1-20 on the ground of nonstatutory double patenting over claims 8-20 of copending application no. 15/589,359.

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 8-20 of copending application no. 15/589,359.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(R). The Office Action provisionally rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-20 of copending application no. 15/853,029 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(S). The Office Action provisionally rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-16 of copending application no. 15/853,029 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(T). The Office Action provisionally rejected claims 1-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 14/712,558.

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-20 of copending application no. 14/712,558.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(U). The Office Action provisionally rejected claims 1-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/951,970.

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-20 of copending application no. 15/951,970.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(V). The Office Action provisionally rejected claims 1-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/382,114.

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-20 of copending application no. 15/382,114.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time

inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(W). The Office Action provisionally rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/382,114 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-16 of copending application no. 15/382,114 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(X). The Office Action provisionally rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/853,029.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-20 of copending application no. 15/853,029. This rejection appears to be a duplicate of the rejection listed herein at **V(R)**.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(Y). The Office Action provisionally rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/853,029 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-16 of copending application no. 15/853,029 in view of Felsvang. This rejection appears to be a duplicate of the rejection listed herein at V(S).

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(Z). The Office Action provisionally rejected claims 1 and 4-20 on the ground of nonstatutory double patenting over claims 1-20 of copending application no. 15/978,760.

This rejection is respectfully traversed. Applicant does not admit that claims 1 and 4-20 are obvious over claims 1-20 of copending application no. 15/978,760.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(AA). The Office Action provisionally rejected claims 2 and 3 on the ground of nonstatutory double patenting over claims 1-16 of copending application no. 15/978,760 in view of U.S. patent no. 5,435,980 ("Felsvang").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious over claims 1-16 of copending application no. 15/978,760 in view of Felsvang.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V(AB). The Office Action provisionally rejected claims 1-20 on the ground of nonstatutory double patenting over claims 1-10, 14, and 21-25 of copending application no. 15/974,343.

This rejection is respectfully traversed. Applicant does not admit that claims 1-20 are obvious over claims 1-10, 14, and 21-25 of copending application no. 15/974,343.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time

inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

CONCLUSION

It is respectfully submitted that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 349-9580 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402-0938
(612) 373-6900

Date December 3, 2018

By /Nicholas P. Lanzatella/

Nicholas P. Lanzatella
Reg. No. 63,803

Electronic Acknowledgement Receipt

EFS ID:	34470688
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Steven M. Reid/Megan Reed
Filer Authorized By:	Steven M. Reid
Attorney Docket Number:	4820.001US10
Receipt Date:	03-DEC-2018
Filing Date:	04-JUN-2018
Time Stamp:	18:08:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SIGNED_4820_001U10_NFOAR esponse.pdf	1092811 ae35ebdb5d0e2831ca53d67a65b7117202 2c973c	yes	41

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Amendment/Req. Reconsideration-After Non-Final Reject	2	2
	Claims	3	5
	Applicant Arguments/Remarks Made in an Amendment	6	41
Warnings:			
Information:			
	Total Files Size (in bytes):	1092811	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	February 2, 2019
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X Amendment and Response under 37 C.F.R. § 1.111 (40 pgs.)

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By: /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/997,091	Filing Date 06/04/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	12/03/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/ALA H HUNTER/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 11/02/2018

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
11/02/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Office Action Summary	Application No. 15/997,091	Applicant(s) Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 08/14/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 2-6, 12, 15 and 20 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 2 recites the limitation "the coal" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 3 recites the limitation "the coal" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 3 recites the limitation "the precursor" in line 2. There is insufficient antecedent basis for this limitation in the claim.

Claim 4 recites the limitation "the gas phase" in line 2. There is insufficient antecedent basis for this limitation in the claim.

Claim 5 recites the limitation "the activated carbon" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 6 recites the limitation "the activated carbon" in line 2. There is insufficient antecedent basis for this limitation in the claim.

Claim 12 recites the limitation "the activated carbon" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 15 recites the limitation "the mercury content" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 15 recites the limitation "the cleaned gas" in lines 1-2. There is insufficient antecedent basis for this limitation in the claim.

Claim 20 recites the limitation "the mercury content" in lines 3 and 6. There is insufficient antecedent basis for this limitation in the claim.

Claim 20 recites the limitation "the cleaned gas" in lines 3, 4 and 6. There is insufficient antecedent basis for this limitation in the claim.

Claim 20 recites the limitation "the sorbent composition" in line 5. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim(s) 1, 4-14 and 16-19 is/are rejected under pre-AIA 35 U.S.C. 102(e) as being anticipated by Nelson US 2004/0003716.

For claim 1, the Nelson reference discloses a method for reducing mercury in a mercury-containing gas, the method comprising: injecting a sorbent into the mercury-containing gas (paragraph [0060]); collecting mercury in the mercury-containing gas on the sorbent to produce a cleaned gas (paragraph [0060]), wherein the sorbent is a promoted activated carbon that is promoted inflight with at least one promoter that is Br_2, HBr, Br^-, or a combination thereof, wherein the mercury-containing gas is a coal-combustion gas (paragraphs [0048]-[0051]).

For claim 4, the Nelson reference discloses the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor (paragraphs [0050] and [0051]).

For claim 5, the Nelson reference discloses promoting the activated carbon in-flight (paragraphs [0048]-[0051]). The examiner interprets the (rotating drum, vertically-moving bed, fluidized-bed and transport reaction of Nelson providing the conditions of "in-flight" reactions of activated carbon and the promoter.

For claim 6, the promoted sorbent as disclosed by Nelson above would include active sites, comprising halide anions bound to the activated carbon.

For claim 7, the promoted sorbent as disclosed by Nelson above would include active sites comprising carbocations bound to halide anions.

For claim 8, the sorbent being promoted and then contacted with the mercury containing gas and removed thereafter as disclosed by Nelson above is chemically and physically equivalent to the claimed collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

For claim 9, the Nelson reference injecting an alkaline sorbent into the mercury-containing gas stream (paragraph [0064]).

For claim 10, the Nelson reference discloses alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof (paragraph [0064]).

For claim 11, the Nelson reference discloses the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (paragraph [0064]).

For claim 12, the Nelson reference discloses the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof (paragraph [0040]).

For claim 13, the Nelson reference discloses the promoter is HBr or Br^- (paragraphs [0048]-[0051]).

For claim 14, the Nelson reference discloses the mercury-containing gas is a flue gas stream downstream of a boiler furnace (fig. 2-6 and paragraph [0060]).

For claim 16, the Nelson reference discloses the sorbent material has a composition comprising from about 1 to about 30 grams of additive per 100 grams of activated carbon (paragraph [0054]).

For claim 17, the Nelson reference discloses injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon (paragraphs [0048]-[0051]).

For claims 18 and 19, the Nelson reference discloses collecting greater than 70 wt% of the mercury in the mercury-containing gas (paragraph [0084]).

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claim 2-3, 5, 15 and 20 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Nelson US 2004/0003716 as applied in claim 1 and further in view of Felsvang et al. US 5,435,980.

For claim 2 the Nelson reference does not disclose the coal that is combusted comprises the promoter or a precursor thereof.

The Felsvang et al. reference discloses the coal that is combusted comprises the promoter or a precursor thereof (column 4, lines 39-46).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include either rearranging steps, or repeat steps to have the coal that is combusted comprises the promoter or a precursor thereof (Felsvang et al. column 4, lines 39-46) so as to increase the removal of mercury in the mercury containing gas rather than release mercury to the atmosphere. Further the courts have held that selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results; In re Gibson, 39 F.2d 975, 5 USPQ 230.

For claim 3, the combination of Nelson and Felsvang et al. would include combusting the coal that comprises the promoter or the precursor thereof as both Nelson and Felsvang et al. disclose combusting the coal.

For claim 5, even if the Nelson reference does not disclose promoting the activated carbon in-flight, the Felsvang et al. reference does disclose this limitation (column 4, lines 39-46 and column 6, lines 6-21)

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include either rearranging steps, or repeat steps to have promoting the activated carbon in-flight (Felsvang et al. column 4, lines 39-46) so as to increase the removal of mercury in the mercury containing gas rather than release mercury to the atmosphere. Further the courts have held that selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results; In re Gibson, 39 F.2d 975, 5 USPQ 230.

For claim 15, the Nelson reference does not disclose monitoring the mercury content of the cleaned gas is performed substantially continuously.

The Felsvang reference discloses monitoring the mercury content of the cleaned gas is performed substantially continuously (column 6 lines 43-46).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include monitoring the mercury content of the cleaned gas is performed substantially continuously (Felsvang et al. promoting the activated carbon in-flight) so as to allow for the maximum amount of mercury to be removed from the waste gas stream.

For claim 20, the Nelson reference discloses the method is a method for reducing mercury in the mercury-containing gas to a desired level (as shown above).

The Nelson reference does not disclose monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level.

The Felsvang et al. reference discloses monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (promoting the activated carbon in-flight).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (Felsvang et al. promoting the activated carbon in-flight) so as to allow for the maximum amount of mercury to be removed from the waste gas stream.

Claim 1-20 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Felsvang et al. US 5,435,980 in view of Nelson US 2004/0003716.

For claim 1, the Felsvang et al. reference discloses a method for reducing mercury in a mercury-containing gas, the method comprising: injecting a sorbent into the mercury-containing gas (figure, objects 14 and 4, and column 4, lines 5-11); collecting mercury in the mercury-containing gas on the sorbent to produce a cleaned gas (column 5, lines 41-65), wherein the sorbent is a promoted activated carbon that is promoted in-flight with at least one promoter (column 4, line 63 – column 5, line 2 and column 6, lines 29-42) wherein the mercury-containing gas is a coal-combustion gas (abstract). The reference does not disclose the promoter is Br_2, HBr, Br^- or a combination thereof.

The Nelson reference discloses the promoter is Br_2, HBr, Br^- or a combination thereof (paragraphs [0017] and [0041]).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Felsvang et al. reference to either replace the Cl with or include in addition to the Cl, Br_2, HBr, Br^- or a combination thereof (Nelson paragraphs [0017] and [0041]) so as to provide an effective carbon sorbent for mercury.

For claim 2, the Felsvang et al. reference discloses the coal that is combusted comprises the promoter or a precursor thereof (column 4, lines 39-46).

For claim 3, the Felsvang et al. reference discloses combusting the coal that comprises the promoter or the precursor thereof (column 4, lines 39-46).

For claim 4, the Felsvang et al. reference discloses the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor (column 4, lines 39-50).

For claim 5, the Felsvang et al. reference discloses promoting the activated carbon inflight (column 4, lines 39-50, 5-15 and column 6, lines 12-31).

For claims 6 and 7 as detailed above each of the claimed steps are disclosed by the combination of Felsvang and Nelson reference and therefore the result of performing the steps would inherently be the same and would result in the promoted activated carbon comprises active sites, comprising halide anions bound to the activated carbon and the promoted activated carbon comprises active sites comprising carbocations bound to halide anions.

For claim 8 the promoted sorbent is disclosed by the combination of Felsvang and Nelson. Further each of the steps as claimed above are also shown by Felsvang and Nelson and would inherently have the same results when the method is performed and would result in collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

For claims 9 and 10, the Felsvang et al. reference discloses injecting an alkaline sorbent into the mercury-containing gas stream, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof (column 4, lines 23-28, column 5, lines 26-40 and clam 3).

For claim 11, the Felsvang et al. reference discloses the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (column 4, lines 27-32).

For claim 12, the Felsvang et al. reference discloses the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof (column 3, lines 5-17).

For claim 13, the Nelson reference discloses the promoter is HBr or Br^- (paragraphs [0017] and [0041]).

For claim 14, the Felsvang et al. reference discloses the mercury-containing gas is a flue gas stream downstream of a boiler furnace (column 5, lines 23-26, abstract and column 3, lines 4-55).

For claim 15, the Felsvang et al. reference discloses monitoring the mercury content of the cleaned gas is performed substantially continuously (column 6, lines 42-47).

For claim 16, the Felsvang et al. reference does not explicitly state the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon. The reference does disclose optimizing the amount of Cl and activated carbon introduced (column 6, lines 42-47).

Further the Nelson reference also discloses optimizing of the promoter so as to obtain a desired mercury reactivity (paragraph [0054]).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Felsvang et al. reference to include the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon (Felsvang et al. column 6, lines 42-46 and Nelson paragraph [0054]) so as to adjust the among of halogen introduced based on the Hg content and to ensure optimum reaction between the halogen and the activated carbon. Further the courts have held that that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller,* 105 USPQ 233.

For claim 17, the Felsvang et al. reference discloses injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon (column 4, lines 39-46 and column 6, lines 6-11).

For claims 18 and 19, the Felsvang et al. reference discloses collecting greater than 70 wt% of the mercury in the mercury-containing gas and collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent (examples 1, 3 and 4). Further the examiner asserts that these limiations are the results of the method. As the method is disclosed by Felsvang et al. and Nelson as shown above, the result of such a combination would occur, i.e. the degree of separation of mercury.

For claim 20, the Felsvang et al. reference discloses the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method further comprising: monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (column 6, lines 42-47).

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file

provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 7,435,286 ('286)

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '286.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 7,435,286 ('286) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '286 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4,

lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. US 8,168,147 ('147).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '147.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-25 of U.S. Patent No. US 8,168,147 ('147) in view of Felsvang et al. US 5,435,980.

'286 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '147 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,512,655 ('655) in view of Felsvang et al. US 5,435,980.

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '655.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 8,512,655 ('655) in view of Felsvang et al. US 5,435,980.

'655 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '655 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-60 of U.S. Patent No. US 8,821,819 ('819).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '819.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 8,521,819 ('819) in view of Felsvang et al. US 5,435,980.

'819 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '819 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-33 of U.S. Patent No. US 9,757,689 ('689).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '689.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 9,757,689 ('689) in view of Felsvang et al. US 5,435,980.

'689 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '689 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of U.S. Patent No. US 9,468,886 ('886).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '886.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 9,468,886 ('886) in view of Felsvang et al. US 5,435,980.

'886discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '886 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. 8,652,235 ('235).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '235.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of U.S. Patent No. US 8,652,235 ('235) in view of Felsvang et al. US 5,435,980.

'235discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '235 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/295594 ('594).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '594.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/295594 ('594) in view of Felsvang et al. US 5,435,980.

'594 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '594 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 8-20 of copending Application No. 15/589359 ('359).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '359.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '029.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 14/712558 ('558) Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording it the limitations correspond to '558.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-20 of copending Application No. 15/951970 ('970). Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '970.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/382114 ('114).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '114.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/382114 ('114) in view of Felsvang et al. US 5,435,980.

'114 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '114 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/853029 ('029).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '029.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/853029 ('029) in view of Felsvang et al. US 5,435,980.

'029 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '029 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4,

lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1 and 4-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-20 of copending Application No. 15/978,760 ('760).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '760.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 2 and 3 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-16 of copending Application No. 15/978,760 ('594) in view of Felsvang et al. US 5,435,980.

'760 discloses the claimed invention except for the limitations of claims 2 and 3

Felsvang et al. and disclose this limitation as shown above.

It would have been obvious to one having ordinary skill in the art to have modified the '760 reference to include the limitations of claims 2 and 3 (Felsvang et al. column 5, 60-65 and column 4, lines 42-45) so as to supplement the halogen content of the system so as to increase the mercury sorption capability.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over 1-10, 14 and 21-25 of copending Application No. 15/974,343 ('343).

Although the claims at issue are not identical, they are not patentably distinct from each other because while the current claim set includes different wording, the limitations correspond to '760.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Response to Arguments

Applicant's arguments with respect to claims 1-20 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ROSE ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Monday-Thursday 7:00-5:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571)272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer

Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AMBER ROSE. ORLANDO
Primary Examiner
Art Unit 1776

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Notice of References Cited	Application/Control No. 15/997,091	Applicant(s)/Patent Under Reexamination	
	Examiner AMBER R ORLANDO	Art Unit 1776	Page 1 of 2

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*	C	US-6136749-A	10-2000	Gadkaree; Kishor P.	B01D53/8665	502/180
*	D	US-6372187-B1	04-2002	Madden; Deborah A.	B01D53/508	110/345
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	P					
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	R					
	S					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Notice of References Cited	Application/Control No. 15/997,091	Applicant(s)/Patent Under Reexamination	
	Examiner AMBER R ORLANDO	Art Unit 1776	Page 2 of 2

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	Art Unit
	AMBER R ORLANDO	1776

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Text Search (See east search history)	07/23/2018	AO
Inventor Search (DAV)	07/23/2018	AO
Text Search (See east search history)	10/29/2018	AO

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 14:12
S1	45	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S2	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorben and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S3	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:20
S7	73	("20020150516" | "4786483" | "5409522" | "5505766" | "6383981" | "6878358" | "20020033097" | "4530765" | "5346674" | "6080281" | "4708853" | "6027551" | "6136072" | "6258334" | "6818043" | "20060057044" | "20080207443" | "20010002387" | "3826618" | "4814152" | "4820318" | "4889698" | "5891324" | "6528030" | "20050227146" | "5419834" | "7942566" | "20080134888" | "3662523" | "3849267" | "4196173" | "4500327" | "6942840" | "20020134242" | "20030136509" | "20050147549" | "20060112823" | "20080134888" | "6471936" | "20010003116" | "20050019240" | "20060048646" | "4956162" | "5575982" | "6372187" | "6375909" | "7435286" | "7514052" | "20050074380" | "20090081092" | "5288306" | "1984164" | "4101631" | "5695726" | "6080281" | "6848374" | "20050000197" | "5300137" | "5607496" | "5672323" | "6214304" | "6953494" | "5245120" | "20070168213" | "7938571" | "20040003716" | "20040013589" | "3194629" | "3786619" | "5827352" | "20040109800" | "20070295347" | "5435980" | "6136749" | "20030206846").PN.	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:25
S8	13	"11209163"	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S9	3	"11209163" and non carbon	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S10	161	(B01D53/64, B01D2257/602,	US-PGPUB;	ADJ	ON	2015/03/17

		B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	USPAT			13:49
S11	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S12	116	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S13	172	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S14	67	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S15	67	"6136749"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:11
S16	20	"684374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S17	1	"20040003716"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S18	68	"6848374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S19	41	"7435286"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S20	13	"8168147"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S21	69	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S22	181	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S25	28	"5266280"	US-PGPUB; USPAT	ADJ	ON	2016/06/07 13:41
S26	281	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:01
S27	148	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:02
S28	159	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2016/09/29 16:18

			IBM_TDB			
S29	206	(sorbent or activated carbon) with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4 and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 16:22
S30	195	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/09/30 13:48
S33	6	"20040003719"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:56
S34	49	"2004003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:57
S35	81	"6848374"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:58
S36	56	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:02
S37	7	olson.in. and ("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:04
S38	0	("40" microns and halocarbon sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S39	0	(halocarbon sorbent).clm. and "40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05

S40	65	"40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S41	3907	("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S42	29	("40" microns and sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S43	1	(halocarbon sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S44	36	(sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S45	0	(sorbent).clm. and olson.in. and "40" micron	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S46	17	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:09
S47	2	"20110233133"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:27
S48	7	"20110023427"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2016/11/16 11:28

			DERWENT; IBM_TDB			
S49	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:32
S50	11	"20040025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:32
S51	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S52	40	"6312489"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S53	30	("20030024872" | "20050045553" | "20050144916" | "4008060" | "4640779" | "4655921" | "4673503" | "4738778" | "4746432" | "4799944" | "5043000" | "5051118" | "5120296" | "5174896" | "5320657" | "5512075" | "5674302" | "6152979" | "6312489" | "6315130" | "6336946" | "6398836" | "6585793" | "6598749" | "7648546").PN. OR ("7931723").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:36
S54	33	("4200444" | "4640779" | "5968215" | "6059851").PN. OR ("6312489").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:40
S55	5	"8518142"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:54
S56	4	"8747505"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:57
S57	2	"14318270"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 12:06
S58	13	pac with size with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 12:13
S59	197	(B01D53/64, B01D2257/602,	US-PGPUB;	ADJ	ON	2016/11/16

		B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	USPAT			15:23
S60	0	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent "4198388"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39
S61	10	"4198388"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39
S62	0	"2010083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S63	2	"20100083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S64	2	absorp$5 with mea with methanol with acid	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:36
S65	2	"20070283813"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:39
S66	21	"4469596"	US-PGPUB; USPAT	ADJ	ON	2016/11/21 08:29
S67	4	"2003229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S68	2	"20030229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S69	45	"5,338,458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S70	45	"5338458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S71	213	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:02
S72	64	("1786483" | "1984164" | "2317857" | "20010002387" | "20010003116" | "20020134242" | "20020150516" | "20030136509" | "20040003716" | "20040013589" | "20050019240" | "20060048646" | "20060191835" | "20090062119" | "20100047146" | "20120183458" | "20140056787" |	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:20

		"3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "4196173" | "4500327" | "4814152" | "4820318" | "4889698" | "4959162" | "5300137" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "7101631" | "7435286" | "7479263" | "7514052" | "7563311" | "7611564" | "8007749" | "8168147" | "8168149" | "8512655").PN.				
S73	3	("20090235848" | "20110076210" | "20150246315").PN.	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:31
S79	3	("20090235848" | "20110076210" | "20140224121").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:36
S80	96	("1984164" | "2317857" | "20010002387" | "20010003116" | "20020043496" | "20020134242" | "20020150516" | "20030104937" | "20030136509" | "20040003716" | "20040013589" | "20040076570" | "20050019240" | "20060048646" | "20060191835" | "20080182747" | "20080292512" | "20090062119" | "20090136401" | "20090320678" | "20100047146" | "20110168018" | "20120183458" | "20130280156" | "20140056787" | "20140255279" | "20140308188" | "20150098878" | "3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "3876393" | "4094777" | "4101631" | "4196173" | "4338896" | "4500327" | "4708853" | "4786483" | "4814152" | "4820318" | "4889698" | "4956162" | "5300137" | "5336835" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6638485" | "6808692" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "6960329" | "7081434" | "7211707" | "7435286" | "7479263" | "7514052" | "7521032" | "7544338" | "7563311" | "7611564" | "7622092" | "7722843" | "7767174" | "7780765" | "8007749" | "8168147" | "8168149" | "8216535" | "8512655" | "8652235" | "8821819" | "9011805").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:41
S81	593	honeycomb with plug$4 and plug$4 with length	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S82	0	honeycomb with plug$4 and plug$4 with length with less than with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S83	0	honeycomb with plug$4 and plug$4 with length with less than	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45

S84	127	honeycomb with plug$4 and plug$4 with length with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:46
S85	241	honeycomb with plug$4 and plug$4 with length with mm	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:47
S86	41	honeycomb with plug$4 and plug$4 with length with "3 mm "	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:49
S87	28	honeycomb with plug$4 and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:52
S88	28	honeycomb and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:53
S89	43	honeycomb and plug$4 with porosity with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:06
S90	20	honeycomb and plug$4 with pore (size or diameter) with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:07
S91	8	saw with honeycomb with filter	US-PGPUB; USPAT	ADJ	ON	2017/06/29 13:31
S92	230	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/12/01 14:36
S93	2	"20060260468"	US-PGPUB; USPAT	ADJ	ON	2018/07/03 10:34
S94	19	engine with air with inlet with filter$4 with cone	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:26
S95	36	engine with air with inlet with filter$4 with (cone or conical or (diameter with (increas$4 or decreas$4)))	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:27
S96	24	("3771638" | "3870495" | "3872012" | "4157902" | "4702754" | "5125940" | "5522909" | "5549724" | "5632793").PN. OR ("5888260").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S97	41	("0153535" | "0439091" | "1398685" | "1530163" | "1887052" | "2087688" | "4003836" | "4018580" | "4032455" | "4039308" | "4065276" | "4261710" | "4410341" | "4414110" | "4699715" | "5106397" | "5178656" | "5522909" | "5549722" | "5549724" | "5888260" | "6397842" | "6508052" | "D401597" | "D401942" | "D403414" | "D403416").PN. OR ("6808552").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S98	15	("D403416").URPN.	USPAT	ADJ	ON	2018/07/03 15:33
S99	0	"20030089233"	USPAT	ADJ	ON	2018/07/04 12:29
S100	3	"20030089233"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S101	26	"6833023"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S102	2	"20070168213"	US-PGPUB;	ADJ	ON	2018/07/09

			USPAT; USOCR; FPRS; EPO; JPO			13:08
S103	14	carbocations with sorbent with bromine	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:14
S104	0	a side forming a cross sectional shape of each of the first	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:47
S105	0	non of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S106	0	none of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S107	0	none of sides forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S109	13	olson.in. and (alkali and promoter and earth).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S110	0	olson.in. and (alkali and promoter and earth with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S111	10	olson.in. and (alkali and promoter with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S112	0	"2015008283"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S113	2	"20150082833"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S114	24	olson.in. and liquid.clm. and promoted	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:50
S115	75	remov$4 with mercury and (br or bromine) with liquid with carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:54
S116	0	separating greater than "70" wt% of the mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17
S117	0	((separating greater) with (of the mercury)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17

S118	20	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:43
S119	40	(during with after with mercury with sorbent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:38
S120	304	sorbent with mercury and sorbent with boiler	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:39
S121	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:41
S122	18	before with burn$4 with coal with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/01 17:42
S123	204	("0174348" | "0202092" | "0208011" | "0224649" | "0229159" | "0298727" | "0346765" | "0347078" | "0367014" | "0537926" | "0537998" | "0541025" | "0625754" | "0647622" | "0685719" | "0688782" | "0700888" | "0744908" | "0846338" | "0894110" | "0896876" | "0911960" | "0945331" | "0945846" | "1112547" | "1167471" | "1167472" | "1183445" | "1788466" | "1984164" | "20020065581" | "20020114749" | "20020184817" | "20030088370" | "20030103882" | "20040003716" | "20040013589" | "20040086439" | "20040219083" | "20050039598" | "20060047526" | "20060210463" | "2016821" | "2059388" | "2089599" | "2511288" | "3194629" | "3288576" | "3437476" | "3599610" | "3662523" | "3725530" | "3764496" | "3823676" | "3838190" | "3849267" | "3849537" | "3956458" | "3961020" | "3974254" | "4040802" | "4075282" | "4094777" | "4101631" | "4115518" | "4148613" | "4174373" | "4196173" | "4226601" | "4233274" | "4272250" | "4280817" | "4305726" | "4322218" | "4377599" | "4387653" | "4394354" | "4440100" | "4472278" | "4474896" | "4519807" | "4519995" | "4555392" | "4582936" | "4602918" | "4629721" | "4693731" | "4716137" | "4741278" | "4758418" | "4764219" | "4786483" | "4804521" | "4807542" | "4824441" | "4830829" | "4873930" | "4886519" | "4892567" | "4915818" | "4933158" | "4936047" | "4964889" | "5013358" | "5024171" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/01 17:42

		"5049163" | "5116793" | "5126300" | "5137854" | "5162598" | "5190566" | "5238488" | "5350728" | "5368617" | "5409522" | "5435980" | "5447703" | "5460643" | "5505746" | "5505766" | "5571490").PN. OR ("5587003" | "5618508" | "5635150" | "5659100" | "5670122" | "5733516" | "5738834" | "5787823" | "5810910" | "5897688" | "5910292" | "5989506" | "6024931" | "6083289" | "6240859" | "6258334" | "6372187" | "6375909" | "6475451" | "6521021" | "6528030" | "6533842" | "6558454" | "6610263" | "6613110" | "6719828" | "6732055" | "6737031" | "6746531" | "6790420" | "6808692" | "6848374" | "6878358" | "6942840" | "6953494" | "6962617" | "6974564" | "6975975" | "7468170" | "7507083" | "7674442" | "7758827" | "7776301").PN.				
S124	1	"15573128"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:07
S125	2	"20110207597"	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/10/02 12:08
S126	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S127	71	sorbent with before with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:30
S128	234	"6953494"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:38
S129	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 17:40
S130	35	promoter with sorbent and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S131	28	promoter with sorbent with mercury and "30" g	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:19
S132	4	promoter with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:20

S133	4	promot$4 with sorbent with mercury and ("30" g).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:23
S134	4	promot$4 with sorbent with mercury and pre.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:41
S135	2	promot$4 with sorbent with mercury and pre-heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/02 22:42
S136	2	promot$4 with sorbent with mercury and pre heater	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S137	57	promot$4 with sorbent with mercury and pre	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:36
S138	24	sorbent with preheat$4 with coal	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:39
S139	121	"5435980"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 08:47
S140	23	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:28
S141	5	"14102896"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 11:48
S142	7	"12429058"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:09
S143	4	"12202595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:23
S144	20	"12201595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:24

S145	3	"14564860"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:27
S146	1	"15978760"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:28
S147	1	"15589359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:32
S148	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:37
S149	8	"15997091"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S150	6	"14712558"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 12:42
S151	2	"15951970"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:18
S152	4	"15382114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:47
S153	1	"15853029"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 15:51
S154	2	"20070168213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:18
S155	69	"4279873"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/03 18:42
S156	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 07:59

S157	4	"15295594"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 08:08
S158	1	("20180257030").PN.	US-PGPUB; USPAT	ADJ	ON	2018/10/04 09:31
S159	86	"5569436"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:32
S160	6	"5785935"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S161	8	"6475471"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 09:33
S162	53	"6103205"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:46
S163	0	pyrolysis with char with mercury with activated	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S164	17	pyrolysis with char with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:49
S165	121	pyrolysis with char with activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S166	0	pyrolysis with char with activated carbon with mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S167	43	pyrolysis with char with activated carbon and mercury with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 11:50
S168	118	pyrolysis with char with tire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 12:04
S169	58	pyrolysis with char with activated carbon and mercury	US-PGPUB; USPAT; USOCR;	ADJ	ON	2018/10/04 12:04

			FPRS; EPO; JPO			
S170	8	"20040081724"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 15:07
S171	4	"14128179"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/04 15:10
S172	84	activat$4 carbon with boiler with coal and remov$4 with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S173	88	activat$4 carbon with boiler with coal and (remov$4 or filter$4 or absorb$4 or adsorb$4) with mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 13:27
S174	0	mercury with stabiliz$4 with sulfer dioxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 14:23
S175	75	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/15 15:07
S176	6	"9468886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:48
S177	17	"8821819"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:51
S178	15	"8652235"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/16 06:55
S179	93	"6136749"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/24 09:08
S180	4	"9757689"	US-PGPUB; USPAT	ADJ	ON	2018/10/24 12:37
S181	9	"8939388"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 09:59

S182	669	urea with inject$4 with filter$4 with exhaust	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:15
S183	2	urea with inject$4 with filter$4 with exhaust and urea with quench$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:16
S184	13	"3615165"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:35
S185	136	urea with quench$4 with remov$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 10:39
S186	48	urea dust with scrub$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 11:25
S187	38	"6221155"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/10/29 12:04

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10

CONFIRMATION NO. 5161

21186
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

PUBLICATION NOTICE

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Title:SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Publication No.US-2018-0280870-A1
Publication Date:10/04/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

REMARKS

This responds to the Non-Final Office Action dated July 27, 2018.

No claims are presently amended. No claims are presently canceled, and no claims were canceled previously. No new claims are presently added. As a result, claims 1-20 are now pending in this application.

The Rejection of Claims Under §102

I. The Office Action rejected claims 1, 4-14, and 16-19 under 35 U.S.C. § 102(e) over U.S. patent publication no. 2004/0003716 ("Nelson").

This rejection is respectfully traversed.

Independent claim 1 recites in-flight promotion with a promoter that is Br_2, HBr, Br^-, or a combination thereof.

The Office Action states at page 2 that Nelson describes a promoted activated carbon that is promoted in-flight with at least one promoter that is Br_2, HBr, Br^-, or a combination thereof, citing to paragraphs [0048]-[0051] of Nelson. Paragraphs [0049]-[0051] describe treating activated carbon with bromine in a gaseous state or with a bromine-containing gas.

As explained in the present application, such as at page 20 at lines 11-17 and 22-28, "in-flight" promotion means that at the time of promotion the sorbent particles are dispersed in a steam of transport air or other gas that conveys the sorbent particles from one location to another in a mercury-removal system. The term "in-flight" promotion refers to the sorbent being promoted in-flight while being conveyed from one location to another in the mercury-removal system. However, the Office Action fails to show in Nelson, and Applicant cannot find in Nelson, a description or suggestion of the claimed feature of in-flight promotion of activated carbon sorbent, wherein at the time of promotion the sorbent is dispersed in a steam of transport air or other gas that conveys the sorbent particles from one location to another in a mercury-removal system. Accordingly, claim 1 is patentable over Nelson.

Dependent claims 4-14 and 16-19 are directly or indirectly dependent on independent claim 1. As such, claims 4-14 and 16-19 incorporate all the features of claim 1. Accordingly, dependent claims 4-14 and 16-19 are patentable for at least the same reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 1, 4-14, and 16-19 under 35 U.S.C. § 102(e) over Nelson.

The Rejection of Claims Under §103

II. The Office Action rejected claims 2-3 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent publication no. 2007/0168213 ("Comrie").

This rejection is respectfully traversed.

Independent claim 1 recites in-flight promotion with a promoter that is Br_2, HBr, Br^-, or a combination thereof. Claims 2 and 3 recite that the coal that is combusted comprises the promoter or a precursor thereof.

As explained herein at **II(A)**, Comrie is not prior art. As explained herein at **II(B)**, Nelson cannot be used to achieve the presently claimed invention. As explained herein at **II(C)**, the presently claimed invention has advantages that could not be predicted by a person of ordinary skill in the art before the invention was made. Further, as explained herein at **II(D)**, the next Office Action cannot be properly made final.

II(A). Comrie is not prior art.

Comrie was published July 19, 2007, and the earliest priority is to a provisional application filed January 19, 2006. In contrast, the present application is a continuation that derives priority from a provisional application filed August 30, 2004 and converted to a U.S. Utility application on August 22, 2005. The present application has priority that is one year and five months prior to Comrie's earliest priority date; even if only the first U.S. Utility application is considered for support, Comrie's earliest priority date is still about five months later. Comrie is not prior art and could not be considered by a person of ordinary skill in the art prior to the time the present invention was made and the present application filed.

II(B). Nelson cannot be used achieve the presently claimed invention.

Nelson mentions promoting activated carbon outside of flue gas, and then adding the activated carbon to flue gas.

No cited reference that is available as prior art to the present application describes or suggests combusting coal that includes Br_2, HBr, Br^- or a precursor thereof. Therefore, dependent claims 2-3 are patentable.

II(C). The presently claimed invention has advantages that could not be predicted by a person of ordinary skill in the art before the invention was made.

The inventors of the present application have discovered that by combusting coal that includes Br_2, HBr, Br^- or a precursor thereof, and by placing a sorbent in the mercury-containing gas, as presently claimed, the sorbent can be bromide-promoted in-flight in the mercury-containing gas. Promotion of the sorbent in the mercury-containing gas has certain advantages that would be impossible for a person of ordinary skill in the art hypothetically having the cited prior art references in-hand.

Applicant's continuation-in-part U.S. application no. 15/853,029, published as U.S. patent publication no. 2018/0133646, includes experimental data in Part II of the Examples that compares the performance of activated sorbents added to the flue gas and promoted in-flight in the mercury-containing gas by bromide promoters that are added to the combustor to the performance of activated sorbents that are promoted outside of the flue gas and then added to the flue gas. As shown in Table 1 and as explained in paragraphs [0116]-[0117], promotion of the activated carbon in-flight in the mercury containing gas yielded significantly improved mercury capture compared to the activated carbon that was promoted before adding to the mercury-containing gas.

The M.P.E.P. at the beginning of § 2143.02 states (emphasis added) "[a] rationale to support a conclusion that a claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, *and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.*" The only cited reference available as prior art is Nelson; there is no way to predict from Nelson the superior mercury capture discovered by the present inventors that occurs when activated carbon is promoted in-flight in the mercury-containing gas, as occurs when following claims 2-3. The presently claimed invention therefore has advantages that could not be predicted from the cited references by a person of

ordinary skill in the art before the invention was made, accordingly, independent claim 1 is patentable over the cited references.

Dependent claims 2-3 are directly or indirectly dependent on independent claim 1. As such, these claims incorporate all the features of claim 1. Accordingly, dependent claims 2-3 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 2-3 under 35 U.S.C. § 103(a) over Nelson in view of Comrie.

II(D). The next Office Action cannot be made final.

As explained herein in section **II**, claims 2-3 are patentable over the cited references. Applicant has not amended the claims and, as such, has not introduced any new features or limitations which would suffice under MPEP §706.07(a) to render any subsequent action on the merits final. If the PTO wishes to issue a further action in response to the remarks presented herein, Applicant respectfully submits that such action should be non-final.

III. The Office Action rejected claims 15 and 20 under 35 U.S.C. § 103(a) over U.S. patent publication no. 2004/0003716 ("Nelson") in view of U.S. patent no. 6,878,358 ("Vosteen").

This rejection is respectfully traversed.

As explained herein at **II(A)-II(C)**, claim 1 is patentable over Nelson. Vosteen fails to remedy the defects of Nelson; therefore, claim 1 is patentable over this combination of references.

Dependent claims 15 and 20 are dependent on independent claim 1. As such, these claims incorporate all the features of claim 1. Accordingly, dependent claims 15 and 20 are patentable for at least the reasons given herein for patentability of independent claim 1.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 15 and 20 under 35 U.S.C. § 103(a) over Nelson in view of Vosteen.

Double Patenting Rejection

IV. The Office Action rejected claims 1, 4-11, and 13-20 for nonstatutory double patenting over claims 1-3, 13, 22, and 26 of U.S. patent no. 7,435,286 ('286).

Applicant does not admit that claims 1, 4-11, and 13-20 are obvious in view of claims 1-3, 13, 22, and 26 of the '286.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

V. The Office Action rejected claims 2 and 3 for nonstatutory double patenting over claim 1 of U.S. patent no. 7,435,286 ('286) in view of U.S. patent publication no. 2007/0168213 ("Comrie").

This rejection is respectfully traversed. Applicant does not admit that claims 2 and 3 are obvious in view of the '286 in view of Comrie.

In the rejection, the Office Action derives the feature of combusting coal in the presence of a promoter from Comrie. However, as explained herein at **II(A)**, Comrie is not prior art, because the present application has priority that is one year and five months prior to Comrie's earliest priority date.

Applicant therefore respectfully requests reconsideration and withdrawal of the rejection of claims 2 and 3 for nonstatutory double patenting over claim 1 of the '286 in view of Comrie.

VI. The Office Action rejected claim 12 for nonstatutory double patenting over claim 1 of U.S. patent no. 7,435,286 ('286) in view of U.S. patent publication no. 2004/0003716 ("Nelson").

Applicant does not admit that claim 12 is obvious in view of the '286 in view of Nelson.

As the current pending claims stand rejected on other grounds and are still subject to amendment, Applicant takes note of these rejections but do not take further action at this time inasmuch as no pending claim has yet to be allowed. Applicant will re-evaluate this rejection, upon an indication of allowable claims.

CONCLUSION

It is respectfully submitted that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 349-9580 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402-0938
(612) 373-6900

Date August 14, 2018

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE CLAIMS

Please amend the claims as follows:

1. (Original) A method for reducing mercury in a mercury-containing gas, the method comprising:

injecting a sorbent into the mercury-containing gas;

collecting mercury in the mercury-containing gas on the sorbent to produce a cleaned gas, wherein the sorbent is a promoted activated carbon that is promoted in-flight with at least one promoter that is Br_2, HBr, Br^-, or a combination thereof, wherein the mercury-containing gas is a coal-combustion gas.

2. (Original) The method of claim 1, wherein the coal that is combusted comprises the promoter or a precursor thereof.

3. (Original) The method of claim 2, further comprising combusting the coal that comprises the promoter or the precursor thereof.

4. (Original) The method of claim 1, wherein the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor.

5. (Original) The method of claim 1, further comprising promoting the activated carbon in-flight.

6. (Original) The method of claim 1, wherein the promoted activated carbon comprises active sites, comprising halide anions bound to the activated carbon.

7. (Original) The method of claim 1, wherein the promoted activated carbon comprises active sites comprising carbocations bound to halide anions.

8. (Original) The method of claim 1, wherein collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

9. (Original) The method of claim 1, further comprising injecting an alkaline sorbent into the mercury-containing gas stream.

10. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

11. (Original) The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

12. (Original) The method of claim 1, wherein the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof.

13. (Original) The method of claim 1, wherein the promoter is HBr or Br^-.

14. (Original) The method of claim 1, wherein the mercury-containing gas is a flue gas stream downstream of a boiler furnace.

15. (Original) The method of claim 1, wherein monitoring the mercury content of the cleaned gas is performed substantially continuously.

16. (Original) The method of claim 1, wherein the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon.

17. (Original) The method of claim 1, further comprising injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon.

18. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas.

19. (Original) The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent.

20. (Original) The method of claim 1, wherein the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method further comprising:

monitoring the mercury content of the cleaned gas; and

controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al. Examiner: AMBER ROSE ORLANDO
Application No.: 15/997,091 Group Art Unit: 1776
Filed: June 4, 2018 Docket No.: 4820.001U10
Confirmation No.: 5161
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant has received the Non-Final Office Action dated July 27, 2018. Please enter the following.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Edwin S. Olson et al.
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	4820.001U10	Serial No.:	15/997,091
Filed:	June 4, 2018	Due Date:	October 27, 2018
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	5161

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X Amendment and Response under 37 C.F.R. § 1.111 (10 pgs.)

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer No.: 21186

By: /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

Electronic Acknowledgement Receipt

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Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Steven M. Reid/Megan Reed
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Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SIGNED_4820_001U10_NFOAResponse.pdf	148579 46c87bb32d795307587c7d86ab33c311c6832945	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	6	11
	Claims	3	5
	Amendment/Req. Reconsideration-After Non-Final Reject	2	2
	Transmittal Letter	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	148579	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/997,091	Filing Date 06/04/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	08/14/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	brenda murphy
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 07/27/2018
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MINNESOTA 55402
UNITED STATES OF AMERICA

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
07/27/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

SLW@blackhillsip.com
uspto@slwip.com

Office Action Summary	Application No. 15/997,091	Applicant(s) Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	AIA Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 06/04/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 06/04/2018 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim(s) 1, 4-14 and 16-19 is/are rejected under pre-AIA 35 U.S.C. 102(e) as being anticipated by Nelson US 2004/0003716.

For claim 1, the Nelson reference discloses a method for reducing mercury in a mercury-containing gas, the method comprising: injecting a sorbent into the mercury-containing gas (paragraph [0060]); collecting mercury in the mercury-containing gas on the sorbent to produce a cleaned gas (paragraph [0060]), wherein the sorbent is a promoted activated carbon that is promoted inflight with at least one promoter that is Br_2, HBr, Br^-, or a combination thereof, wherein the mercury-containing gas is a coal-combustion gas (paragraphs [0048]-[0051]).

For claim 4, the Nelson reference discloses the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor (paragraphs [0050] and [0051]).

For claim 5, the Nelson reference discloses promoting the activated carbon in-flight (paragraphs [0048]-[0051]).

For claim 6, the promoted sorbent as disclosed by Nelson above would include active sites, comprising halide anions bound to the activated carbon.

For claim 7, the promoted sorbent as disclosed by Nelson above would include active sites comprising carbocations bound to halide anions.

For claim 8, the sorbent being promoted and then contacted with the mercury containing gas and removed thereafter as disclosed by Nelson above is chemically and physically equivalent to the claimed collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

For claim 9, the Nelson reference injecting an alkaline sorbent into the mercury-containing gas stream (paragraph [0064]).

For claim 10, the Nelson reference discloses alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof (paragraph [0064]).

For claim 11, the Nelson reference discloses the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (paragraph [0064]).

For claim 12, the Nelson reference discloses the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof (paragraph [0040]).

For claim 13, the Nelson reference discloses the promoter is HBr or Br_2 (paragraphs [0048]-[0051]).

For claim 14, the Nelson reference discloses the mercury-containing gas is a flue gas stream downstream of a boiler furnace (fig. 2-6 and paragraph [0060]).

For claim 16, the Nelson reference discloses the sorbent material has a composition comprising from about 1 to about 30 grams of additive per 100 grams of activated carbon (paragraph [0054]).

For claim 17, the Nelson reference discloses injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon (paragraphs [0048]-[0051]).

For claims 18 and 19, the Nelson reference discloses collecting greater than 70 wt% of the mercury in the mercury-containing gas (paragraph [0084]).

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claim 2-3 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Nelson US 2004/0003716 as applied in claim 1 and further in view of Comrie US 2007/0168213.

For claim 2 the Nelson reference does not disclose the coal that is combusted comprises the promoter or a precursor thereof.

The Comrie reference discloses that the sorbent compositions can be added anywhere within the coal burning process, before, during or after (paragraph [0006]). This would include the promoter or a precursor there of.

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include either rearranging steps, or repeat steps to have the combusting coal in the presence of the additive and activated carbon and comprising mixing the additive and the coal before combusting the coal so as to entrap the contaminants in the mercury containing gas rather than release them to the atmosphere which would include the promoter or a precursor there of Nelson (Comrie paragraph [0006]). Further the courts have held that selection of any order of

performing process steps is prima facie obvious in the absence of new or unexpected results); In re Gibson, 39 F.2d 975, 5 USPQ 230.

For claim 3, the combination of Nelson and Comrie would include combusting the coal that comprises the promoter or the precursor thereof as both Nelson and Comrie disclose combusting the coal.

Claims 15 and 20 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Nelson US 2004/0003716 as applied in claim 1 and further in view of Vosteen et al. US 6,878,358.

For claim 15, the Nelson reference does not disclose monitoring the mercury content of the cleaned gas is performed substantially continuously.

The Vosteen reference discloses monitoring the mercury content of the cleaned gas is performed substantially continuously (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include monitoring the mercury content of the cleaned gas is performed substantially continuously (Vosteen column 5, lines 47-63) so as to allow for the maximum amount of mercury to be removed from the waste gas stream.

For claim 20, the Nelson reference discloses the method is a method for reducing mercury in the mercury-containing gas to a desired level (as shown above).

The Nelson reference does not disclose monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level.

The Vosteen reference discloses monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of

injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the Nelson reference to include monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level (Vosteen column 5, lines 47-63) so as to allow for the maximum amount of mercury to be removed from the waste gas stream.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application,

or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1- rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-3, 13, 22 and 26 of U.S. Patent No. 7,435,286 ('286).

Claim 1 of the current application corresponds to claim claims 1 of '286.

Claim 4 of the current application corresponds to claim claims 1 and 13 of '286.

Claim 5 of the current application corresponds to claim claims 1 and 13 of '286.

Claims 6-8 of the current application corresponds to claim claims 1 of '286.

Claim 9-11 of the current application corresponds to claim claims 1-3 of '286.

Claim 13 of the current application corresponds to claim claims 1 and 23 of '286.

Claim 14 of the current application corresponds to claim claims 1 of '286.

Claim 15 of the current application corresponds to claim claims 1 and 22 of '286.

Claim 16 of the current application corresponds to claim claims 1 and 26 of '286.

Claim 17 of the current application corresponds to claim claims 1 of '286.

Claims 18 and 19 of the current application corresponds to claim claims 1 of '286.

Claim 20 of the current application corresponds to claim claims 1 and 22 of '286.

Claims 2 and 3 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 of U.S. Patent No. 7,435,286 ('286) in view of Comrie US 2007/0168213.

The Comrie reference discloses that the sorbent compositions can be added anywhere within the coal burning process, before, during or after (paragraph [0006]). This would include the promoter or a precursor there of.

It would have been obvious to one having ordinary skill in the art before the invention was made to have modified the '286 reference to include either rearranging steps, or repeat steps to have the combusting coal in the presence of the additive and activated carbon and comprising mixing the additive and the coal before combusting the coal so as to entrap the contaminants in the mercury containing gas rather than release them to the atmosphere which would include the promoter or a precursor there of Nelson (Comrie paragraph [0006]). Further the courts have held that selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results); In re Gibson, 39 F.2d 975, 5 USPQ 230.

Claims 12 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 of U.S. Patent No. 7,435,286 ('286) in view of Nelson US 2004/0003716.

Claim 12 of the current application correspond to claim 1 of '286 except for '286 does not disclose the activated carbon is chosen from powdered activated carbon, granular activated carbon black, carbon fiber, aerogel carbon, pyrolysis char and combinations thereof.

The Nelson reference discloses the activated carbon is chosen from powdered activated carbon, granular activated carbon black, carbon fiber, aerogel carbon, pyrolysis char and combinations thereof (paragraph [0040]).

It would have been obvious to one having ordinary skill in the art before the claimed invention to have modified the '286 reference to include the activated carbon is chosen from powdered activated carbon, granular activated carbon black, carbon fiber, aerogel carbon, pyrolysis char and combinations thereof (Nelson paragraph [0040]) as the courts have held that since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin,* 125 USPQ 416.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ROSE ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Monday-Thursday 7:00-5:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571)272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer

Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AMBER ROSE. ORLANDO
Primary Examiner
Art Unit 1776

/AMBER R ORLANDO/
Primary Examiner, Art Unit 1776

Notice of References Cited	Application/Control No. 15/997,091	Applicant(s)/Patent Under Reexamination Olson et al.	
	Examiner AMBER R ORLANDO	Art Unit 1776	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-5569436-A	10-1996	Lerner; Bernard J.	B01D53/64	110/235
*	B	US-6136749-A	10-2000	Gadkaree; Kishor P.	B01D53/8665	502/180
*	C	US-20040003716-A1	01-2004	Nelson, Sidney G. JR.	B01D53/02	95/134
*	D	US-6818043-B1	11-2004	Chang; Ramsay	B01D53/64	423/213.2
*	E	US-6848374-B2	02-2005	Srinivasachar; Srivats	B01D53/10	110/165R
*	F	US-7435286-B2	10-2008	Olson; Edwin S.	B01D53/10	95/142
*	G	US-7514052-B2	04-2009	Lissianski; Vitali Victor	B01D53/56	423/210
*	H	US-20090320678-A1	12-2009	Chang; Ramsay	B01D46/002	95/92
*	I	US-7780765-B2	08-2010	Srinivasachar; Srivats	B01D53/10	110/203
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/997,091	Olson et al.
	Examiner	Art Unit
	AMBER R ORLANDO	1776

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Text Search (See east search history)	07/23/2018	AO
Inventor Search (DAV)	07/23/2018	AO

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/AMBER R ORLANDO/ Primary Examiner, Art Unit 1776	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	70	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 14:41
S1	45	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S2	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorben and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:19
S3	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2013/09/09 09:20
S7	73	("20020150516" | "4786483" | "5409522" | "5505766" | "6383981" | "6878358" | "20020033097" | "4530765" | "5346674" | "6080281" | "4708853" | "6027551" | "6136072" | "6258334" | "6818043" | "20060057044" | "20080207443" | "20010002387" | "3826618" | "4814152" | "4820318" | "4889698" | "5891324" | "6528030" | "20050227146" | "5419834" | "7942566" | "20080134888" | "3662523" | "3849267" | "4196173" | "4500327" | "6942840" | "20020134242" | "20030136509" | "20050147549" | "20060112823" | "20080134888" | "6471936" | "20010003116" | "20050019240" | "20060048646" | "4956162" | "5575982" | "6372187" | "6375909" | "7435286" | "7514052" | "20050074380" | "20090081092" | "5288306" | "1984164" | "4101631" | "5695726" | "6080281" | "6848374" | "20050000197" | "5300137" | "5607496" | "5672323" | "6214304" | "6953494" | "5245120" | "20070168213" | "7938571" | "20040003716" | "20040013589" | "3194629" | "3786619" | "5827352" | "20040109800" | "20070295347" | "5435980" | "6136749" | "20030206846").PN.	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:25
S8	13	"11209163"	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S9	3	"11209163" and non carbon	US-PGPUB; USPAT	ADJ	ON	2015/03/17 12:28
S10	161	(B01D53/64, B01D2257/602,	US-PGPUB;	ADJ	ON	2015/03/17

		B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	USPAT			13:49
S11	0	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and sorbent and promoter and activated carbond and mercury	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S12	116	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/03/17 13:50
S13	172	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S14	67	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2015/08/20 22:04
S15	67	"6136749"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:11
S16	20	"684374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S17	1	"20040003716"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S18	68	"6848374"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:12
S19	41	"7435286"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S20	13	"8168147"	US-PGPUB; USPAT	ADJ	ON	2016/05/27 09:13
S21	69	(95/134.ccls. or 95/142.ccls. or 110/345.ccls. or 423/210.ccls.) and activated carbon and promoter	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S22	181	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/06/07 09:06
S25	28	"5266280"	US-PGPUB; USPAT	ADJ	ON	2016/06/07 13:41
S26	281	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:01
S27	148	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 15:02
S28	159	sorbent with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2016/09/29 16:18

			IBM_TDB			
S29	206	(sorbent or activated carbon) with mercury and (diameter or size) with ("30" or "40" or "50" or "60" or "70") with (sorbent or carbon) and halogen$4 and activated carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/09/29 16:22
S30	195	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2016/09/30 13:48
S33	6	"20040003719"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:56
S34	49	"2004003716"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:57
S35	81	"6848374"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 10:58
S36	56	"7435286"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:02
S37	7	olson.in. and ("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:04
S38	0	("40" microns and halocarbon sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05
S39	0	(halocarbon sorbent).clm. and "40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:05

S40	65	"40" microns and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S41	3907	("40" microns).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S42	29	("40" microns and sorbent).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:06
S43	1	(halocarbon sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S44	36	(sorbent).clm. and olson.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S45	0	(sorbent).clm. and olson.in. and "40" micron	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:08
S46	17	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:09
S47	2	"20110233133"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:27
S48	7	"20110023427"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2016/11/16 11:28

			DERWENT; IBM_TDB			
S49	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:32
S50	11	"20040025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:32
S51	15	"2004025274"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S52	40	"6312489"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 11:33
S53	30	("20030024872" | "20050045553" | "20050144916" | "4008060" | "4640779" | "4655921" | "4673503" | "4738778" | "4746432" | "4799944" | "5043000" | "5051118" | "5120296" | "5174896" | "5320657" | "5512075" | "5674302" | "6152979" | "6312489" | "6315130" | "6336946" | "6398836" | "6585793" | "6598749" | "7648546").PN. OR ("7931723").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:36
S54	33	("4200444" | "4640779" | "5968215" | "6059851").PN. OR ("6312489").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:40
S55	5	"8518142"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:54
S56	4	"8747505"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 11:57
S57	2	"14318270"	US-PGPUB; USPAT; USOCR	ADJ	ON	2016/11/16 12:06
S58	13	pac with size with sorbent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2016/11/16 12:13
S59	197	(B01D53/64, B01D2257/602,	US-PGPUB;	ADJ	ON	2016/11/16

		B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	USPAT			15:23
S60	0	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent "4198388"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39
S61	10	"4198388"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 12:39
S62	0	"2010083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S63	2	"20100083696"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:32
S64	2	absorp$5 with mea with methanol with acid	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:36
S65	2	"20070283813"	US-PGPUB; USPAT	ADJ	ON	2016/11/17 13:39
S66	21	"4469596"	US-PGPUB; USPAT	ADJ	ON	2016/11/21 08:29
S67	4	"2003229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S68	2	"20030229245"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:36
S69	45	"5,338,458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S70	45	"5338458"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2017/05/10 10:38
S71	213	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:02
S72	64	("1786483" | "1984164" | "2317857" | "20010002387" | "20010003116" | "20020134242" | "20020150516" | "20030136509" | "20040003716" | "20040013589" | "20050019240" | "20060048646" | "20060191835" | "20090062119" | "20100047146" | "20120183458" | "20140056787" |	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:20

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S73	3	("20090235848" | "20110076210" | "20150246315").PN.	US-PGPUB; USPAT	ADJ	ON	2017/05/10 11:31
S79	3	("20090235848" | "20110076210" | "20140224121").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:36
S80	96	("1984164" | "2317857" | "20010002387" | "20010003116" | "20020043496" | "20020134242" | "20020150516" | "20030104937" | "20030136509" | "20040003716" | "20040013589" | "20040076570" | "20050019240" | "20060048646" | "20060191835" | "20080182747" | "20080292512" | "20090062119" | "20090136401" | "20090320678" | "20100047146" | "20110168018" | "20120183458" | "20130280156" | "20140056787" | "20140255279" | "20140308188" | "20150098878" | "3194629" | "3662523" | "3786619" | "3826618" | "3849267" | "3876393" | "4094777" | "4101631" | "4196173" | "4338896" | "4500327" | "4708853" | "4786483" | "4814152" | "4820318" | "4889698" | "4956162" | "5300137" | "5336835" | "5409522" | "5462908" | "5505766" | "5575982" | "5607496" | "5672323" | "5695726" | "5827352" | "5891324" | "6027551" | "6080281" | "6136072" | "6136749" | "6214304" | "6258334" | "6372187" | "6375909" | "6383981" | "6471936" | "6528030" | "6638485" | "6808692" | "6818043" | "6848374" | "6878358" | "6942840" | "6953494" | "6960329" | "7081434" | "7211707" | "7435286" | "7479263" | "7514052" | "7521032" | "7544338" | "7563311" | "7611564" | "7622092" | "7722843" | "7767174" | "7780765" | "8007749" | "8168147" | "8168149" | "8216535" | "8512655" | "8652235" | "8821819" | "9011805").PN.	US-PGPUB; USPAT	ADJ	ON	2017/06/27 09:41
S81	593	honeycomb with plug$4 and plug$4 with length	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S82	0	honeycomb with plug$4 and plug$4 with length with less than with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45
S83	0	honeycomb with plug$4 and plug$4 with length with less than	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:45

S84	127	honeycomb with plug$4 and plug$4 with length with "5"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:46
S85	241	honeycomb with plug$4 and plug$4 with length with mm	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:47
S86	41	honeycomb with plug$4 and plug$4 with length with "3 mm "	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:49
S87	28	honeycomb with plug$4 and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:52
S88	28	honeycomb and plug$4 with length with "3 mm " and plug$4 with porosity	US-PGPUB; USPAT	ADJ	ON	2017/06/27 14:53
S89	43	honeycomb and plug$4 with porosity with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:06
S90	20	honeycomb and plug$4 with pore (size or diameter) with "100"	US-PGPUB; USPAT	ADJ	ON	2017/06/27 15:07
S91	8	saw with honeycomb with filter	US-PGPUB; USPAT	ADJ	ON	2017/06/29 13:31
S92	230	(B01D53/64, B01D2257/602, B01D2253/104, B01D2253/10, B01D53/10).cpc. and (halogen or halide of HBr) with sorbent	US-PGPUB; USPAT	ADJ	ON	2017/12/01 14:36
S93	2	"20060260468"	US-PGPUB; USPAT	ADJ	ON	2018/07/03 10:34
S94	19	engine with air with inlet with filter$4 with cone	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:26
S95	36	engine with air with inlet with filter$4 with (cone or conical or (diameter with (increas$4 or decreas$4)))	US-PGPUB; USPAT	ADJ	ON	2018/07/03 15:27
S96	24	("3771638" | "3870495" | "3872012" | "4157902" | "4702754" | "5125940" | "5522909" | "5549724" | "5632793").PN. OR ("5888260").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S97	41	("0153535" | "0439091" | "1398685" | "1530163" | "1887052" | "2087688" | "4003836" | "4018580" | "4032455" | "4039308" | "4065276" | "4261710" | "4410341" | "4414110" | "4699715" | "5106397" | "5178656" | "5522909" | "5549722" | "5549724" | "5888260" | "6397842" | "6508052" | "D401597" | "D401942" | "D403414" | "D403416").PN. OR ("6808552").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2018/07/03 15:31
S98	15	("D403416").URPN.	USPAT	ADJ	ON	2018/07/03 15:33
S99	0	"20030089233"	USPAT	ADJ	ON	2018/07/04 12:29
S100	3	"20030089233"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S101	26	"6833023"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/04 12:29
S102	2	"20070168213"	US-PGPUB;	ADJ	ON	2018/07/09

			USPAT; USOCR; FPRS; EPO; JPO			13:08
S103	14	carbocations with sorbent with bromine	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:14
S104	0	a side forming a cross sectional shape of each of the first	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:47
S105	0	non of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S106	0	none of side forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S107	0	none of sides forming	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/09 13:56
S109	13	olson.in. and (alkali and promoter and earth).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S110	0	olson.in. and (alkali and promoter and earth with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S111	10	olson.in. and (alkali and promoter with vapor).clm.	US-PGPUB; USPAT	ADJ	ON	2018/07/17 16:22
S112	0	"2015008283"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S113	2	"20150082833"	US-PGPUB; USPAT	ADJ	ON	2018/07/23 06:26
S114	24	olson.in. and liquid.clm. and promoted	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:50
S115	75	remov$4 with mercury and (br or bromine) with liquid with carbon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 07:54
S116	0	separating greater than "70" wt% of the mercury	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17
S117	0	((separating greater) with (of the mercury)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:17

S118	20	"11209163"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO	ADJ	ON	2018/07/23 09:43

7/ 23/ 2018 2:56:48 PM
C:\ Users\ amillerharris\ Documents\ EAST\ Workspaces\ 12429058.wsp

Bibliographic Data

Application No: 15/997,091

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /AMBER R ORLANDO/ Examiner's Signature | Initials

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/04/2018	423	1776	
RULE			

APPLICANTS

Midwest Energy Emissions Corp, Lewis Center, OH,

INVENTORS

Edwin S. Olson Grand Forks, ND, UNITED STATES

Michael J. Holmes Thompson, ND, UNITED STATES

John H. Pavlish East Grand Forks, MN, UNITED STATES

CONTINUING DATA

This application is a CON of 15974343 05/08/2018

15974343 is a CON of 15951970 04/12/2018

15951970 is a CON of 14712558 05/14/2015

14712558 is a CON of 14318270 06/27/2014 PAT 9757689

14318270 is a CON of 13966768 08/14/2013 PAT 8821819

13966768 is a CON of 13427665 03/22/2012 PAT 8512655

13427665 is a CON of 12419219 04/06/2009 PAT 8168147

12419219 is a CON of 12201595 08/29/2008

12201595 is a CON of 11209163 08/22/2005 PAT 7435286

11209163 has PRO of 60605640 08/30/2004

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/21/2018

STATE OR COUNTRY

UNITED STATES

ADDRESS

FILING FEE RECEIVED

$5,860

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/997,091	06/04/2018	Edwin S. Olson	4820.001US10	5161

21186 7590 07/12/2018
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402
UNITED STATES OF AMERICA

EXAMINER
ORLANDO, AMBER ROSE

ART UNIT	PAPER NUMBER
1776	

NOTIFICATION DATE	DELIVERY MODE
07/12/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

uspto@slwip.com
SLW@blackhillsip.com

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Doc Code:
TRACK1.GRANT

Decision Granting Request for Prioritized Examination (Track I or After RCE)	Application No.:15/997,091

1. THE REQUEST FILED June 4, 2018 IS **GRANTED.**

The above-identified application has met the requirements for prioritized examination
A. ☒ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination.** The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;
B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims**, or a multiple dependent claim;
C. filing a **request for continued examination**;
D. filing a notice of appeal;
E. filing a request for suspension of action;
F. mailing of a notice of allowance;
G. mailing of a final Office action;
H. completion of examination as defined in 37 CFR 41.102; or
I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to Kimberly Inabinet at 571-272-4618.

/Kimberly Inabinet/ Paralegal Specialist, Office of Petitions

Office of Petitions: Routing Sheet



Application No. 15997091

This application is being forwarded to your office for further processing. A decision has been rendered on a petition filed in this application, as indicated below. For details of this decision, please see the document PET.OP.DEC filed on the same date as this document.

- [X] **GRANTED**
- [ ] **DISMISSED**
- [ ] **DENIED**

Office of Petitions: Decision Count Sheet

Mailing Month: 7

Application No.: 15997091

15997091

For US serial numbers: enter number only, no slashes or commas. Ex: 10123456
For PCT: enter "51+single digit of year of filing+last 5 numbers", Ex. for PCT/US05/12345, enter 51512345

Deciding Official: Kimberly Inabinet

Count (1) - Palm Credit 15997091

Decision: GRANT

FINANCE WORK NEEDED
☐ Select Check Box for YES

GRANT

Decision Type: 643 - Track One request

643

Notes:

Count (2)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Count (3)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Initials of Approving Official (if required)

If more than 3 decisions, attach 2nd count sheet & mark this box ☐

Printed on: 7/9/2018

Office of Petitions Internal Document - Ver. 5.0

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/997,091	06/04/2018	1736	1720	4820.001US10	20	1

CONFIRMATION NO. 5161

21186
SCHWEGMAN LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

FILING RECEIPT



Date Mailed: 06/26/2018

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Edwin S. Olson, Grand Forks, ND;
Michael J. Holmes, Thompson, ND;
John H. Pavlish, East Grand Forks, MN;

Applicant(s)

Midwest Energy Emissions Corp, Lewis Center, OH;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 15/974,343 05/08/2018
which is a CON of 15/951,970 04/12/2018
which is a CON of 14/712,558 05/14/2015
which is a CON of 14/318,270 06/27/2014 PAT 9757689
which is a CON of 13/966,768 08/14/2013 PAT 8821819
which is a CON of 13/427,665 03/22/2012 PAT 8512655
which is a CON of 12/419,219 04/06/2009 PAT 8168147
which is a CON of 12/201,595 08/29/2008 ABN
which is a CON of 11/209,163 08/22/2005 PAT 7435286
which claims benefit of 60/605,640 08/30/2004

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/21/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/997,091**

Projected Publication Date: 10/04/2018

Non-Publication Request: No

Early Publication Request: No

Title

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Preliminary Class

423

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor

community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/997,091

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors: Edwin S. Olson et al.

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Attorney Docket No.: 4820.001US10

Customer No.: 21186

PATENT APPLICATION TRANSMITTAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items and information (as indicated with an "X"):

X **CONTINUATION under 37 CFR 1.53(b) of prior Patent Application No. 15/974,343 comprising:**

- X Application Data Sheet (8 pgs).
- X Copy of signed Declaration from prior application (3 pgs).
- X Specification (61 pgs, including claims numbered 1 through 20 and a 1 page Abstract).
- X Formal Drawings (11 sheets).
- X Certification and Request for Prioritized Examination (Track 1) (1 pg), including authorization to charge Deposit Account 19-0743 in the amount of $4000.00 for the Prioritized Examination (Track 1) filing fee as set forth in 37 C.F.R. § 1.17(c); and Authorization to charge Deposit Account 19-0743 for the Processing Fee (Track 1) set forth in 37 C.F.R. § 1.17(i) in the amount of $140.00.
- X **Authorization to charge Deposit Account 19-0743 in the amount of $5,860.00**

The filing fee has been calculated below as follows:

	No. Filed	No. Extra	Rate	Fee
TOTAL CLAIMS	20 - 20	0	x $100.00 =	$0.00
INDEPENDENT CLAIMS	1 - 3	0	x $460.00 =	$0.00
[]MULTIPLE DEPENDENT CLAIMS PRESENTED				$0.00
BASIC FEE				$300.00
SEARCH FEE				$660.00
EXAMINATION FEE				$760.00
PRIORITIZED EXAMINATION (TRACK 1) FILING FEE				$4,000.00
PROCESSING FEE (TRACK 1)				$140.00
	No. of pages (75% for e-filing)	Extra sets of 50 pages	Rate	
APPLICATION SIZE FEE	(54 - 100) / 50	0	$400.00	$0.00
TOTAL				$5,860.00

Please charge any additional required fees or credit overpayment to Deposit Account No. 19-0743. If applicable, any papers or fees supplied herewith are considered to be timely filed pursuant to 37 C.F.R. § 1.7(a), the response period falling on a Federal Holiday, Saturday or Sunday being extended to the next succeeding business day.

SCHWEGMAN LUNDBERG & WOESSNER, P.A.
Customer Number: 21186

By /Nicholas P. Lanzatella/
Nicholas P. Lanzatella
Reg. No. 63,803

Date of Deposit: June 4, 2018
This paper or fee is being filed on the date indicated above using the USPTO's electronic filing system EFS-Web, and is addressed to The Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ **Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)**

Inventor Information:

Inventor 1: Edwin S. Olson

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Edwin	S.	Olson	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service

City	Grand Forks	State/Province	ND	Country of Residence	United States of America

Mailing Address of Inventor:

Address 1	223 Circle Hills Drive		
Address 2			
City	Grand Forks	State/Province	ND
Postal Code	58201	Country	United States of America

Inventor 2: Michael J. Holmes

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Michael	J.	Holmes	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service

City	Thompson	State/Province	ND	Country of Residence	United States of America

Mailing Address of Inventor:

Address 1	614 6th Avenue Northeast		
Address 2			
City	Thompson	State/Province	ND
Postal Code	58278	Country	United States of America

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Inventor 3: John H. Pavlish

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	John	H.	Pavlish	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service

City	East Grand Forks	State/Province	MN	Country of Residence	United States of America

Mailing Address of Inventor:

Address 1	42204 210th Street SW		
Address 2			
City	East Grand Forks	State/Province	MN
Postal Code	56721	Country	United States of America

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence information of this application.

Customer Number	21186
Email Address	request@slwip.com

Application Information:

Title of the Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		
Attorney Docket Number	4820.001US10	Small Entity Status Claimed	☐
Application Type	Non-Provisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	11	Suggested Figure for Publication (if any)	

Modified PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country Publication

Publication Information:

☐ **Request Early Publication (Fee required at time of Request 37 CFR 1.219)**

☐ **Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.**

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	21186		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
This application	continuation of	15/974,343	2018-05-08
Prior Application Status	Pending		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
15/974,343	continuation of	15/951,970	2018-04-12
Prior Application Status	Pending		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
15/951,970	continuation of	14/712,558	2015-05-14
Prior Application Status	Patented		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
14/712,558	continuation of	14/318,270	2014-06-27
Prior Application Status	Patented		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
14/318,270	continuation of	13/966,768	2013-08-14
Prior Application Status	Patented		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
13/966,768	continuation of	13/427,665	2012-03-22
Prior Application Status	Patented		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
13/427,665	continuation of	12/419,219	2009-04-06

Modified PTO/AIA/14 (12-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Prior Application Status	Abandoned		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
12/419,219	continuation of	12/201,595	2008-08-29
Prior Application Status	Patented		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
12/201,595	division of	11/209,163	2005-08-22
Prior Application Status	Expired		
Application Number	**Continuity Type**	**Prior Application Number**	**Filing or 371(c) Date (YYYY-MM-DD)**
11/209,163	Claims benefit of provisional	60/605,640	2004-08-30

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)i the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the POX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country	Parent Filing Date (YYYY-MM-DD)	Access Code (if applicable)

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant must opt-out of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is ONLY reviewed and processed with the INITIAL filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby grants the USPTO authority to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ **A. Applicant DOES NOT authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.**

☐ **B. Applicant DOES NOT authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.**

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant: Midwest Energy Emissions Corp

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor
☐ Person to whom the inventor is obligated to assign	☐ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

☐ Deceased	☐ Legally incapacitated

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here: ☒

Organization Name: Midwest Energy Emissions Corp

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information:

Address 1	670 D Enterprise Dr		
Address 2			
City	Lewis Center	State/Province	OH
Country	United States of America	Postal Code	43035
Phone Number			
Email Address			

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4820.001US10
	Application Number	Unknown
Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	

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This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Nicholas M. Lanzatella/			Date (YYYY-MM-DD)	2018-06-04
First Name	Nicholas	Last Name	Lanzatella	Registration Number	63,803

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-14**

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 13/966,758, filed on August 14, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Edwin S. Olson Date (Optional):

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 13/956,768, filed on August 14, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Michael J. Holmes Date (Optional): Oct. 22, 2013

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 13/866,768, filed on August 16, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: John Henry Pavlish Date (Optional):

Signature: John Pavlish

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/02 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e)

(Page 1 of 1)

First Named Inventor:	Edwin S. Olson	Nonprovisional Application Number (if known):	Unknown
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	Docket No.:	4820.001US10

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. **Original Application(Track One) – Prioritized Examination under § 1.102(e)(1)**

   i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

   ---OR---

   (b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

   ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, or the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

Signature: /Nicholas P. Lanzatella/	Date: June 4, 2018
Name: (Print/Typed) Nicholas P. Lanzatella	Practitioner: Registration Number: 63,803

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

*Total of 1 forms are submitted.

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Patent Application Serial No. 15/974,343, filed May 8, 2018, which is a continuation of U.S. Patent Application Serial No. 15/951,970, filed April 12, 2018, which is a continuation of U.S. Patent Application Serial No. 14/712,558, filed May 14, 2015, which is a continuation of U.S. Patent Application Serial No. 14/318,270, filed June 27, 2014, which is a continuation of U.S. Patent Application Serial No. 13/966,768, filed August 14, 2013, issued as U.S. Patent No. 8,821,819, which is a continuation of U.S. Patent Application Serial No. 13/427,665, filed March 22, 2012, issued as U.S. Patent No. 8,512,655, which is a continuation of U.S. Patent Application Serial No. 12/419,219, filed April 06, 2009, issued as U.S. Patent No. 8,168,147, which is a continuation of U.S. Patent Application Serial No. 12/201,595, filed August 29, 2008, which is a division of U.S. Patent Application Serial No. 11/209,163, filed August 22, 2005, issued as U.S. Patent No. 7,435,286, which application claims the benefit under 35 U.S.C. § 119 (e) of U.S. Provisional Patent Application No. 60/605,640 filed Aug. 30, 2004, the disclosure of which is hereby incorporated by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with United States Government support under Grant Numbers R 827649-01 and CR 830929-01 awarded by the United States Environmental Protection Agency and under Contract Number DE-FC26-98FT40320 awarded by the United States Department of Energy. The United States Government has certain rights in this invention.

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

The present invention relates to methods and materials for the removal of pollutants from flue gas or product gas from a gasification system. In particular, mercury is removed from gas streams generated during the burning or gasification of fossil fuels by highly reactive regenerable sorbents.

2. Background of the Invention

The combustion and gasification of fossil fuel such as coal generates flue gas that contains mercury and other trace elements that originate from the fuel. The release of the mercury (and other pollutants) to the environment must be controlled by use of sorbents, scrubbers, filters, precipitators, and other removal technologies. Mercury is initially present in the elemental form during combustion and gasification. In downstream process sections, such as in the ducts and stack of a combustion system, some of the elemental mercury is oxidized. The amount that is oxidized depends on the amount of acid gases present in the flue gas and other factors. Amounts of mercury vary with the fuel, but concentrations of mercury in the stream of flue gas from coal combustion are typically less than 5 parts per billion (ppb). Large coal combustion facilities such as electric utilities may emit a pound of mercury, or more, per day. Mercury removal applications include, without limitation, flue gas from coal (or other fossil fuel) combustion, waste incineration, product gas from gasification, as well as off gases from mineral processing, metal refining, retorting, cement manufacturing, chloralkali plants, dental facilities, and crematories.

Mercury Sorbent Technologies

Several types of mercury control methods for flue gas have been investigated, including injection of fine sorbent particles into a flue gas duct and passing the flue gas through a sorbent bed. Fine-particle injection sorbents include activated carbon, metal oxide sorbent, sodium sulfide particles, and basic silicate or oxide sorbents. When particle injection is employed, the mercury captured on the sorbent particles is removed from the gas stream in a bag house or electrostatic precipitator (ESP) and collected along with ash particulate. The sulfide and basic

silicate and oxide particles are effective only for the oxidized mercury, and the metal oxide sorbents exhibit slower capture kinetics than the carbon particles. Additionally, injection of fine carbon particles into the flue gas stream has been only partially successful in removing mercury, especially elemental mercury, where effective removal of only about 60% is attained for some applications with a FF (fabric filter) to collect carbon and ash. Even lower removal rates have been observed when using an ESP to collect the carbon because the contact time of the carbon with the gas is very short.

A major problem with existing carbon injection systems is that the sorbent is initially unreactive, and only after extended exposure to the flue gas does the sorbent become effectively seasoned and provide increased reactivity with the mercury in the gas. Consequently, these sorbents must be used in large amounts, at high sorbent-to-mercury ratios, to effectively capture the mercury. These sorbents tend to be relatively expensive and cannot be easily separated from the ash for regeneration and reuse. The collection of carbon in the ash also creates solid waste disposal problems, and the spent sorbent may contaminate the collected ash, preventing its use in various applications.

Accordingly, there remains a need for more economical and effective mercury removal technology. This invention provides for cost-effective removal of pollutants including mercury, using sorbent enhancement additives and/or highly reactive sorbents, with contact times of seconds (or less), and that may be regenerated and reused.

SUMMARY OF THE INVENTION

It is thus an object of the present invention to overcome the deficiencies of the prior art and thereby to provide new and economical methods for the removal of mercury from the gases produced in the utilization of fossil fuels.

A halogen/halide promoted activated carbon sorbent is described that is highly effective for the removal of mercury from flue gas streams. The sorbent comprises a new halide-modified carbon form containing a reactive compound produced by the reaction of bromine (or halide or other halogen) with the carbon.

Optional secondary components and alkali may be added to further increase reactivity and mercury capacity. Mercury removal efficiencies obtained exceed or match conventional methods with added benefits such as reduced costs. Optionally, the sorbent can be regenerated and reused. Sorbent treatment and/or preparation methods are also described. New methods for in-flight preparation, introduction, and control of the active sorbent into the mercury contaminated gas stream are described.

In some embodiments, a promoted carbon sorbent is provided comprising a base activated carbon that has reacted with a promoter selected from the group consisting of halides, halogens, and combinations thereof, such that the reaction product is effective for the removal of mercury from a gas stream.

In an embodiment, a promoted carbon sorbent is provided wherein the base activated carbon is selected from the group consisting of powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, activated carbon with an average particle size greater than that of flyash produced such that it is physically separable therefrom, and combinations thereof, and the promoter is selected from the group consisting of molecular halogens, Group V (CAS nomenclature is used throughout) halides, Group VI halides, hydrohalides, and combinations thereof. In an embodiment, the base activated carbon may have an mass mean particle diameter such that it can be substantially separated by physical means from entrained ash in the gas stream from which mercury is to be removed. In an embodiment, the base activated carbon may have a mass mean particle diameter greater than about 40 micrometers.

In another embodiment, the sorbent comprises from about 1 to about 30 grams promoter per 100 grams of base activated carbon. Another embodiment further comprises an optional secondary component comprising a halogen or a hydrohalide such that the reactivity and mercury capacity of the sorbent are enhanced.

In another embodiment, the concentration of the optional secondary component on the finished sorbent is within the range of from about 1 to about 15 wt-% of the concentration of the promoter on the finished sorbent.

In another embodiment, an optional alkali component may preferably be added to provide a synergistic effect through combination of this alkali with the primary sorbent.

In another embodiment, the optional secondary component is selected from the group consisting of Group V halides, Group VI halides, HI, HBr, HCl, and combinations thereof. In another embodiment, the promoter is substantially in vapor form when combined with the base activated carbon. In another embodiment, the promoter is combined with an organic solvent prior to reaction with the base activated carbon. In another embodiment, the promoter and optional secondary component are combined with the base activated carbon substantially simultaneously. Another embodiment further comprises adding a mercury-stabilizing reagent selected from the group consisting of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, and combinations thereof. Another embodiment further comprises adding an optional alkali component.

In an embodiment, a method is provided comprising providing a granular activated carbon; reacting the activated carbon with a promoter selected from the group consisting of halogens, halides, and combinations thereof, such that the reaction product comprises a promoted carbon sorbent effective for removal of mercury from a gas stream. In a further embodiment, the reaction product comprises from about 1 to about 30 grams promoter per 100 grams activated carbon. In another embodiment the reaction product has an average particle size distribution greater than the average size of entrained ash particles in the gas stream from which mercury is to be removed, such that the reaction product can be substantially removed from the entrained ash particles by physical means. In another embodiment the reaction product has a mass mean particle diameter greater than about 40 micrometers.

In another embodiment, the promoter is selected from the group consisting of molecular halogens, hydrohalides, Group V halides, Group VI halides, and combinations thereof. In another embodiment the promoter is in the gas phase when contacting the activated carbon. In another embodiment, the promoter is in an organic solvent when contacting the activated carbon.

In another embodiment, the promoter is selected from the group consisting of Br_2, a Group V bromide, a Group VI bromide, and combinations thereof.

In another embodiment, the method further comprises reacting the granular activated carbon with an optional secondary component comprising a halogen or a hydrohalide such that the reactivity and mercury capacity of the sorbent are enhanced. In another embodiment, the promoter and optional secondary component are contacted simultaneously with the activated carbon. In another embodiment the method further comprises adding a mercury-stabilizing reagent selected from the group consisting of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, and combinations thereof. In an embodiment, a method is provided for control of mercury in a flue gas with substantially lower sorbent requirements. Through enhanced sorbent reactivity, mercury removal per gram of sorbent is increase, thereby decreasing the capital and operating costs by decreasing sorbent requirements.

In an embodiment, a method is provided for reducing mercury in flue gas comprising providing a sorbent, injecting the sorbent into a mercury-containing flue gas stream, collecting greater than 70 wt-% of the mercury in the flue gas on the sorbent to produce a cleaned flue gas, and substantially recovering the sorbent from the cleaned flue gas. In embodiments where less than 70 wt-% mercury removal is desired, the required removal may preferably be attained using less than half as much carbon as would be required with standard (non-enhanced) carbon. In a further embodiment, the method further comprises monitoring the mercury content of the clean flue gas, regenerating the recovered sorbent, and using the monitored mercury content of the cleaned flue gas to control the rate of injection of the sorbent. In another embodiment the injected sorbent is prepared in-flight by reacting an activated carbon and a promoter within a pneumatic transport line from which the reaction product is injected to the mercury-containing flue gas stream.

In another embodiment, the promoter is selected from the group consisting of molecular halogens, halides, and combinations thereof. In another embodiment, the promoter is reacted in the gas phase or as a vapor. In another embodiment, the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon.

In another embodiment, the injected sorbent is prepared in-flight by reacting an activated carbon, a promoter, and an optional secondary component to enhance the reactivity and capacity of the sorbent within a pneumatic transport line from which the reaction product is injected to the mercury-containing flue gas stream.

In another embodiment, the optional secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof. In another embodiment, the optional secondary component is added at from about 1 to about 15 wt% of the promoter content. In another embodiment, the method further comprises adding to the sorbent a mercury-stabilizing reagent selected from the group consisting of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, and combinations thereof.

In an embodiment, the method further comprises co-injecting an optional alkaline material, including without limitation alkaline and alkaline earth components, to improve the efficiency of mercury capture by capturing oxidized mercury and/or capturing gaseous components that might otherwise reduce sorbent capacity. In another embodiment, the optional alkaline material may preferably comprise calcium oxide, sodium carbonate, and the like, as are known in the art.

In another embodiment, the method further comprises using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent. In another embodiment, the injected sorbent is prepared in-flight by reacting an activated carbon and a promoter within a pneumatic transport line from which the reaction product is injected to the mercury-containing flue gas stream, wherein the promoter is selected from the group consisting of molecular halogens, halides, and combinations thereof, wherein the promoter is reacted in the gas phase or as a vapor, wherein the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon, wherein the rate at which the promoter is added and the rate of sorbent injection are determined by a digital computer based at least in part on the monitored mercury content of the cleaned flue gas.

In an embodiment, a method for reducing the mercury content of a mercury and ash containing gas stream is provided wherein particulate activated carbon sorbent with a mass mean size greater than 40 μm is injected into the gas stream,

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mercury is removed from the gas by the sorbent particles, the sorbent particles are separated from the ash particles on the basis of size, and the sorbent particles are re-injected to the gas stream. In another embodiment, the mercury-containing sorbent particles are regenerated to remove some or substantially all of the mercury. In another embodiment, an alkaline component is co-injected into the gas stream. In another embodiment, the sorbent may further comprise a promoter. The promoter may preferably comprise a halide, a halogen, or both.

As will be described in more detail below, the present invention thus provides several advantages over previously known techniques, including significantly more effective and economical mercury sorbents for effluent gases, advantageously applicable to treating gas streams from fired equipment and gasification systems.

The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter that form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiments disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more detailed description of the preferred embodiments of the present invention, reference will now be made to the accompanying drawings.

FIG. 1 schematically illustrates methods for preparation of promoted carbon sorbents in accordance with the present invention.

FIG. 2 illustrates a proposed mechanistic model of the chemical reactions resulting in the oxidation and capture of mercury.

FIG. 3 schematically illustrates preparation of promoted carbon sorbents and processes for flue gas mercury reduction in flue gases and/or product gases from a gasification system in accordance with the present invention, including in-flight preparation of promoted carbon sorbent.

FIG. 4 is a diagram illustrating breakthrough curves for 5 wt/wt % brominated NORIT Darco FGD sorbent (37 mg+113 mg sand) in low-HCl (1 ppm) synthetic flue gas.

FIG. 5 is a diagram illustrating breakthrough curves for non-halogenated NORIT Darco FGD sorbent (37 mg+113 mg sand) in low-HCl (1 ppm) synthetic flue gas.

FIG. 6 is a bar chart illustrating pilot-scale mercury removal results, including large-size sorbent results.

FIG. 7 is a diagram illustrating the effects of sorbent size and injection rate on mercury removal for ESPs and fabric filters.

FIG. 8 is a diagram illustrating the breakthrough curves for a brominated NORIT Darco FGD sorbent with inert sand.

FIG. 9 is a diagram illustrating the breakthrough curves for brominated NORIT Darco FGD sorbent with a co-injected alkali material.

FIG. 10 is a plot of mercury removal vs. carbon injection rate with and without co-injection of alkali material.

FIG. 11 is a block diagram illustrating the use of the invention in a coal fueled facility.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Herein will be described in detail specific preferred embodiments of the present invention, with the understanding that the present disclosure is to be considered an exemplification of the principles of the invention, and is not intended to limit the invention to that illustrated and described herein. The present invention is susceptible to preferred embodiments of different forms or order and should not be interpreted to be limited to the specifically expressed methods or compositions contained herein. In particular, various preferred embodiments of the present

invention provide a number of different configurations and applications of the inventive method, compositions, and their uses.

The present invention provides a cost-effective way to capture pollutants by utilizing exceptionally reactive halogen/halide promoted carbon sorbents using a bromide (or other halogen/halide) treatment of the carbon, that capture mercury via mercury-sorbent surface reactions, at very short contact times of seconds or less. The sorbent does not require in situ activation (no induction period) in the gas stream to achieve high reactivity, as do conventional activated carbon sorbents. The reactivity of the sorbent toward the pollutants is greatly enhanced and the sorption capacity can be regenerated, the promoted sorbent may be regenerated, recycled and/or reused.

The treated carbons, treatment techniques, and optional additives discussed herein have applicability to mercury control from the product or effluent gas or gases from gasification systems, syngas generators, and other mercury-containing gas streams, in addition to the flue gas from combustion systems. Thus, it should be understood that the terms combustion system and flue gas as used throughout this description may apply equally to gasification systems and syngas or fuel gas, as will be understood by those skilled in the art.

Referring now to FIG. 1, there is shown a block flow diagram illustrating some preferred embodiments of the process of the present invention to prepare promoted sorbents useful for mercury capture from flue gas and/or product gas form a gasification system streams. In a preferred embodiment illustrated by path 10-20, block 10 illustrates providing a base activated carbon, and adding a halogen or halide promoter that reacts with the carbon, illustrated at block 20, to produce a product promoted carbon sorbent. In embodiments where the halogen or halide is added, for example, as a vapor, no further steps may be necessary. In embodiments where the halogen or halide is added in, for example, a solvent, it may be desirable to employ solvent removal as illustrated by block 20A.

Referring still to FIG. 1, another preferred embodiment of the process of the present invention is illustrated by path 10-20-30, comprising providing a base activated carbon as shown by block 10, adding a halogen or halide promoter that

reacts with the carbon, illustrated at block 20, and adding a secondary component illustrated at block 30 that reacts with the result of block 20 to produce a product promoted carbon sorbent. In embodiments where both the halogen or halide promoter and the secondary component are added, for example, as a vapor, no further steps may be necessary. In embodiments where the halogen or halide promoter and/or secondary component are added in, for example, a solvent, it may be desirable to employ solvent removal as illustrated by block 30A.

Referring still to FIG. 1, another preferred embodiment of the process of the present invention is illustrated by path 10-40, comprising providing a base activated carbon as illustrated at block 10, and adding a halogen or halide promoter and a secondary component to the activated carbon together, with which they react as illustrated by block 40, producing a product promoted carbon sorbent. As above, in embodiments where vapor additions are made to the activated carbon no further steps may be desired. In embodiments where one or more components are added in solvent, a solvent removal step may be provided as illustrated by block 40A.

Referring still to FIG. 1, also illustrated are preferred embodiments in which, as illustrated by block 50, a flue gas stream is treated with product promoted carbon sorbent prepared as described above.

In some preferred embodiments the activated carbon provided may preferably be any of several types, as understood by those skilled in the art. For example, the activated carbon may include powdered activated carbon, granular activated carbon, carbon black, carbon fiber, carbon honeycomb or plate structure, aerogel carbon film, pyrolysis char, regenerated activated carbon from product promoted carbon sorbent, or other types as known in the art.

In some preferred embodiments the activated carbon provided may preferably be any of several types, as understood by those skilled in the art. For example, the activated carbon may include powdered activated carbon, granular activated carbon, carbon black, carbon fiber, carbon honeycomb or plate structure, aerogel carbon film, pyrolysis char, an activated carbon or regenerated activated carbon with a mass mean particle size greater than fly ash in a flue gas stream to be treated.

In some preferred embodiments the activated carbon provided may preferably be any of several types, as understood by those skilled in the art. For example, the activated carbon may include powdered activated carbon, granular activated carbon, carbon black, carbon fiber, carbon honeycomb or plate structure, aerogel carbon film, pyrolysis char, an activated carbon or regenerated activated carbon with a mass mean particle diameter preferably greater than 40 micrometers, more preferably greater than 60 micrometers, or a particle size distribution greater than that of the fly ash or entrained ash in a flue gas stream to be treated, such that the activated carbon and ash can be separated by physical means.

In some preferred embodiments, the halogen or halide promoter that is added to, and reacts with, the base activated carbon may preferably comprise, by way of illustration and not limitation, a molecular halogen in vapor or gaseous form, a molecular halogen in an organic solvent, a Group V or Group VI halide, such as PBr_3 or SCl_2, respectively, in vapor, liquid, or solution form (though not in an aqueous solvent).

Embodiments are also provided in which the organic solvent may preferably comprise a chlorinated hydrocarbon, such as dichloromethane, a hydrocarbon solvent, including for example, petroleum ether, ligroin, pentane, hexane, toluene, and benzene, carbon disulfide, a waste solvent, an ether, a recycled solvent, a supercritical solvent, such as supercritical CO_2, water (though not in the case of a Group V or Group VI halide), and others as will be apparent to those of skill in the art.

Referring now to FIG. 2, there is illustrated a theory developed from scientific evidence to explain the nature of the promoting compounds. For example, as illustrated in FIG. 2, hydrogen bromide reacts with the unsaturated structure of the activated carbon. This may be, by way of illustration only, a carbene species on the edge of the graphene sheet structures of the carbon. Molecular bromine or a bromine compound reacts to form a similar structure, with a positive carbon that is active for oxidizing the mercury with subsequent capture by the sorbent.

It has now been found that the formation of the new bromide compound with carbon increases their reactivity toward mercury and other pollutants. Additionally,

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the resulting bromide compound is uniquely suited to facilitate oxidation of the mercury. The effectiveness of the oxidation apparently results from the promotion effect of the halide, exerted on the developing positive charge on the mercury during the oxidation, known in the chemical art as a specific catalytic effect. Thus, as the mercury electrons are drawn toward the positive carbon, the halide anion electrons are pushing in from the other side, stabilizing the positive charge developing on the mercury and lowering the energy requirement for the oxidation process. Bromide is especially reactive, owing to the highly polarizable electrons in the outer 4p orbitals of the ion. Thus, adding HBr or Br_2 to the carbon forms a similar carbon bromide, in which the positive carbon oxidizes the mercury with the assistance of the bromide ion.

Referring now to FIG. 3, a schematic flow diagram is provided of mercury control system 100 comprising preparation of promoted carbon sorbents, and flue gas mercury reduction, in accordance with preferred embodiments of the present invention. There is provided base activated carbon reservoir 110, an optional halogen/halide promoter reservoir 120, an optional secondary component reservoir 130, and an optional akali component reservoir 180, each of which with corresponding flow control device(s) 201, 202, 203, and 208/209, respectively. In conjunction with the optional alkali component reservoir 180, optional flow control devices 208 and 209 can be used independently, together, or not at all.

Reservoirs 110, 120, 130, and 180 connect through their respective flow control devices and via associated piping, to transport line 115. Optional alkali component reservoir 180 may also connect, through respective flow control devices and via associated piping, to transport line 118. A source of air, nitrogen, or other transport gas(es) is provided by gas source 170 to transport line 115 for the purpose of entraining materials discharged from reservoirs 110, 120, 130, and 180 and injecting such materials, via injection point 116, into contaminated flue gas stream 15. A source of air, nitrogen, or other transport gas(es) may be provided by gas source 171 to transport line 118 for the purpose of entraining materials discharged from reservoirs 180 and injecting such materials, via injection point 119, into flue gas stream 15. Gas sources 170 and 171 may be the same or different, as desired.

Alternatively, transport gas(es) may be provided to both transport lines 115 and 118 by gas source 170 (connection from source 170 to line 118 not shown). Although gas sources 170 and 171 are shown in FIG. 3 as compressors or blowers, any source of transport energy known in the art may be acceptable, as will be appreciated by those of skill in the art.

For clarity, single injection points 116 or 119 are shown in FIG. 3, although one skilled in the art will understand that multiple injection points are within the scope of the present invention. Optical density measuring device(s) 204 is connected to transport line 115 and/or 118 to provide signals representative of the optical density inside transport line 115 and/or 118 as a function of time.

Downstream from injection point 116 and 119 is provided particulate separator 140. By way of illustration and not limitation, particulate separator 140 may comprise one or more fabric filters, one or more electrostatic precipitators (hereinafter "ESP"), or other particulate removal devices as are known in the art. It should be further noted that more than one particulate separator 140 may exist, sequentially or in parallel, and that injection point 116 and 119 may be at a location upstream and/or downstream of 140 when parallel, sequential, or combinations thereof exist. Particulate separator 140 produces at least a predominantly gaseous ("clean") stream 142, and a stream 141 comprising separated solid materials. A sorbent/ash separator 150 separates stream 141 into a largely ash stream 152, and a largely sorbent stream 151. Stream 151 may then preferably be passed to an optional sorbent regenerator 160, which yields a regenerated sorbent stream 161 and a waste stream 162.

An optional Continuous Emission Monitor (hereinafter "CEM") 205 for mercury is provided in exhaust gas stream 35, to provide electrical signals representative of the mercury concentration in exhaust stream 35 as a function of time. The optional mercury CEM 205 and flow controllers 201, 202, 203, 208, and 209 are electrically connected via optional lines 207 (or wirelessly) to an optional digital computer (or controller) 206, which receives and processes signals and preferably controls the preparation and injection of promoted carbon sorbent into contaminated flue gas stream 15.

In operation, promoted carbon sorbent and/or an optional alkali component is injected into contaminated flue gas stream 15. After contacting the injected material with the contaminated flue gas stream 15, the injected material reduces the mercury concentration, transforming contaminated flue gas into reduced mercury flue gas, 25. The injected material is removed from the flue gas 25, by separator 140, disposed of or further separated by optional separator 150, and disposed of or regenerated by an optional regenerator 160, respectively. The reduced mercury "clean" flue gas stream 142 is then monitored for mercury content by an optional CEM 205, which provides corresponding signals to an optional computer/controller 206. Logic and optimization signals from 206 then adjust flow controllers 201, 202, 203, 208, 209 to maintain the mercury concentration in exhaust stream 35 within desired limits, according to control algorithms well known in the art. Flow controllers 201, 202, 203, 208, 209 can also be adjusted manually or be some other automated means to maintain the mercury concentration in exhaust stream 35 within desired limits, according to control algorithms well known in the art.

Referring still to FIG. 3, there are illustrated several preferred embodiments for preparation and injection of promoted carbon sorbents and/or alkali components in accordance with the present invention. Stream 111 provides for introduction of base activated carbon from reservoir 110, as metered by flow controller 201 manually or under the direction of computer 206. The halogen/halide may be combined and react with the base activated carbon according to any of several provided methods. The halogen/halide may preferably be combined via line 121 directly into transport line 115, within which it contacts and reacts with the base activated carbon prior to injection point 116. This option is one form of what is referred to herein as "in-flight" preparation of a promoted carbon sorbent in accordance with the invention. Further, the halogen/halide may be combined via line 121*b* with base activated carbon prior to entering transport line 115. Still further, the halogen/halide may be contacted and react with the base activated carbon by introduction via line 121*c* into reservoir 110. This option is preferably employed when, for example, reservoir 110 comprises an ebullated or fluidized bed of base activated carbon, through which halogen/halide flows in gaseous form or as

a vapor. Of course, the halogen/halide may also preferably be contacted with the base activated carbon in liquid form or in a solvent, as discussed previously, and solvent removal (not shown in FIG. 3) may then be provided if necessary as mentioned with respect to embodiments discussed with reference to FIG. 1.

Similarly, the optional secondary component may be contacted and react directly in transport line 115 via line 131, or optionally as described above with respect to the halogen/halide, via lines 131*b* and 131*c*.

Similarly, the optional alkali component from 180 may either be added in transport line 115 directly, or may be injected separately by transport line 118, combining downstream in flue gas 15 for synergistic effects with base activated carbon, promoted carbon, or optional secondary components. Being able to vary onsite the amount of the optional alkali component relative to base activated carbon, promoted carbon, or optional secondary components is a key feature to overcome and optimize for site-specific operating and flue gas conditions.

In some preferred embodiments wherein contacting between components and reaction is performed in a liquid or solvent phase, stirring of such liquid and/or slurry mixtures may be provided. In other embodiments, the halogen/halide promoter and optional secondary component(s) may preferably be sprayed in solution form into or on the base activated carbon. In some such embodiments, drying, filtering, centrifugation, settling, decantation, or other solvent removal methods as are known in the art may then be provided.

In embodiments wherein the halogen/halide promoter is in gaseous or vapor form, it may be diluted in air, nitrogen, or other gas as appropriate. The halide/halogen gas, for example, gaseous HBr or Br_2, may be passed through an ebullated or fluidized bed of granular or fibrous activated carbon, with the promoted carbon sorbent so produced removed from the top of the bed via gas entrainment for injection.

In some embodiments, the secondary component(s) may preferably comprise iodine or other halogens, hydrohalides, including without limitation HI, HBr, HCl, a Group V or Group VI element with a molecular halogen, such as SCl_2 and others. In some preferred embodiments, the promoted carbon sorbent may comprise from

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about 1 to about 30 g halogen/halide per 100 g base activated carbon. In some preferred embodiments, the promoted carbon sorbent may comprise an secondary component in concentration of from about 1 to about 15 wt-% of the concentration of the halogen/halide component.

In still other embodiments, the product promoted carbon sorbent may be applied to a substrate. In other embodiments, such prepared substrate(s) may be caused to contact a contaminated flue gas or gasification system product gas stream for mercury reduction purposes. Such substrates may be monolithic, rotating, or exposed to the gas stream in any number of ways known to those skilled in the art.

In some embodiments, a method is provided whereby a mercury stabilizing reagent is added to a promoted carbon sorbent to produce a bifunctional sorbent. Such stabilizing reagent(s) may be sequentially added, either before or after the addition and reaction of the halogen/halide. In some preferred embodiments, the halogen/halide preferably comprises Br or HBr, and the mercury-stabilizing reagent may comprise S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, and combinations thereof.

Halogens in Mercury Capture

Methodologies for using halogens for the treatment of flue gas have been problematic, owing to their reactivity with other gases and metals, resulting in corrosion and health issues. A "halogen" is defined as a member of the very active elements comprising Group VIIA (CAS nomenclature is used throughout; Group VIIA (CAS) corresponds to Group VIIB (IUPAC)) of the periodic table. In the molecular elemental form of the halogens, including F_2, Cl_2, Br_2, and I_2, the reaction with a hot flue gas components leave little to react with elemental mercury. The atomic elemental halogen form, which includes the fluorine, chlorine, bromine, and iodine atoms, is about a million times more reactive to mercury but the concentration of the atomic forms is typically extremely low. In a large portion of electric utility coal combustion facilities, the concentrations are generally not sufficient to oxidize a significant amount of mercury.

The term "halide" as used herein is defined as a compound formed from the reaction of a halogen with another element or radical. In general, halide compounds are much less reactive than the molecular halogens, having a low chemical potential.

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Halides are considered reduced forms that do not, alone, oxidize other compounds. In the conventional view therefore, a halide-salt-treated activated carbon will not effectively oxidize elemental mercury and capture elemental mercury.

Halogen Promoted Sorbent Characteristics

The sorbent described here has a very high initial reactivity for oxidizing mercury and therefore can be used in very small amounts to achieve very high capture efficiencies, thus lowering operation costs and lessening waste disposal problems. In addition, further disposal reductions are obtainable by regenerating and reusing the sorbents produced using the inventive technology. The time interval required for the mercury and the promoted carbon sorbents of the present invention to successfully interact in a flue gas duct, with the subsequent collection of the mercury on the sorbent and ash is very short—less than seconds. Clearly, such collection times require the sorbent to have both high capacity and high reactivity toward mercury. The promoted carbon sorbent can be utilized in a very finely powdered form to minimize mass transfer limitations. However, again, the reactivity should be very high to capture all of the mercury encountered by the fine particles. Additionally, use of these enhancement technologies allows capture to be effective for larger sorbent particles which also allows separation of the sorbent from the ash to enable subsequent regeneration as well as ash utilization. One feature of this invention is the process to prepare a sorbent containing a halide compound formed on the carbon structure that provides a sorbent that is highly active on initial contact with the mercury contaminated gas stream, which allows for very effective capture of the mercury.

It appears that the inventive sorbents chemically combine molecular bromine, for example, from solution, with activated carbon (edge sites). X-ray photoelectron spectroscopy has established that the addition of bromine, chlorine, HBr, or HCl formed a chemical compound in the carbon structure. Thus, the sorbent produced from halogen and activated carbon does not represent a molecular halogen form, but rather a new chemically modified carbon (or halocarbon) structure. This phenomenon may not occur with the less reactive iodine, where an I_2 molecular complex can exist on the carbon basal plane. In the case of bromine, modified

cationic carbon has a high chemical potential for oxidation of mercury. Thus, an entirely new model is presented for the reactivity of the bromine-treated carbon with mercury. The reactive carbon form can preferably be generated by the addition of bromine, hydrogen bromide, or combinations of bromine and other elements, as described herein. Halogen treatment resulted in higher-activity carbons because the halide anions (especially bromide and iodide) were effective in promoting the oxidation by stabilizing the developing positive charge on the mercury in the transition state for oxidation. Based on this model, several innovative, inexpensive, activity-enhancing features have been developed.

Optional Second Component

It has been demonstrated that addition of an optional second component, in addition to the bromine, results in improved reactivity and capacity for the sorbent, typically exceeding that of both the untreated carbon and the brominated carbon. The second compound comprises either a second halogen or a compound derived from a second halogen, such as HI. Thus, in addition to having a reactive carbon form present, the second component generates a Lewis base with greater ability to stabilize the developing positive charge on the mercury. Thus, the second component is an element with more polarized electrons (4p and 5p).

Optional Alkali Component

It has been demonstrated that addition of an optional alkali component with a base or promoted activated carbon results in improved mercury capture, typically exceeding that of both the untreated carbon and the promoted carbon. Test data indicate that flue gas contaminants, flue gas constituents (SO_2, NO_x, HCl, etc), operating temperature, mercury form, and mercury concentration may impact the effectiveness of the alkali addition. This suggests the need to be able to adjust and tailor the alkali-to-activated-carbon ratio onsite in order to overcome and optimize for a given set of site conditions.

The synergy that can be gained when co-injecting the two materials can be explained as follows. First, testing shows that binding sites on activated carbon (hereinafter "AC") can be consumed by chlorine species, sulfur species (i.e. sulfates), and other flue gas contaminants (arsenates, selenates, etc). The addition of

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optional alkali material will interact and react with these species/contaminants thus minimizing their consumption of AC mercury binding sites. Second, testing also shows that standard AC will continue to oxidize mercury, even though the binding sites are fully consumed. This oxidized mercury can then react with alkali material and subsequently be captured by particulate control devices. Consequently, the addition of the optional alkali component acts to protect mercury binding sites and capture oxidized mercury, thereby resulting in improved mercury reduction at lower cost. Alkali is generally much lower in cost (~an order of magnitude less) than activated carbon, thus more of it can be used still resulting in overall lower costs.

"In-Flight" Sorbent Preparation

Furthermore, we have demonstrated that the halogen promoted carbon sorbent can be readily produced "in-flight". This is accomplished by, for example, contacting the vapors of any combination of halogens and optionally a second component, in-flight, with very fine carbon particles. The particles may be dispersed in a stream of transport air (or other gas), which also conveys the halogen/halide promoted carbon sorbent particles to the flue gas duct, or other contaminated gas stream, from which mercury is to then be removed. There is no particular temperature requirement for this contact. This technology is obviously very simple to implement, and results in a great cost savings to facilities using this technology for mercury capture.

Advantages of On-Site Preparation

In-flight preparation of the halogen/halide promoted carbon sorbent on location produces certain advantages. For example, the treatment system can be combined with the carbon injection system at the end-use site. With this technique, the halogen/halide is introduced to the carbon-air (or other gas) mixture in a transport line (or other part of the sorbent storage and injection system). This provides the following benefits over current conventional concepts for treating sorbents off-site:

Capital equipment costs at a treatment facility are eliminated.

Costs to operate the treatment facility are eliminated.

There are no costs for transporting carbon and additive to a treatment facility.

The inventive process uses existing hardware and operation procedures.

The inventive technology ensures that the sorbent is always fresh, and thus, more reactive.

No new handling concerns are introduced.

There are no costs for removing carbon from treatment system.

The inventive process allows rapid on-site tailoring of additive-sorbent ratios in order to match the requirements of flue gas changes, such as may be needed when changing fuels or reducing loads, thus further optimizing the economics.

The inventive technology reduces the amount of spent sorbents that are disposed.

With the foregoing and other features in view, there is provided, in accordance with the present invention, embodiments including a process for preparing and regenerating halogen/halide promoted carbon sorbents, whose activity for mercury capture is enhanced by the addition of halogen (e g. bromine) to the carbon structure.

Sorbent Injection Location

Some of the preferred embodiments contemplate the use of a halogen promoted sorbent in a powdered form that has been injected into a flue gas stream before or after ash particulates have been removed. Other embodiments of the inventive composition of the halogen promoted carbon sorbent comprise a powdered modified activated carbon prepared by adding Br_2 or HBr plus a second optional component. Other embodiments allow the addition of the optional alkali component in conjunction with a base activated carbon and/or with the use of a halogen based sorbent and any other combinations of the sorbent technologies provided in this patent. Alternatively, embodiments include methods wherein the sorbent is on a moving contactor consisting of particles or fibers containing one or more of the compositions listed above.

Sorbent Regeneration

Any of the above embodiments of the halogen/halide promoted carbon sorbent can be easily regenerated; the poisoning contaminants from the flue gas are preferably removed and an inexpensive promoting agent added, to restore mercury sorption activity. This process of promoting the activity of the carbon itself contrasts with the earlier, more expensive, conventional methods of adding a reagent (such as peroxide, gold, triiodide, etc.) to a sorbent. The halogen/halide promoted carbon sorbent of the present invention, treated with bromine and/or optional components, is noncorrosive. Detailed examples of sorbent regeneration techniques are described in co-pending, commonly owned PCT patent application No. PCT/US04/12828, titled "PROCESS FOR REGENERATING A SPENT SORBENT", which is hereby incorporated by reference in its entirety.

Sorbent Injection Control Schemes

Another advantage of the present invention relates to the use of a feedback system to more efficiently utilize certain aspects of the invention. Where possible and desirable, the mercury control technology of the present invention may preferably utilize continuous measurement of mercury emissions as feedback to assist in control of the sorbent injection rate. Tighter control on the sorbent and optional component(s) levels can be achieved in this way, which will ensure mercury removal requirements are met with minimal material requirements, thus minimizing the associated costs. In an embodiment, the mercury emissions are continuously measured downstream of the injection location, preferably in the exhaust gas at the stack.

Promoted Carbon Sorbents

Reactions of halogens and acidic species with the basic binding sites on the activated carbon sorbent create sites for oxidizing mercury. Other metal ions, such as boron, tin, arsenic, gallium, Sb, Pb, Bi, Cd, Ag, Cu, Zn, or other contaminants, will also react with the oxidation sites generated on the carbon.

According to our model, adding the bromine from the bromine reagent or a proton from a hydrogen halide acid to a basic carbene site on the carbon edge structure forms a carbocation that accepts electrons from the neutral mercury atom forming the oxidized mercury species that is bound to the sorbent surface. The

reactive site may also generate reactive bromine radicals or carbon radicals at the active sites on the carbon. Thus, the activated carbon serves to stabilize the bromine, yet provides a highly reactive bromine-containing reagent that can oxidize the mercury and promote its capture on the activated carbon. The sorbent that contains bromine is expected to be more reactive than the corresponding sorbent containing chlorine and much less expensive than the sorbent containing iodine.

EXAMPLES

To more clearly illustrate the present invention, several examples are presented below. These examples are intended to be illustrative and no limitations to the present invention should be drawn or inferred from the examples presented herein.

Example 1

Preparation and Testing of Halogenated Carbon (& Comparative Example) Gas Phase Halogenation

Finely powdered activated carbon (such as NORIT Darco FGD, NORIT Americas, Inc., Marshall, Tex. (USA), although others are suitable, as will be recognized by those skilled in the art), was placed in a rotating plastic barrel with side blades (a 5 ft^3 (0.14 m^3) cement mixer) fitted with a tight plastic lid to prevent loss of the fine powder during the preparation. In a separate vessel, gas phase bromine was generated by passing a nitrogen stream over a weighed amount of liquid bromine that is warmed to about 40°-50° C. The vapor pressure of the bromine was such that a dark red gas is generated and passed out of the generator. The outlet from the gaseous bromine generator is connected via a 1/4 inch (0.64 cm) plastic hose to a stationary metal tube inserted through a flange in the center of the plastic lid and passing into the center of the barrel. The flange is not air tight so that the excess of nitrogen is released after the bromine is transferred to the tumbling carbon. Thus, the bromine gas stream continuously passed into the rotating barrel where it contacted the tumbling carbon. The unit is then operated until the desired amount of bromine has combined with the carbon. Typically, this is 0.4 to 1 kg of

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bromine to 20 kg of carbon (2-5 wt. %). When the reaction is completed, the carbon is weighed. The treated carbon is odorless and does not cause skin irritation since the bromine has completely reacted with the carbon to produce the brominated carbon.

XPS spectra demonstrate that the brominated carbon contains both covalent carbon-bound (organic) bromide as well as anionic bromide. The product contains the same moisture originally present in the activated carbon (5-17 wt %), but does not require further drying for use. The moisture is driven out at higher temperatures (>150° C.), and the bromine was not released until very high temperatures

Bench-Scale Testing of Mercury Oxidation and Capture Efficiency

A bench-scale apparatus and procedure based on the above description was used to test the initial activities and capacities of several promoted activated carbon sorbents using powdered carbon, including bromine-containing activated carbons prepared from a variety of carbons, including commercially available sorbents, aerogel film sorbents, and the original precursor carbons for comparison.

A detailed description of the apparatus and its operation is provided in Dunham, G.E.; Miller, S. J. Chang, R.; Bergman, P. *Environmental Progress* 1998, 17, 203, which is incorporated herein by reference in its entirety. The bench scale mercury sorbent tests in the flue gas compositions were performed with finely (--400 mesh) powdered sorbents (37 mg) mixed with 113 mg sand and loaded on a quartz filter (2.5 inch (6.35 cm)). The loaded filter and holder were heated in an oven (125° C.) in the simulated flue gas stream (30 SCFH (standard cubic feet/hr) or 0.79 NCMH (normal cubic meters per hour)) containing the following: O_2 (6%), CO_2 (12%), SO_2 (600 ppm), NO (120 ppm) NO_2 (6 ppm), HCl (1 ppm), Hg^0 (11 $\mu g/m^3$), H_2O (15%), and N_2 (balance). Elemental mercury was provided by a standard permeation tube source placed in a double jacketed glass condenser, and heated to the desired temperature. Mercury concentrations in the gas streams were determined with a continuous mercury emission monitor (Sir Galahad mercury CEM mfr. P.S. Analytical Deerfield Beach Fla. USA), and a $SnCl_2$ cell was used to convert oxidized species to elemental, so that both elemental and oxidized mercury concentration data could be obtained for both the influent and the effluent

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concentrations from the sorbent bed. Mercury concentrations were calibrated for the flow rates used. Spent sorbents were analyzed for mercury to determine the mass balance.

Referring now to FIG. 4, the effluent mercury concentration data are plotted as a percent of the influent mercury versus time. The resulting curve (breakthrough curve) for the halogenated sorbents typically showed 0%-1% Hg in the effluent (99+% capture) at the beginning, and increasing only after 30-60 minutes (breakthrough point), depending on the sorbent. FIG. 4 illustrates the breakthrough curves for 5 wt/wt % brominated NORIT Darco FGD sorbent (37 mg+113 mg sand) with synthetic flue gas containing 1 ppm HCl. Total Hg (solid circles) and elemental Hg (solid squares) in the effluent are presented as a per cent of the inlet Hg. "EOT" indicates the end of test (the later data points shown are for calibration checks).

FIG. 5 presents the comparative breakthrough curves for the corresponding nonhalogenated sorbents typically initiated at 5%-50% of inlet mercury, depending on the HCl concentration in the synthetic flue gas, thus indicating considerably lower reactivity for oxidation and capture of the mercury for the nonhalogenated sorbents. After breakthrough of either halogenated or nonhalogenated sorbent, most of the mercury in the effluent was oxidized mercury.

Example 2

Gas Phase Halogenation of Fluidized Carbon

A bed of activated carbon supported in a vertical tube by a plug of glass wool was fluidized by a nitrogen stream. The top of the fluidized bed tube was connected to a catching trap for carbon fines that blow out the top of the tube. The bromine gas generator as described in Example 1 was attached to the fluidized carbon bed and the desired amount of gaseous bromine was passed into the bed. The contents of the trap were then mixed with the material in the bed and weighed. The resulting brominated carbon exhibited properties similar to the brominated carbon of Example 1.

Example 3

Liquid Phase (Water) Halogenation

A 5% solution of bromine in water was prepared by carefully adding 50 g of bromine to 1 liter of cold water. One kg of activated carbon was added to the bromine solution in a large metal can. The resulting slurry was stirred with a large paddle during the addition and for a short time afterwards until all the bromine had reacted with the carbon, as indicated by the disappearance of the red color. The slurry was then filtered using a Buchner funnel under vacuum. The moist carbon that was collected on the filter was dried in an oven at 110° C. for several hours to constant weight. As in Example 1, some moisture remains in the carbon, however. The dried carbon was then tumbled in the rotating barrel with metal pieces to break up and fluff the carbon.

Example 4

Addition of the Optional Second Halide Component

Brominated carbon was produced by solution phase bromination similar to that described with reference to Example 3. However, before filtration, a solution of hydriodic acid (HI) was added to the slurry in an amount equal to 10% of the bromine amount. The slurry was stirred to complete the reaction and then filtered and dried as described in Example 3.

Example 5

Liquid Phase Phosphohalogenation

A solution of phosphorus tribromide (500 g) in ligroin (10 liters) was stirred in a large metal can and 10 kg of activated carbon was added. The resulting slurry was stirred with a large paddle at ambient temperature to complete the reaction. The slurry was filtered under vacuum on a large Buchner funnel in several batches. The wet filter cake was dried at 110° C. in an oven to constant weight. The dried product was fluffed in the rotating barrel as described in Example 3.

Example 6

Preparation and Sorption on Larger-Particle Carbon

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Tests were conducted on a pilot-scale combustor while firing a subbituminous coal, to evaluate mercury control by injecting larger-than-normal sized treated activated carbon. Standard AC sorbents generally are of fine size with a mean particle diameter of less than 20 micrometers, which is also typical of the flyash that is generated from pulverized coal combustion. Consequently, because the sizes of standard AC and flyash are similar, separation of the two is difficult. Injection of larger sized AC is generally not considered because the sorbent effectiveness decreases with size. In a scheme to recycle the injected carbon, the carbon is separated from the flyash. A separation based on size fractionation requires a treated larger particle sorbent. To test this concept, a treated larger sized (>60 μm) sorbent was developed, prepared, and tested.

Treatment—Gas Phase Halogenation

Granular activated carbon (Calgon F400) was ground and sieved through conventional mesh screens. The mesh size fraction −170 to +240 (corresponding to about 60 to about 88 micrometers) was collected and placed in a rotating vessel as described in Example 1 above. In a separate vessel, gas phase bromine was generated by passing a nitrogen stream over a weighed amount of liquid bromine that was warmed to about 40°-50° C., and the outlet from this gaseous bromine generator was connected via a ¼ inch (6.35 mm) plastic hose to a stationary metal tube inserted through a flange in the center of the lid and passing into the center of the rotating vessel, also as described in Example 1. The unit was operated until the desired amount of bromine had combined with the carbon, in this case 0.05 kg of bromine to 1 kg of carbon (5 wt. %). When the reaction was completed, the carbon was weighed. The treated carbon was odorless as has been described above.

PTC Apparatus

The pilot-scale combustor, known as the "Particulate Test Combustor" (hereinafter "PTC"), is a 550,000-Btu/hr (about 161 kW) pulverized coal ("PC")-fired unit, designed to generate combustion flue gas properties and fly ash that are representative of those produced in a full-scale utility boiler. The combustor is oriented vertically to minimize wall deposits. A refractory lining helps to ensure adequate flame temperature for complete combustion and prevents rapid quenching

of the coalescing or condensing fly ash. Based on the superficial gas velocity, the mean residence time of a particle in the combustor is approximately 3 seconds. The coal nozzle of the PTC fires axially upward from the bottom of the combustor, and secondary air is introduced concentrically to the primary air with turbulent mixing. Coal is introduced to the primary air stream via a screw feeder and eductor. An electric air preheater is used for precise control of the combustion air temperature. Originally, the PTC used cold-water annular heat exchangers to provide flue gas temperature control to the baghouse (also referred to as a "fabric filter") or electrostatic precipitator (ESP). However, analysis of ash deposits collected from the heat exchangers indicated that some mercury was collected on the duct walls. To minimize this effect, the heat exchangers were modified to provide for higher duct wall temperatures.

The PTC instrumentation permits system temperatures, pressures, flow rates, flue gas constituent concentrations, and particulate control device (baghouse, Advanced Hybrid Particle Collector/AHPC™, and/or electrostatic precipitator/ESP) operating data to be monitored continuously and recorded on a data logger.

PTC Procedure

Flue gas samples were taken at combinations of two of the three available system sample points: the furnace exit, the particulate control device inlet, and the particulate control device outlet. After passing through sample conditioners to remove moisture, the flue gas was typically analyzed for O_2, CO, CO_2, SO_2, and NO_x. Each constituent was normally analyzed at both the furnace exit and the outlet of the particulate control device simultaneously, using two analyzers. The concentration values from all of the instruments were recorded continuously. In addition, data were manually recorded at set time intervals. NO_x was determined using a pair of Rosemount Analytical NO_x chemiluminescent analyzers. SO_2 was measured using a pair of Ametek Instruments photometric gas analyzers. The remaining gases were measured by a pair of Rosemount Analytical multi-gas continuous emissions monitors. Each of these analyzers was regularly calibrated and maintained to provide accurate flue gas concentration measurements.

The baghouse vessel was a 20 inch (50.8 cm) (ID) chamber that is heat-traced and insulated, with the flue gas introduced near the bottom. The combustor produced about 200 ACFM (actual cubic feet per minute; about 5.7 actual m^3/min) of flue gas at 300° F. (about 150° C.), therefore three 13-ft by 5-inch (3.96 m by 12.7 cm) bags provided an air-to-cloth ratio of 4 ft/min (1.22 m/min). Each bag was cleaned separately in operation with its own diaphragm pulse valve. In order to quantify differences in pressure drop for different test conditions, the bags were cleaned on a time basis, rather than with the cleaning cycle initiated by pressure drop. Once bag cleaning was initiated, all three bags were pulsed in rapid succession on-line.

Tests were also conducted with a single-wire, tubular ESP replacing the fabric filter. The ESP unit was designed to provide a specific collection area of 125 at 300° F. (150° C.). Since the flue gas flow rate for the PTC is 130 SCFM (standard cubic feet per minute; about 3.7 NCMM (normal m^3/min)), the gas velocity through the ESP is 5 ft/min (about 1.52 m/min). The plate spacing for the ESP unit is 11 in (27.9 cm). The ESP was designed to facilitate thorough cleaning between tests so that all tests can begin on the same basis.

PTC Results

Results are illustrated in FIG. 6. As can be observed in FIG. 6, even though the tested sorbent particle size is significantly larger than normal sorbent particles, the treated larger-than-normal sized (that is, >60 micrometers) activated carbon sorbent was quite effective at capturing mercury. Approximately 75% of the mercury was captured when the larger-sized treated AC was injected ahead of the pilot-scale ESP, while approximately 85% of the mercury was captured when injected ahead of the pilot-scale fabric filter ("FF"). Note that in FIG. 6 (and throughout) "Macf" (and "MACF") indicates million actual cubic feet (1 MACF is about 0.028 million actual cubic meters or "MACM").

Referring now to FIG. 7, it can be observed that the larger-sized treated AC when injected ahead of the pilot-scale ESP (diamond symbol(s)) performed better than the finer standard AC (triangles) under the same arrangement. In comparison, when injected ahead of the fabric filter (FF), the larger-sized treated AC (square)

performed similarly to slightly worse. However, for this application, the larger-sized treated AC can be physically separated from the smaller flyash particles, and the sorbent can then be regenerated, recycled, and reused. This will substantially improve overall utilization and economics. These data thus show that a larger-than-normal sized sorbent can provide effective mercury control and ease flyash and AC separation, thereby also preserving the characteristics of the flyash for sale and beneficial use. Accordingly, because >60 μm sorbent particles have been successfully demonstrated, superior mercury control can be obtained with >40 μm particles, which may be preferred in some applications, depending on the sorbent particle/ash separation system used. Note that in FIG. 7 (and throughout) "Macf" (and "MACF") indicates million actual cubic feet.

Example 7

Liquid Phase (Organic Solvent) Halogenation

A 5% solution of bromine in ligroin was prepared by carefully adding 50 g of bromine to 1 liter of cold ligroin. One kg of activated carbon was added to the bromine solution in a large metal can. The slurry was stirred with a large paddle during the addition and for a short time afterwards until all the bromine had reacted with the carbon as indicated by the disappearance of the red color. The slurry was filtered using a Buchner funnel under vacuum. The carbon cake that was collected on the filter was dried in an oven at 110° C. for several hours until it appeared dry and a constant weight was obtained. As in Example 1, some moisture was left in the carbon, however. The dried carbon was then tumbled in the rotating barrel with metal pieces to break up and fluff the carbon.

Example 8

Promoted Activated Carbon Sorbents

A bench-scale procedure based on the above description was used to test the initial activities and capacities of several promoted activated carbon sorbents using powdered carbon, including the bromine-containing activated carbons prepared from a commercially available sorbent and an aerogel carbon film sorbent, as well

as the original precursor carbons for comparison. Bromine-treated carbons were prepared by impregnation of the powdered activated carbon precursors in a stirred solution of bromine in carbon tetrachloride or methylene chloride, or alternatively, in an aqueous solution of HBr, followed by drying in air at ambient temperature and drying in an oven at 100° C. in air or nitrogen. Bromine-treated carbons were also prepared by impregnating bromine from the gas phase by passing the gas through a rotating dry bed of the activated carbon precursor. The results indicated that adding a second component to the solution improved the capacity of the sorbent.

The carbons were initially tested in a heated bed, where a synthetic flue gas stream containing elemental mercury (11 $\mu g/m^3$) was passed through the bed. Concentrations of total and elemental Hg in the effluent gas were determined using a Sir Galahad mercury CEM ("continuous emission monitor") (mfr. P S Analytical, Deerfield Beach, Fla., USA). The powdered sorbent was supported on a quartz filter during the test, and the other sorbents were tested as a triple layer. A comparison of the original commercial-grade powdered carbon sorbent with the sorbent after it was treated with 0.1 N HBr, and the powder was collected by centrifugation and drying, revealed that the mercury capture activity increased from an initial capture efficiency of about 50% of the Hg in the inlet to 100% capture. A comparison of the sorbent after subsequent regeneration with HBr indicated that it not only captured mercury at the same level as before (100% capture) but its capacity was prolonged by several minutes, and thus enhanced. Similar results were obtained with the carbon film and carbon fiber sorbents by treatment with molecular bromine in solution or in dry beds as described above.

Example 9

Fluidized/Ebullated Bed Preparation

An activated carbon sorbent was prepared by treating the carbon by impregnating molecular bromine from a gas composition containing molecular bromine by flowing the gas through a liquid bromine reservoir in series with a fluidized bed or ebullated bed of the carbon. The amount of bromine taken up by the

carbon ranges (in one example) from <1 to about 30 g per 100 g of activated carbon, depending on the proportions used.

Example 10

Full-Scale Testing

In this example, a baghouse (fabric filter) or ESP was used to collect particulates in the exhaust of a full-scale commercial pulverized coal-burning facility. A scrubber and sorbent bed were also used to remove undesired constituents from the flue gas stream, before being fed to the stack. In this example, the halogen/halide promoted carbon sorbent was injected into the flue gas after the boiler. In general however, the inventive sorbent can be injected where desired (e.g., before, after, or within the boiler).

In one exemplary test conducted at a facility fired with lignite coal, the flue gas phase mercury (elemental) concentration was between 10 and 11 $\mu g/m^3$. The ash and injected carbon were collected in the baghouse at 350° F. to 375° F. (about 175-190° C.). Injection of commercial-grade activated carbon powder (untreated) at a rate of 1.0 lb/MACF ("MACF" and "Macf" represent one million actual cubic feet; 1.0 lb/MACF is about 16 kg/MACM (million actual cubic meters)) resulted in mercury effluent concentrations of 3.8-4.2 $\mu g/m^3$ (representing 62%-58% removal of the mercury from the gas, respectively), and at 2.0 lb/MACF (about 32 kg/MACM), gave 74%-71% removal. Injection of the bromine-treated carbon at 1.0 lb/MACF resulted in 73%-69% removal and at 2.0 lb/MACF gave 86%-84% removal. Thus, a significant increase in the mercury capture was exhibited during use of the bromine promoted carbon sorbent of the present invention.

Example 11A

Addition of Optional Alkaline Component—Bench-Scale

The efficiency of the activated carbons for mercury capture can be improved considerably by employing a basic material co-injected with the activated carbon, in order to capture any oxidized mercury that may be released from the sorbent, or to

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capture some of the sulfur or selenium oxides in the flue gas that can have a detrimental effect on the sorbent capacity.

Bench-scale testing was conducted by preparing a filter composed of 37 mg of brominated activated carbon mixed with 113 mg of calcium oxide. The test was conducted as described in Example 1 and compared with the same carbon sorbent but with an inert diluent. The breakthrough curve for the mixture of brominated (2%) NORIT Darco FGD sorbent with inert sand is shown in FIG. 8, and the breakthrough curve for the mixture with CaO is shown in FIG. 9. It can be seen that the point of 50% breakthrough improves to 65 minutes with the mixture with CaO from only 48 min with the sand mixture.

Example 11B

Addition of Optional Alkaline Component—Pilot-Scale

Tests were conducted on the pilot-scale PTC combustor described above with reference to Example 6 while firing a Texas lignite to evaluate mercury control by co-injecting a standard activated carbon (also referred to herein as "AC") and an alkali material upstream of a fabric filter. Typical results are illustrated in FIG. 10. As shown in FIG. 10, co-injecting lime with activated carbon vastly improved mercury removal. Mercury removals of approximately 90% were achieved with the co-injected sorbents, whereas less than 60% removal was achieved with the use of standard AC alone, even at much higher injection rates. Data from similar tests show that injecting similar quantities of sodium carbonate and AC, and lime and AC, resulted in mercury removals of approximately 80%, and 87%, respectively. These data suggest that other alkali can also be co-injected with AC to improve mercury removal. Other data show that flue gas temperature may impact the effectiveness of the alkali addition. Further test data indicate that flue gas contaminants, flue gas constituents (SO_2, NO_x, HCl, etc.), operating temperature, mercury form, and mercury concentration may impact the effectiveness of the alkali addition. This indicates that it may be desirable to be able to adjust and tailor, onsite, the alkali-to-AC ratio in order to optimize removal for a given set of site conditions.

Without wishing to be bound by any particular theory, the synergy observed in the improved performance when co-injecting the two materials can be explained as follows. First, tests indicate that binding sites on AC can be consumed by sulfur species and other contaminants. The alkali material interacts and reacts with these species thus minimizing their consumption of AC mercury binding sites. Second, other work has shown that standard AC will continue to oxidize mercury even though the binding sites are fully consumed. This oxidized mercury can then react with alkali material and subsequently be captured by the particulate control device. Thus, combining alkali with treated and/or non-treated AC synergistically takes advantage of these two mechanisms, resulting in improved mercury capture at reduced costs.

Example 12

Brominated Carbon Sorbent for Gasification Fuel Gas

Preparation of 5% Br2W-AC

Using a procedure similar to Example 3, a 2.5 wt/vol % solution of bromine in water was prepared. Granular Calgon F400 was added to the bromine solution to give a 5 wt/wt % brominated carbon product. The bromine solution was stirred with a large paddle during and after the addition until the red color in the water disappeared. The suspension was filtered by vacuum on a large Buchner funnel. The filter cake was dried in air, and then in an oven at 110° C. until a stable weight was obtained The moisture was reduced to 15%.

Preparation of 5% Br2D-AC

A brominated sorbent was prepared from Br_2 addition in solvent as described in Example 7, except that dichloromethane was used as the solvent instead of ligroin, and granular Calgon F400 was used.

Preparation of 5% PBr3-AC

A phosphohalogenated sorbent was prepared from PBr_3 using the method described in Example 5, except granular Calgon F400 was used.

Testing in Hydrogen Atmosphere—Procedure

To simulate the capture of mercury from a heated fuel gas or syngas from coal gasification, tests were conducted employing a stream comprising 10% vol/vol hydrogen in nitrogen passing through the sorbent at 500 cc/min. The stream contained 26.9 micrograms/m^3 of elemental mercury from a commercial mercury permeation source.

In the tests, the sorbent (0.5 g) was placed in a 0.39 inch (1 cm, inside diameter) glass tube fitted with a medium frit sintered glass filter disc to hold the sorbent in the gas stream. The tube containing the sorbent bed was connected to a gas inlet tube for introducing the gas stream containing the mercury vapor and at the outlet to a tube connection to the detector. The detector was a Semtech 2000 continuous mercury emission monitor. The tube was equilibrated in a nitrogen flow (450 cc/min) for 5 minutes at ambient temperature to stabilize the system. The detector showed 0 concentration of mercury in the effluent from the sorbent bed. (The blank run with no sorbent read 26.9 micrograms/m^3). The tube was then placed in an oven at the selected temperature for the test (from 250° to 400° C.). Effluent mercury concentration data from the detector were collected until the detector showed a constant reading for 5 minutes. Hydrogen (50 cc/min) was then added to the gas stream and detector readings were taken every 5 min. Tests were conducted at several oven temperatures for various periods of time up to 3 hours, depending on the temperature and sorbent. The elemental mercury concentration data were plotted as a percent of inlet mercury concentration versus time as in Example 1. All the mercury in the effluent was elemental, so a single detector was sufficient, and no $SnCl_2$ trap was needed to convert to elemental mercury (as in Example 1). The time for 50% breakthrough (time to reach 50% capture) was then determined from the breakthrough curves.

Results

The results are shown in Table 1 (below) for the unbrominated sorbent (Calgon F-400), the brominated sorbents (5% Br2W-AC and 5% BrD-AC), and the phosphobrominated sorbent (5% PBr3-AC). The maximum mercury concentration obtained in the effluent in each run is also reported in Table 1 for the time period indicated in the last column.

Under the reducing hydrogen conditions, the unbrominated sorbent broke through immediately and was exhausted after only 6.5 min. This complete failure occurred because the hydrogen reduces the captured mercury in the unbrominated sorbent at any temperature above 100° C. Both of the brominated sorbents exhibited excellent reactivity and good capacity at all temperatures, up to at least 400° C. The phosphobrominated sorbent exhibited superior reactivity and capacity at all temperatures, up to at least 400° C.

	Times for 50% Breakthrough Maximum Observed Hg Concentrations for Sorbents (10% Hydrogen Streams)			
Sorbent	Temp (° C.)	50% breakthrough (min)	Maximum [Hg] ($\mu g/m^3$)	Time (min)
F-400	250	6	20.3	6.5
5% Br2W-AC	250	>150	1.4	150
5% Br2W-AC	300	>180	4.3	180
5% Br2W-AC	350	160	15.1	180
5% Br2W-AC	400	60	13.9	65
5% PBr3-AC	250	>140	0.4	140
5% PBr3-AC	300	>150	0.5	150
5% PBr3-AC	350	>150	1.4	150
5% Br2D-AC	350	>180	2.1	180
5% Br2D-AC	400	>180	10.9	180

While the preferred embodiments of the invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the spirit and teachings of the invention. The embodiments described herein are exemplary only, and are not intended to be limiting. Many variations and modifications of the invention disclosed herein are possible and are within the scope of the invention. Accordingly, the scope of protection is not limited by the description set out above, but is only limited by the claims which follow, that scope including all equivalents of the subject matter of the claims.

The examples provided in the disclosure are presented for illustration and explanation purposes only and are not intended to limit the claims or embodiment of this invention. While the preferred embodiments of the invention have been shown and described, modifications thereof can be made by one skilled in the art without

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departing from the spirit and teachings of the invention. Process criteria, equipment, and the like for any given implementation of the invention will be readily ascertainable to one of skill in the art based upon the disclosure herein. The embodiments described herein are exemplary only, and are not intended to be limiting. Many variations and modifications of the invention disclosed herein are possible and are within the scope of the invention. Use of the term "optionally" with respect to any element of the invention is intended to mean that the subject element is required, or alternatively, is not required. Both alternatives are intended to be within the scope of the invention.

The discussion of a reference in the Background is not an admission that it is prior art to the present invention, especially any reference that may have a publication date after the priority date of this application. The disclosures of all patents, patent applications, and publications cited herein are hereby incorporated herein by reference in their entirety, to the extent that they provide exemplary, procedural, or other details supplementary to those set forth herein.

Although the invention is described herein as a sorbent material and associated processes for its preparation and use, it is nevertheless not intended to be limited to the details described, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

PROVISIONAL APPLICATION

A reactive sorbent material is described for capture of mercury in a vapor stream. The vapor stream includes flue gas from coal combustion or incineration, synthesis gas from gasification, as well as offgases from mineral processing, metal refining, retorting, cement manufacturing, chloralkali plants, dental facilities, and crematories. The sorbent is especially suited to, but not limited to, use in low-chlorine flue or exhaust gases where the mercury is mainly elemental. The sorbent comprises a bromide-modified carbon form containing a reactive compound produced by the reaction of bromine with the carbon. Other additional promoting substances can be added in smaller amounts to increase the reactivity with and

sorption of elemental mercury. This combination results in a carbon bromide structure in the carbon lattice that can oxidize the mercury to a species that is strongly bonded to the carbon structure and, therefore, easily retained on the sorbent at higher temperatures in the presence of flue gas constituents. In some examples, the sorbent consists of a fine or coarse powdered material for injection into the gas stream or a granular or fibrous material for use in a fixed or moving bed. In some examples, the sorbent does not require in situ activation (an induction period) in a flue gas stream as do conventional activated carbon sorbents. Other additives of base chemistry (Ca, Na, and others) may be added to flue gas as a sorbent mixture, or co-injected to selectively sorb acid gases or other flue gas constituents to keep available reactive sites for mercury oxidation and subsequent capture. The sorbent can be regenerated by washing off contaminating components derived from flue gas that poison the spent sorbent. Novel methods for introduction of the sorbent dispersion into the mercury contaminated gas stream are described.

Following is an outline of examples of the invention. The invention may also take on various other examples or embodiments, as a person skilled in the art would understand.

1. A modified carbon sorbent was prepared by reacting the carbon with molecular bromine by applying a solution of molecular bromine in an organic solvent to the carbon, followed by removal of the modified carbon from the bulk of solvent and further removal of solvent from the pores by drying the carbon in air or nitrogen. The solution may also contain an additional promoting substance in small amounts. In one example, the amount of bromine taken up by the carbon ranges from <1 to about 30g per 100g of activated carbon, depending on the proportions used.

1A. (Dependent)

Same as 1, carbon is powdered activated carbon.

Carbon is granular activated carbon.

Carbon is very fine carbon black.

Carbon is very fine carbon fiber.

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Carbon is aerogel carbon film.

Carbon is char recovered from pyrolysis process.

Carbon is powdered activated carbon of size distribution larger than fly ash size distribution, so that it can be physically separated from the ash and regenerated for reuse.

Carbon is regenerated from previous usage cycle and recycled.

Other desired types of carbon may also be used.

1B. (Dependent)

Same as 1, Solvent is chlorinated hydrocarbon such as dichloromethane.

Same as 1, Solvent is hydrocarbon solvent such as petroleum ether or ligroin or pentane or hexane or toluene or benzene.

Same as 1, Solvent is water.

Same as 1, Solvent is carbon disulfide.

Same as 1, Solvent is a waste solvent.

Same as 1, Solvent is an ether.

Same as 1, Solvent is recycled from previous batch.

Same as 1, Solvent is supercritical solvent such as CO_2.

Other desired types of Solvents may also be used.

1C. (Dependent)

Same as 1, solution of bromine is applied by stirring the carbon in the bromine solution.

Same as 1, solution of bromine is applied by spraying a solution of molecular bromine in an organic solvent, followed by removal of solvent from the pores by drying the carbon in air or nitrogen.

The bromine may also be applied using other desired techniques.

1D. (Dependent)

Same as 1, removal of solvent is by filtration, centrifugation, settling, and decantation and drying in vacuum, air, or other gas.

Same as 1, when sprayed or minimal volume, removal of solvent is by drying in air, vacuum, or other gas.

The solvent may also be removed using other desired techniques.

1E. (Dependent)

Same as 1, additional substance is iodine, at 1%-10% of the bromine concentration added.

Same as 1, additional substance is hydrohalide (HI, HBr, HCl), etc:, 1%-10 % of bromine.

Same as 1, additional substance is a compound comprised of a Group V or VI element or combination of Group V or VI with Group VII element, such as SCl_2, 1-10 wt % of bromine.

2. A modified carbon sorbent was prepared by reacting the carbon with molecular bromine by contacting the carbon with a gas containing molecular bromine. In one example, the amount of bromine taken up by the carbon ranges from <1 to about 30 g per 100g of activated carbon, depending on the proportions used.

Contacting is by passing the Br_2 gas through a bed of the carbon.

Bed is ebullated or fluidized.

Bed is moving bed of granules or fibers.

Contacting is by admitting Br_2 gas to a duct through which the carbon is transported from a reservoir to the flue gas duct via an air-driven entrainment method, thus promoting the activity of the carbon in-flight.

Same additives as 1E, except these are added in the gas phase, and added in-flight as in 2 above.

3. A modified activated carbon sorbent was prepared by reacting the carbon with hydrogen bromide (HBr) by stirring the carbon in a solution of HBr in an organic solvent or in water, followed by removal of the modified carbon from the bulk of solvent and further removal of solvent from the pores by drying the carbon

in air or nitrogen. In one example, the amount of bromine taken up by the carbon ranges from <1 to about 30 g per 100g of activated carbon, depending on the proportions used.

Same dependent clauses as in 1A with regard to carbon forms. Same solutions and treatment as 1B, 1C, 1D.

Same additives as 1E, added into the solution phase or later in the gas phase, and added in-flight as in 2 above.

4. An activated carbon sorbent was prepared by impregnating hydrogen bromide by passing a gas composition containing hydrogen bromide diluted with nitrogen or air through a fluidized bed or ebullated bed of the carbon. In one example, the amount of bromine taken up by the carbon ranges from <1 to about 30 g per 100g of activated carbon, depending on the proportions used.

Same dependent clauses as in 1A with regard to carbon forms.

Contacting options are similar to 2.

5. Sequential treatment of activated carbon with bromine or HBr, followed by another mercury stabilizing reagent to generate a highly reactive bifunctional sorbent, the reagent to include sulfur and selenium species, such as H_2S, SO_2, H_2Se, Se, SeO_2, CS_2, P_2S_5.

6. Sequential treatment of activated carbon with mercury stabilizing reagent, followed by bromine or HBr to generate a highly reactive bifunctional sorbent, the reagent to include sulfur and selenium species, such as H_2S, SO_2, H_2Se, Se, SeO_2, CS_2, P_2S_5.

7. Treatment of a carbon with a Group V or VI element combined with Group VII element, such as PBr_3 or SCl_2. In one example, the amount of Group V or VI halide is 1-30 wt % of the carbon. The compound is added in vapor phase or in solution (solvent is hydrocarbon, chlorinated hydrocarbon, or other solvent as described in 1B, but not water, since the compound is destroyed in water solution).

8. The process for preparing the bromine-containing activated carbon sorbent as described in Examples 1-6 and coupled with the injection of the bromine-containing fine-particle sorbent into the contaminated gas stream and subsequent removal of the fine particles of sorbent from the gas stream in a collection device, such as bag filtration of electrostatic precipitator (ESP).

9. The process of using additives (1-8) in conjunction with sorbents to capture acid gases and other flue gas constituents that block oxidation reactions or consume sorbent sites that would otherwise capture mercury. The additive is a compound comprised of Group I or II elements, such as Ca, Na, and others. These additives of base chemistry may be added to flue gas as a sorbent mixture or co-injected to selectively sorb acid gases or other gas constituents that compete for mercury reactive/sorption sites, thereby improving the effectiveness of activated carbon to capture mercury. In addition, the base additives can augment the treated activated carbon by helping to capture oxidized mercury forms in the flue gas, such as mercuric chloride, or that are produced on the carbon sorbent, such as mercuric bromide, but are released to the gas phase as the sorbent becomes saturated or capacity limited.

10. The process of preparing a larger-than-normal (>40 μm) sorbent particle size, promoting with the halogen treatment as described in 1-8, using the treated sorbent for capture of mercury by injecting in the flue gas, and finally separating and recovering the sorbent from the ash particles. The larger sorbent size thus will allow easy mechanical/physical separation so that sorbent can be regenerated, recycled, and reused, and the ash can be sold as a low-carbon cementatious byproduct for concrete. The separation can be effected by various methods, such as density (gravity), floatation, or sieving methods.

11. The process for preparing the bromine-containing activated carbon sorbent as described in Example 1-10, coupled with the direct injection of the slurry of the

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prepared fine-particle sorbent in the solvent or aqueous phase, so that the aerosol particles of the slurry achieve a high degree of dispersion in the gas stream and evaporation of the solvent in the hot gas occurs rapidly. The amount of slurry added is flow-controlled, and the concentration of particles in the slurry is monitored by optical density measurements prior to injection. Collection of particles is performed.

12. The process for preparing the bromine-containing activated carbon sorbent, as described in Examples 2 and 4, coupled where the fine-particle dispersion of brominated sorbent in the gas stream at the top of the ebullated bed is led to the flue gas or offgas duct where the said dispersion is contacted with mercury-contaminated flue gas or offgas stream. The amount of aerosol dispersion added is controlled by the gas flow to the ebullated bed, and the concentration of particles in the dispersion can be monitored by optical density measurements prior to injection. Collection of particles is performed by the existing particulate-collection equipment.

13. The process for preparing the bromine-containing activated carbon sorbent bed, coupled with contacting the bed with the mercury-contaminated flue gas or offgas.

14. The process for preparing the bromine-containing activated carbonBsorbent, as described in Examples 2 and 4, or untreated activated carbon, coated on a substrate or as activated carbon material. This material is placed in a moving system that geometrically allows for control of rate of exposure, sorption, and exchange of material in a continuous or semicontinuous manner.

15. In the sorbent and mercury removal process outlined in paragraphs above, the bromine reagents promote metal oxidation activity by creating cationic or radical character on the carbon edge structure that attracts mercury atoms and extracts electrons from said mercury atoms, resulting in oxidized mercury, which is more easily captured on a sorbent. A similar mechanism applies to oxidation and capture of reduced arsenic and other pollutant species.

The invention relates to the process for the removal of mercury and other pollutant species from gas streams generated during the burning of fossil fuels, such as in a coal-fired utility or synthesis gas from gasification facilities. This removal process would utilize a sorbent and/or a combination of additives to remove pollutants from the gas stream, which are at the same time interacting with other gas components that result in poisoning or deactivating the sorbent and reducing its capacity or reaction rates with the targeted pollutant species. The present invention provides a cost-effective way to capture the pollutants by utilizing exceptionally active carbon sorbents and promoting mercury sorbent surface reactions, containing a bromide form of the carbon, that capture mercury with high kinetic chemisorption (oxidation) activity, so that capture can occur during contact times of seconds or less. The sorbent does not require in situ activation (induction period) in the gas stream to achieve high activity as do conventional activated carbon sorbents. The reactivity of the sorbent toward the pollutants and the sorption capacity can be regenerated, recycled, and reused.

Burning fossil fuels generates a flue gas that contains mercury (and other trace elements) that was in the coal, plus oxides of sulfur and nitrogen (acid gas emissions) and particulates whose release to the environment must be controlled by use of sorbents, scrubbers, filters, precipitators, and other removal technologies. While control of other elements and/or flue gas pollutants may apply, the discussion provided is focused on mercury. Initially, mercury is released in the elemental form during combustion/gasification, but downstream of the boiler, in the ducts and stack of the combustion system, part of the elemental mercury is oxidized. The amount oxidized depends on the amount of acid gases present in the flue gas and other factors. Amounts of mercury vary with the coal, but a typical concentration of mercury in the stream of combustion gas is about 5 parts per billion (ppb). A pound of mercury or more per day may be emitted in some utilities.

Discussion of Sorbent Technologies

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Several types of mercury control methods for flue gas have been investigated, including injection of fine sorbent particles into a flue gas duct and passing the flue gas through a sorbent bed. Fine-particle injection sorbents include activated carbon, metal oxide sorbent, sodium sulfide particles (for example, see U.S. Patent 6,214,304), and basic silicate or oxide sorbents (for example, see the Ghorishi reference (Ghorishi,B.; Gullet, B.K. Waste Manage Res. 1993, 16, 582). and Lancia references). When particle injection is employed, the mercury chemisorbed to the sorbent particle is removed from the gas stream in a bag house or ESP and collected along with ash particulates (for example, see U.S. Patents 4,889,698, 4,956,162, 5,672,323, 5,827,352, 6,027,551, and 5,505,766). The sulfide and basic silicate and oxide particles are effective only for the oxidized mercury, and the metal oxide sorbents exhibit slower capture kinetics than the carbon particles. Additionally, injection of fine carbon particles into the flue gas stream has been only partially successful in removing mercury, especially elemental mercury, where effective removal of approximately 60% was attained with a baghouse to collect carbon and ash. Even lower removal rates have been observed when using an ESP to collect the carbon, since the contact time of the carbon with the gas is very short.

A major problem with existing carbon injection systems is that the sorbent is initially unreactive, and only after exposure to the flue gas for about 20 minutes does the seasoned sorbent become effective and provide capture of 60% of the mercury in the gas. Consequently, these sorbents must be used in large amounts (high sorbent-to-mercury ratios) to effectively capture the mercury. These sorbents can be relatively expensive and cannot be easily separated from the ash, regenerated and reused. The collection of carbon in the ash also creates solid waste disposal problems, and the spent sorbent may contaminate the collected ash for use in various applications.

Use of Halogens in Mercury Capture

Methodologies for using halogens for the treatment of flue gas have not previously been effective. Halogen is defined as a member of the very active

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elements comprising Group VII-A of the periodic table. In the molecular elemental halogen form, including F_2, Cl_2, Br_2, and I_2, the reaction with elemental mercury is not fast enough to result in the formation of oxidized mercury in a coal combustion flue gas with conventional ash control technology. The atomic elemental halogen form, which includes F atom, Cl atom, Br atom, and I atom, is about a million times more reactive to mercury, but the concentrations of these forms are extremely low, and also, therefore, cannot result in oxidation of mercury in a utility flue gas.

A halide is a compound formed from reaction of a halogen with another element or radical. In general, the halide compounds are normally very much less reactive than the molecular halogens, having expended their high chemical potential in forming the low energy halide. The halide is considered a reduced form and cannot therefore oxidize anything by itself. It is for this reason that it is not obvious that a halide-halogen treated activated carbon would be effective at oxidizing elemental mercury and provide effective capture of elemental mercury. In fact, for tests with salts, analytical data show the addition of bromine to an activated carbon or carbon black or soot does form a compound by reacting with the unsaturated groups on the carbon. By applying x-ray photoelectron spectroscopy, it has been determined that bromine or HBr added to carbon black forms chemical compounds within a carbon structure.

A body of theory has been developed from scientific evidence to explain the nature of the promotion effect of the bromine compounds. This principle is illustrated in FIG. 2, which in step 1 shows the reaction of the hydrogen bromide with the unsaturated structure of the activated carbon. This may be a carbene species on the edge of the graphene sheets structures of the carbon. Molecular bromine or a bromine compound reacts to form a similar structure, with a positive carbon that is active for oxidizing the mercury.

We now teach that the formation of the new bromide compound with carbon increases the reactivity of the carbon forms toward mercury and other pollutants. The resulting bromide compound is uniquely suited to facilitate oxidation of the mercury. The effectiveness of the oxidation results from the promotion effect of the halide exerted on the developing positive charge on the mercury during the

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oxidation, known in the chemical art as a specific catalytic effect. Thus, as the mercury electrons are drawn toward the positive carbon, the halide anion electrons are pushing in from the other side, which stabilizes the positive charge developing on the mercury and lowers the energy requirement for the oxidation process. Bromide is especially reactive, owing to the highly polarizable electrons in the outer 4p orbitals of the ion. Thus, adding HBr or Br_2 to the carbon forms a similar carbon bromide, in which the positive carbon oxidizes the mercury with the assistance of the bromide ion.

Prior Art Publications

The earliest patents that relate to mercury capture on a sorbent are actually not for flue gas mercury control but for capture of mercury from air or other gas mixtures on a carbon or other sorbent. These patents were based on a model that recognized the affinity of halogens for mercury, rather than the formation of a reactive carbon. These patents are discussed below according to the type of halogen used for impregnation.

One patent that teaches a halogen impregnation (Stock, U.S. Patent 1,984,164, issued in 1934) describes the use of activated carbon or other solid impregnated with a halogen for removing Hg from air. The impregnation method is not specified. This seems to be the most general claim with respect to halogen impregnation. All the statements and claims appear to refer to halogen or iodine, but the patent does not appear to address bromides or other halides or bromide compounds or even specifically iodide or an iodine compound. The only example in the description is iodine impregnation. The patent also is restricted to air systems and did not pertain to flue gas systems with reactive acid gases. The description did not assume that the iodine formed a reactive carbon species.

Japanese Patent JP 49-43197 describes the treatment of Hg-contaminated electrolysis cell gas using a metal iodide salt on a support. A similar treatment using a resin impregnated with a metal iodide is described in JP 50-6438. These patents do not appear to represent a carbon bromide compound as specified in this patent application.

Another early patent (Hilgen, U.S. Patent 3,849,267, issued in 1974) describes a method for Hg removal from a gas which claims mixing molecular chlorine (Cl_2) with the gas to be cleaned and passing it through a nonporous sorbent such as glass wool and NaCl (not carbon). This was evidently not an obvious extension of the Stock patent, since a halogen was introduced as part of the gas phase being cleaned.

A later patent (deJong, et al., U.S. Patent 4,196,173, issued in 1980) describes a method for Hg removal in air which claims using a bed of activated carbon impregnated with halogen-only Cl_2 is specified in the other claims and examples, and it is prepared by flowing the Cl_2 stream through a carbon bed.

An improved sorbent for mercury in air was patented by Revoir and Jones (U.S. Patent 3662523, issued in 1972), in which ICl and ICl_3 vapors were impregnated into the activated carbon. No explanation of the increased activity was provided. Since these compounds are interhalogen compounds, the patent did not infringe Stock.

U.S. Patent 5,891,324 describes an activated carbon containing an acid (HCl, H_2SO_4, or H_3PO_4) for the removal of mercury contained in a liquid phase, such as would occur in a process steam in the oil industry. In this case, the model presented was that mercury is adsorbed from the liquid into the solid carbon phase at relatively low temperatures.

In U.S. Patent Application 2004/0003716, a method is described for removing mercury from a combustion gas. This method employs an exposure of a finely powdered activated carbon to a molecular bromine gas at an elevated temperature or to HBr to produce a sorbent with good mercury removal ability when injected into the flue gas duct. The model for the efficacy of the Nelson sorbent is not clearly stated, so it can be presumed that the reasoning for using bromine is the simple premise that some bromine form will help capture the mercury, as does iodine and chlorine. The methods for incorporation of the bromine in the Nelson application are not the same as with the present invention, and the Nelson method will not produce the identical carbon bromide species that are obtained in the art described in this application. The Nelson method lacks many of the features

described in this application that impart exceptional activity to the sorbent in a convenient way, for example, the addition of smaller amount of a second more powerful promoting agent, the use of facile solvent systems, including aqueous bromine, and the use of in-flight bromine treatment. Additionally, the patent application does not mention regeneration, recycling, or reuse, or the use of moving contactors or larger particle size to facilitate sorbent-ash separation.

Embodiments of the Invention.

A sorbent that is initially very reactive in oxidizing mercury can be used in very small amounts to achieve high capture efficiencies, thus lowering operation costs and lessening the disposal problem. In addition, further disposal reduction is made possible by recycling and reusing the sorbent that is produced using this technology. The time interval for the mercury and sorbent to interact in a flue gas duct and the subsequent collection of the mercury on the sorbent and ash may be very short- only seconds. This requires the sorbent to have high capacity and be very reactive toward mercury. A sorbent can be utilized in a very finely powdered form (e.g., 1-10 μm) to minimize mass transfer limitations. But, again, the reactivity should be very high to capture all of the mercury encountered by the fine particles. One feature of this invention is the process to prepare a sorbent containing a bromide compound formed on the carbon structure that provides a sorbent that is highly active on initial contact with the mercury contaminated gas stream, which allows for effective capture of the mercury.

One possible way to do this is to chemically combine molecular bromine from solution with activated carbon (edge sites). X-ray photoelectron spectroscopy established that the addition of bromine formed a chemical compound in the carbon structure. Thus, the sorbent does not represent a molecular bromine halogen form but a new chemically modified carbon structure. This may not occur with the less reactive iodine, where an I_2- molecular complex can exist on the carbon basal plane. In the bromine case, it is actually the carbon that oxidizes the mercury. Thus, an entirely new model is presented for the reactivity of the bromine-treated carbon with mercury. The reactive carbon form can be generated by the addition of bromine,

hydrogen bromide, or combinations of bromine and other elements as described herein. Chlorine treatment resulted in lower-activity carbons because the chloride anion was less effective in promoting the oxidation by stabilizing the developing positive charge on the mercury in the transition state for oxidation. Based on this model, several innovative, inexpensive, activity-enhancing features have been developed.

It has been demonstrated that addition of an optional second component, in addition to the bromine, results in improved reactivity and capacity for the sorbent, exceeding that of both the untreated carbon and the brominated carbon. The second compound comprises either a second halogen or a compound from a second halogen, such as HBr. Thus, in addition to having a reactive carbon form present, the second component generates a Lewis base with greater ability to stabilize the developing positive charge on the mercury. Thus the second component is an element with more polarized electrons (4p and 5p).

Furthermore, we demonstrated that the sorbent can be readily treated with any combination of bromine and the second component in-flight using vapors of these components contacting the very fine carbon particles dispersed in air or other gas stream that conveys the particles to the flue gas duct. There is no particular temperature requirement for this contact. This technology is very simple to implement, so it will result in a great cost savings to the utility using this technology for mercury capture.

A unique, nonobvious technique for preparation of the treated carbon is through combining the treatment system with the carbon injection system at the end-use site. With this technique, the halogen is introduced to the carbon-air mixture in the transport line (or other part of the sorbent storage and injection system). Benefits over current concepts to treat sorbents off-site include the following:

- Capital equipment costs at a treatment facility are eliminated.
- Costs to operate the treatment facility are eliminated.
- There are no costs for transporting carbon and additive to a treatment facility.
- This process uses existing hardware and operation procedures.

- This technology ensures that the sorbent is always fresh, and thus, more reactive.
- No new handling concerns are introduced.
- There are no costs for removing carbon from treatment system.
- This process allows rapid on-site tailoring of additive-sorbent ratios in order to match the requirements of flue gas changes, such as needed when changing fuels or reducing loads, thus further optimizing the economics.
- This technology reduces the amount of spent sorbents that are disposed.

With the foregoing and other features in view, there is provided, in accordance with the invention, a process for preparing and regenerating carbon sorbents whose activity for mercury capture is promoted by the addition of bromine to the carbon structure.

The invention applies to use of a sorbent in a powdered form that has been injected into a flue gas stream before or after ash particulates have been removed. Examples of the composition of the sorbent are a powdered modified activated carbon prepared by adding Br_2 or HBr plus a second optional component. Alternatively, the sorbent is on a moving contactor consisting of particles or fibers containing the compositions listed in the previous sentence. Either type can be regenerated; the poisoning contaminants from the flue gas are removed and an inexpensive promoting agent added to restore mercury sorption activity. This process of promoting the activity of the carbon itself contrasts with the earlier, more expensive art of adding a reagent (such as peroxide, gold, triiodide, etc.) to the sorbent. The activated carbon sorbent treated with bromine and/or the other components is noncorrosive.

Detailed examples of sorbent regeneration techniques are described in co-pending, commonly-owned PCT patent application No. PCT/US04/12828, titled "PROCESS FOR REGENERATING A SPENT SORBENT", which is incorporated by reference herein.

Although the invention is described herein as a sorbent material, it is nevertheless not intended to be limited to the details described, since various modifications and structural changes may be made therein without departing from

the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific exemplary embodiments.

FIG. 11 is a block diagram illustrating the use of the invention in a coal fueled facility. Of course, the invention can also be used in any other desired type of facility. FIG. 11 shows a boiler for burning pulverized coal. The facility utilizes various devices to clean the exhaust of the boiler. In this example, a baghouse or ESP is used to collect particulates in the exhaust. A scrubber and sorbent bed are also used to remove undesired constituents from the flue gas stream, before being fed to the stack. In the example shown, the sorbent is injected into the flue gas after the boiler. The additive can be injected where desired (e.g., before, after, or within the boiler).

Another advantage of the present invention relates to the use of a feedback system to more efficiently utilize the invention. Where possible, the mercury control technology of the present invention will utilize measurement of mercury emissions as feedback to assist in control of the sorbent injection rate. Tighter control on the sorbent levels in this way will ensure mercury removal requirements are met with the minimal sorbent requirements and therefore the associated costs will be minimized. In one example, the emissions are measured at the stack.

Carbon Sorbent

Reactions of halogens and acidic species with the basic binding sites on the activated carbon sorbent create sites for oxidizing mercury. Other metal ions, such as boron, tin, arsenic, galium, Sb, Pb, Bi, Cd, Ag, Cu, Zn, or other contaminants, will also react with the oxidation sites generated on the carbon.

According to our model, adding the bromine from the bromine reagent or a proton from a hydrogen halide acid to a basic carbene site on the carbon edge structure forms a carbocation that accept electrons from the neutral mercury atom forming the oxidized mercury species that is bound to the sorbent surface. The

reactive site may also generate reactive bromine radicals or carbon radicals at the active sites on the carbon. Thus, the activated carbon serves to stabilize the bromine, yet provides a highly reactive bromine- containing reagent that can oxidize the mercury and promote its capture on the activated carbon. The sorbent that contains bromine is expected to be more reactive than the corresponding sorbent containing chlorine and much less expensive than the sorbent containing iodine.

A bench-scale procedure based on the above description was used to test the initial activities and capacities of several powdered carbon sorbents, including the bromine-containing activated carbons prepared from a commercially available sorbent and an aerogel carbon film sorbent, as well as the original precursor carbons for comparison. Bromine-treated carbons were prepared by impregnation of the powdered activated carbon precursors in a stirred solution of bromine in carbon tetrachloride or methylene chloride, or alternatively, in an aqueous solution of HBr, followed by drying in air at ambient temperature and drying in an oven at 100°C in air or nitrogen. Bromine-treated carbons were also prepared by impregnating bromine from the gas phase by passing the gas through a rotating dry bed of the activated carbon precursor. Adding a second component to the solution was demonstrated to improve the capacity of the sorbent.

The carbons were initially tested in a heated bed, where a synthetic flue gas stream containing elemental mercury (11 $\mu g/m^3$) was passed through the bed. Concentrations of total and elemental Hg in the effluent gas were determined using a Sir Galahad mercury CEM. The powdered sorbent was supported on a quartz filter during the test, and the other sorbents were tested as a triple layer.

A comparison of the original commercial-grade powdered carbon sorbent with the sorbent after it has been treated with 0.1 N HBr, collecting the powder by centrifugation and drying, revealed that the mercury capture activity is increased from an initial capture efficiency of about 50% of the Hg in the inlet to 100% capture. A comparison of the sorbent after subsequent regeneration with HBr indicates that it not only captures mercury at the same level as before (100% capture) but is enhanced such that its capacity is prolonged by several minutes.

Similar results were obtained with the carbon film and carbon fiber sorbents by treatment with molecular bromine in solution or in dry beds as described above.

An activated carbon sorbent was prepared by treating the carbon by impregnating molecular bromine from a gas composition containing molecular bromine by flowing the gas through a liquid bromine reservoir in series with a fluidized bed of ebullated bed of the carbon. The amount of bromine taken up by the carbon ranges (in one example) from <1 to about 30 g per 100 g of activated carbon, depending on the proportions used.

In one exemplary test conducted at a facility fired with lignite coal, the flue gas phase mercury (elemental) concentration was between 10 and 11 $\mu g/m^3$. The ash and injected carbons were collected in the baghouse at 350E to 375EF. Injection of commercial-grade activated carbon powder (untreated) at a rate of 1.0 lb/Macf resulted in mercury effluent concentrations of 3.8-4.2 $\mu g/m^3$ (representing 62%-58% removal of the mercury from the gas), and at 2.0 lb/Macf, gave 74%-71% removal. Injection of the bromine-treated carbon at 1.0 lb/Macf resulted in 73%-69% removal and at 2.0 lb/Macf gave 86%-84% removal. Thus, a significant increase in the mercury capture was exhibited during use of the bromine-treated carbon.

Addendum: Other References to Hg Sorption

Sorbent Beds with Particulate Removal

Carbon beds have also been utilized for mercury capture in flue gas. The German Patent 34 26 059 describes the use of a very thick carbon bed for treatment of flue gases containing polyhalogenated compounds. Although the system employed at Dusseldorf would also have the potential for Hg removal (for example, see the Streng reference), it is not very practical to use such a thick bed. Spent sorbent is burned and not regenerated. The carbons are not pretreated.

The GE-Mitsui-BF system (Tsuji, K.; Shiraishi, I.; Dague, R.F. Proceedings, Sixth International Symposium, Air & Water Management Assoc., New Orleans, LA, March 10-12, I993) employs a recirculating carbon bed, where mercury is removed along with acid gases (as ammonium salts) and the carbon is regenerated at high temperatures where ammonium sulfate is decomposed to SO_2 and N_2 and

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mercury is converted to the elemental form, which desorbs from the sorbent. Attrition of the sorbent results in a significant sorbent cost. The carbons are not pretreated.

Sorbent Injection After Particulate Removal

A process of injecting manganese oxide sorbent particles is described in U.S. Patent Application 2002/0150516. Regeneration is claimed by removal of spent oxide particles from the reaction zone and rinsing with dilute aqueous acid.

Sorbent Beds After Particulate Removal

Of particular interest in designing a mercury control process is to use the sorbent downstream of a particulate control device so the sorbent is not highly diluted with the ash particles. The sorbent could then be more easily regenerated and recycled. The prior art teaches several examples of this type of configuration and sorbent processing.

U.S. Patent 5,607,496 teaches the oxidation of mercury on a metal oxide sorbent bed and subsequent absorption to sorbent. The sorbent bed follows the particulate-removal equipment and, thus, the gas still contains the SO_x and NO_x, which react with the metal oxide sorbent to form the metal sulfates, which poison the bed. High temperatures are proposed to regenerate the bed. However, Hg is only partially removed from the sorbent at temperatures up to 500°C. The sorbents do not work effectively after regeneration using this technique; the problem may be that manganese sulfate formed during the sorption cycle does not completely decompose back to an active manganese oxide form.

U.S. Patent 6,383,981 describes a fixed MnO_2 or Fe_2O_3 bed for removal of Hg from a hydrocarbon stream. No regeneration method appears to be included.

A recent U.S. Patent application (2001/0003116) describes the regeneration of a plate or honeycomb material composed of transition metal oxides that was used for sorption of mercury in flue gas. The claimed process involves heating the sorbent in a reducing gas stream to remove poisons, followed by impregnation with a polyfunctional complex-forming reagent containing the catalyst active component

to restore mercury capture capacity. The first of these steps can remove the mercury, but it is unclear whether it actually removes the sulfate poison. The second of these steps is rather expensive, because one is actually reconstituting the reagent on the sorbent

Porous beds containing a mercury oxidizing reagent on a solid support are described in several patents for removal of mercury from gas streams. These include peroxomonosulfate (for example, see U.S. Patent 4,786,483), triiodide or other mixed halogens (for example, see U.S. Patents 3,194,629; 3,662,523), or sulfur (for example, see U.S. Patents 3,194,629, 4,101,631, 4,708,853, 6,258,334). The reagent material is destroyed either by reaction with the flue gas during sorption or by attempts to regenerate the sorbent; there is no way to regenerate these sorbents, except by reimpregnation of the expensive reagent.

Amalgamating noble metals (gold, silver) on a suitable support can be regenerated by microwave heating (for example, see U.S. Patent 6,136,072), but they are expensive and not especially active for sorption in flue gas.

Hg Sorbents for Air or Natural Gas Treatment

Melkersson (U.S Patent 3786619) described a Hg sorbent comprising SeO_2 or SeS_2 for air treatment. This method did not appear to employ a carbon support or halide.

Yan (U.S. Patent 4814152) described a Hg sorbent comprising elemental sulfur and a metal catalyst on a carbon support. This method did not appear to employ a halide.

Attia (U.S. Patent 65080281) described a sorbent for mercury and a variety of other contaminants comprising an inorganic aerogel composition. This method did not appear to employ a carbon support or halide.

Following is a List of Various Backgroumd References:

Lancia, A.; Musmarra, D.; Pepe, F.; Volpicelli, G. *Combust. Sci. & Technol.* **1993,** *93*, 277.

Streng, S.; Kassebohm, B. *Fuel Proc. Technol.* **1994,** *39,431.*

U.S. Patent 6,214,304 Rosenthal

U.S. Patent 4,889,698 Moller

U.S. Patent 4,956,162 Smith

U.S. Patent 5,672,323 Bhat.

U.S. Patent 5,827,352 Altman

U.S. Patent 6,027,551 Hwang

U.S. Patent 5,505,766 Chang

U.S. Patent 5,607,496 Brooks

U.S. Patent 6,383,981 Blankenship

U.S. Patent 4,786,483 Audeh

U.S. Patent 3,194,629 Dreibelbis, et al

U.S. Patent 4,101,631 Ambrsini, et al

U.S. Patent 3,662,523 Revoir

U.S. Patent 4,708,853 Matviya

U.S. Patent 6,258,334 Gadkaree

U.S. Patent 6,136,072 Sjostrom

U.S. Patent Application 2002/0150516

U.S. Patent Application 2001/0003116 Neufert

CLAIMS

1. A method for reducing mercury in a mercury-containing gas, the method comprising:

injecting a sorbent into the mercury-containing gas;

collecting mercury in the mercury-containing gas on the sorbent to produce a cleaned gas, wherein the sorbent is a promoted activated carbon that is promoted in-flight with at least one promoter that is Br_2, HBr, Br^-, or a combination thereof, wherein the mercury-containing gas is a coal-combustion gas.

2. The method of claim 1, wherein the coal that is combusted comprises the promoter or a precursor thereof.

3. The method of claim 2, further comprising combusting the coal that comprises the promoter or the precursor thereof.

4. The method of claim 1, wherein the promoted activated carbon is promoted with the promoter while the promoter is in the gas phase or is a vapor.

5. The method of claim 1, further comprising promoting the activated carbon in-flight.

6. The method of claim 1, wherein the promoted activated carbon comprises active sites, comprising halide anions bound to the activated carbon.

7. The method of claim 1, wherein the promoted activated carbon comprises active sites comprising carbocations bound to halide anions.

8. The method of claim 1, wherein collecting the mercury comprises chemically reacting carbene species edge sites in the activated carbon with the mercury.

9. The method of claim 1, further comprising injecting an alkaline sorbent into the mercury-containing gas stream.

10. The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

11. The method of claim 9, wherein the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

12. The method of claim 1, wherein the activated carbon is chosen from powdered activated carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and combinations thereof.

13. The method of claim 1, wherein the promoter is HBr or Br^-.

14. The method of claim 1, wherein the mercury-containing gas is a flue gas stream downstream of a boiler furnace.

15. The method of claim 1, wherein monitoring the mercury content of the cleaned gas is performed substantially continuously.

16. The method of claim 1, wherein the sorbent has a composition comprising from about 1 to about 30 grams of promoter per 100 grains of activated carbon.

17. The method of claim 1, further comprising injecting sorbent into the mercury-containing gas stream to form the promoted activated carbon.

18. The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas.

19. The method of claim 1, comprising collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent.

20. The method of claim 1, wherein the method is a method for reducing mercury in the mercury-containing gas to a desired level, the method further comprising:

monitoring the mercury content of the cleaned gas; and

controlling, in response to the monitored mercury content of the cleaned gas, an injection rate of injecting the sorbent into the mercury-containing gas, the sorbent composition, or a combination thereof, so that the mercury content of the cleaned gas is maintained at or below the desired level.

Abstract

A promoted activated carbon sorbent is described that is highly effective for the removal of mercury from flue gas streams. The sorbent comprises a new modified carbon form containing reactive forms of halogen and halides. Optional components may be added to increase reactivity and mercury capacity. These may be added directly with the sorbent, or to the flue gas to enhance sorbent performance and/or mercury capture. Mercury removal efficiencies obtained exceed conventional methods. The sorbent can be regenerated and reused. Sorbent treatment and preparation methods are also described. New methods for in-flight preparation, introduction, and control of the active sorbent into the mercury contaminated gas stream are described.

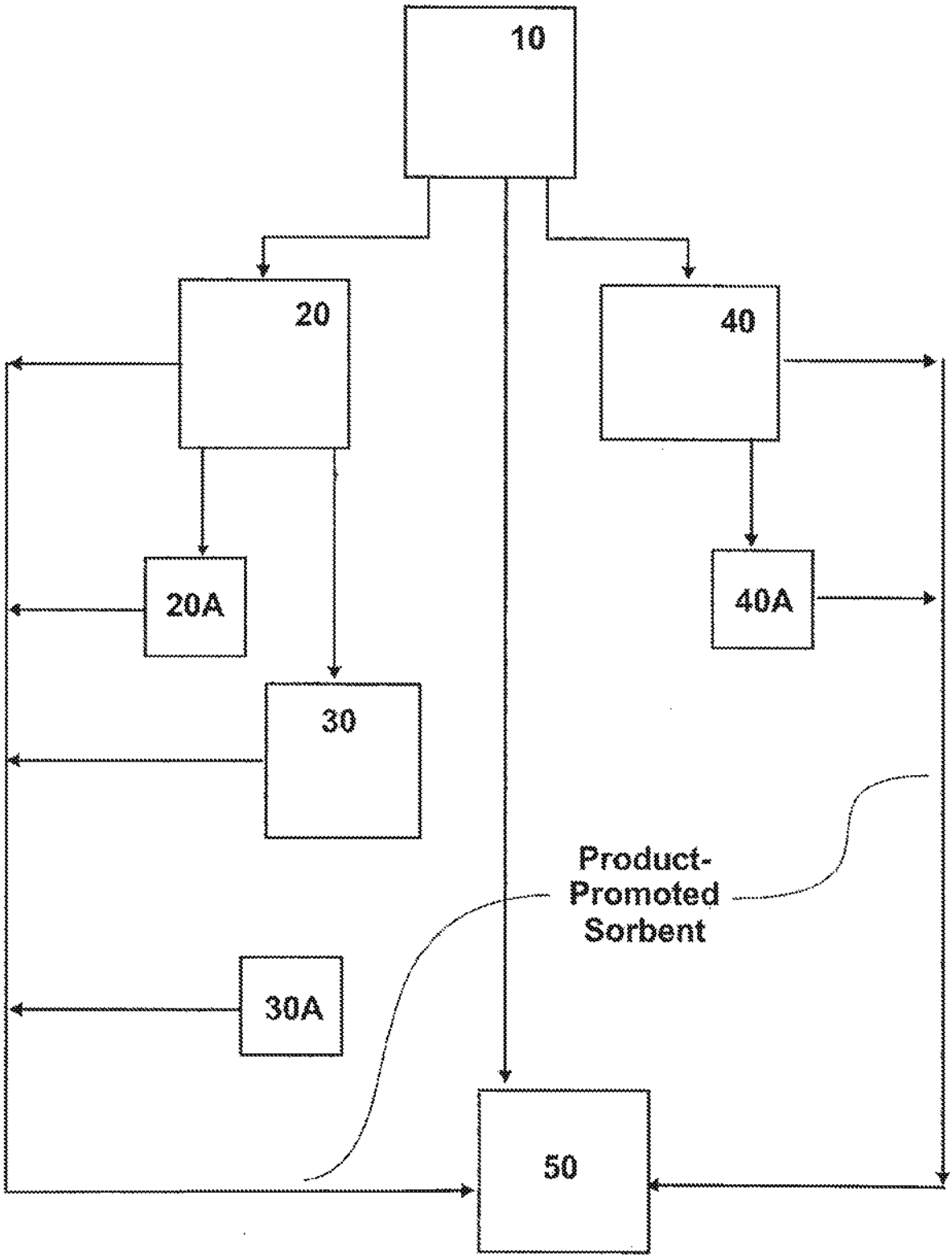


FIG. 1

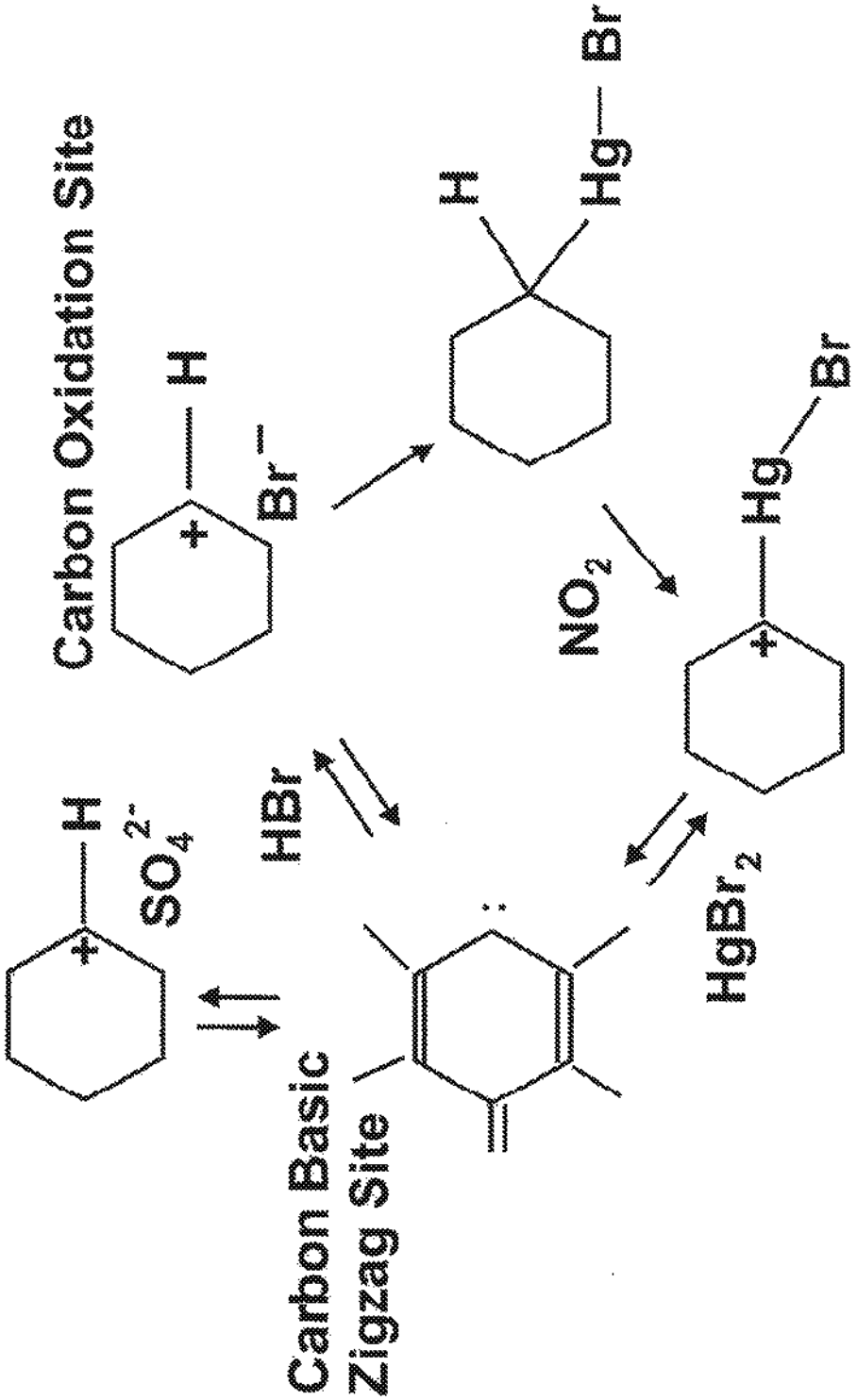

Carbon Oxidation Site
H
Br⁻
H
Hg—Br
NO₂
Hg—Br
HBr
H
SO₄²⁻
HgBr₂
Carbon Basic
Zigzag Site

FIG. 2

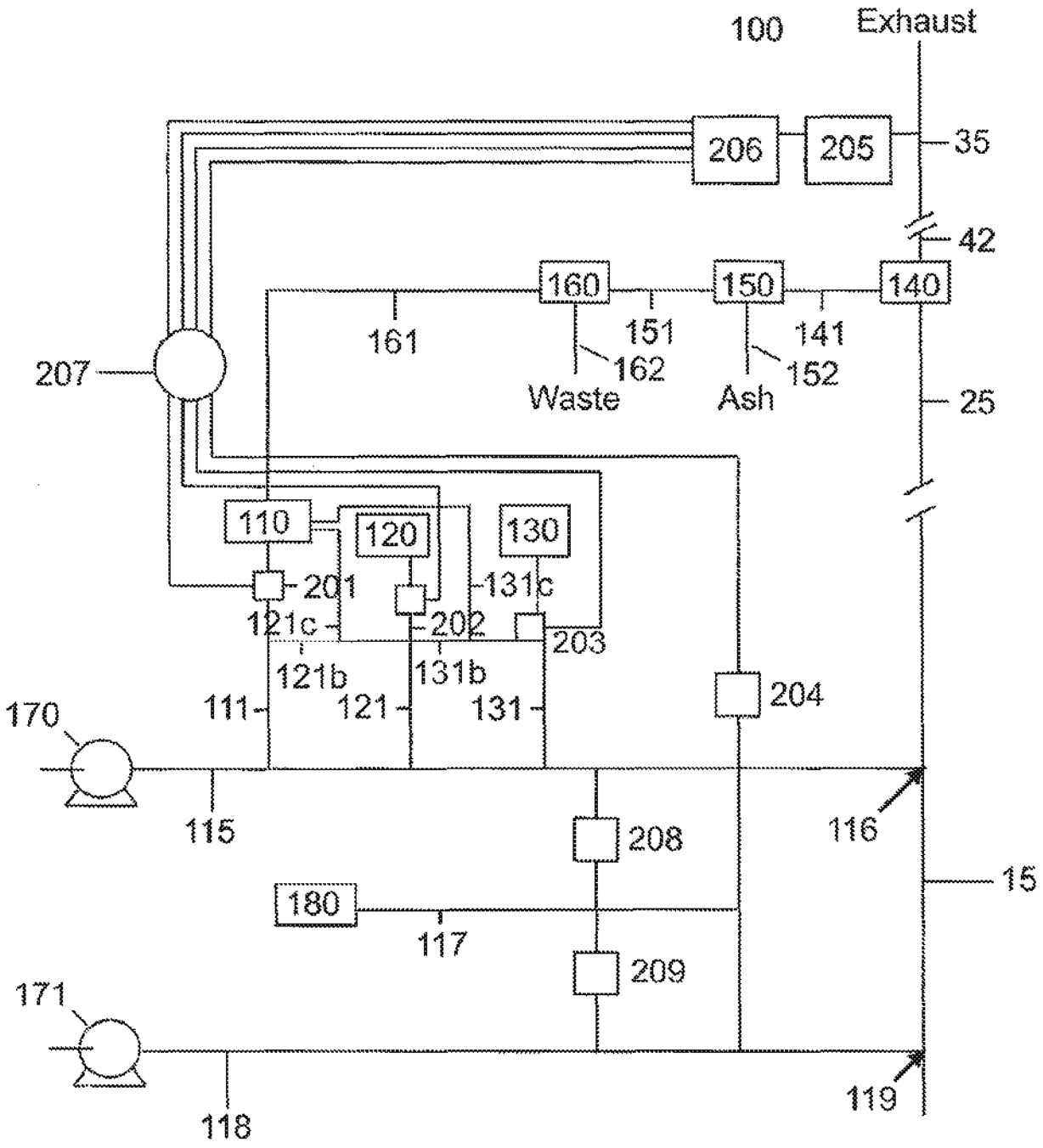

100
Exhaust
206
205
35
42
160
150
140
161
151
141
162
152
207
Waste
Ash
25
110
120
130
201
131c
121c
202
203
121b
131b
111
121
131
204
170
115
208
116
15
180
117
209
171
118
119

FIG. 3

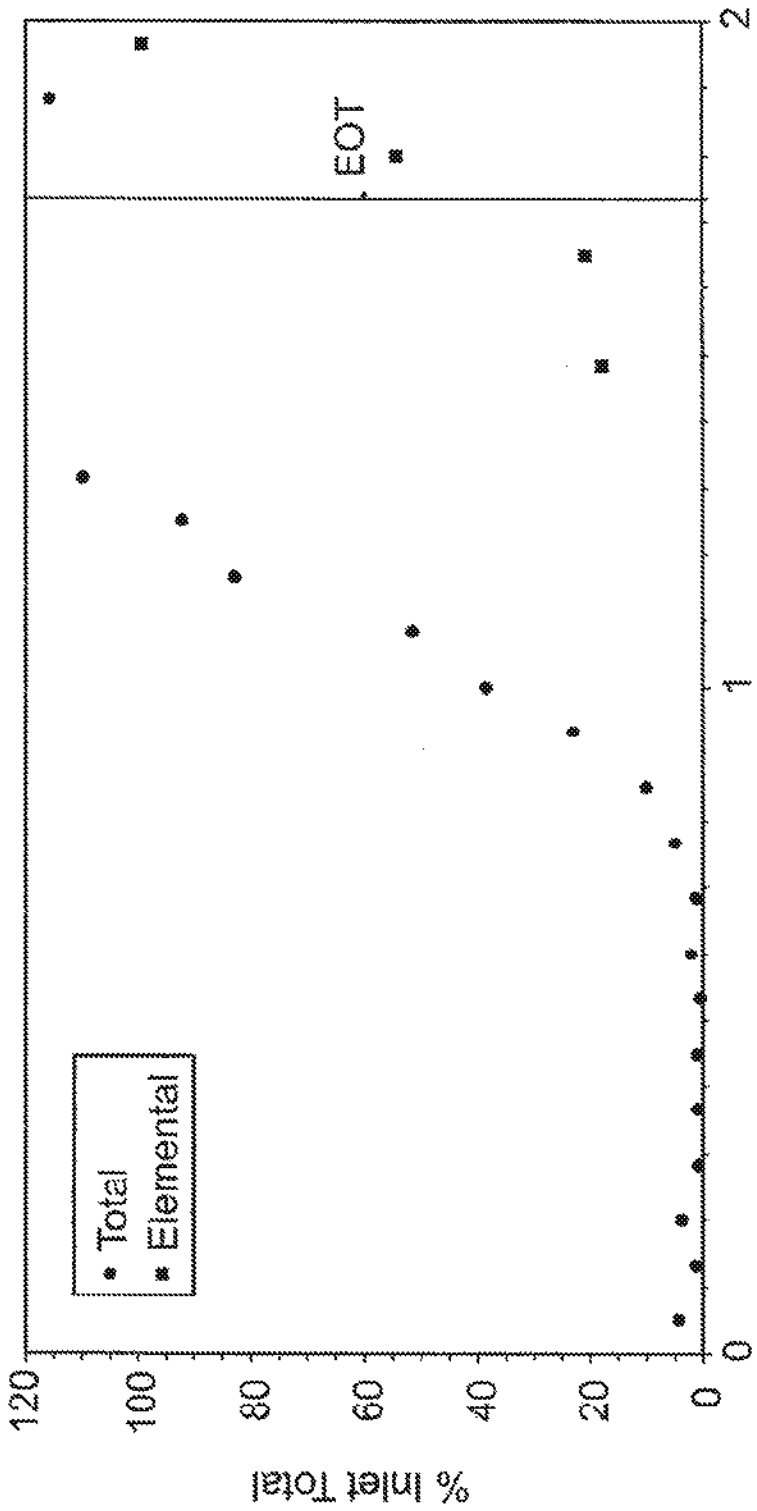

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 4

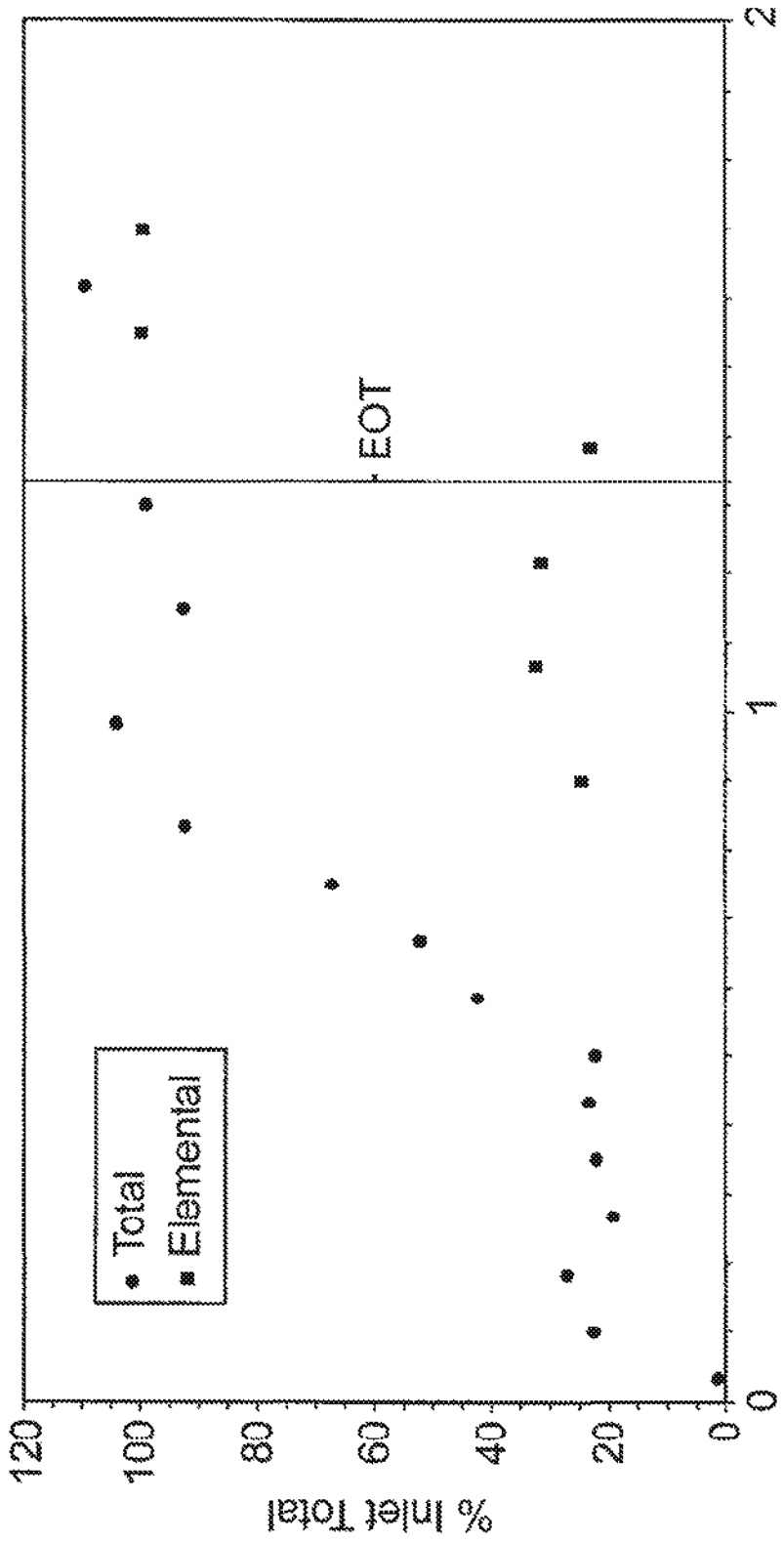

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 5

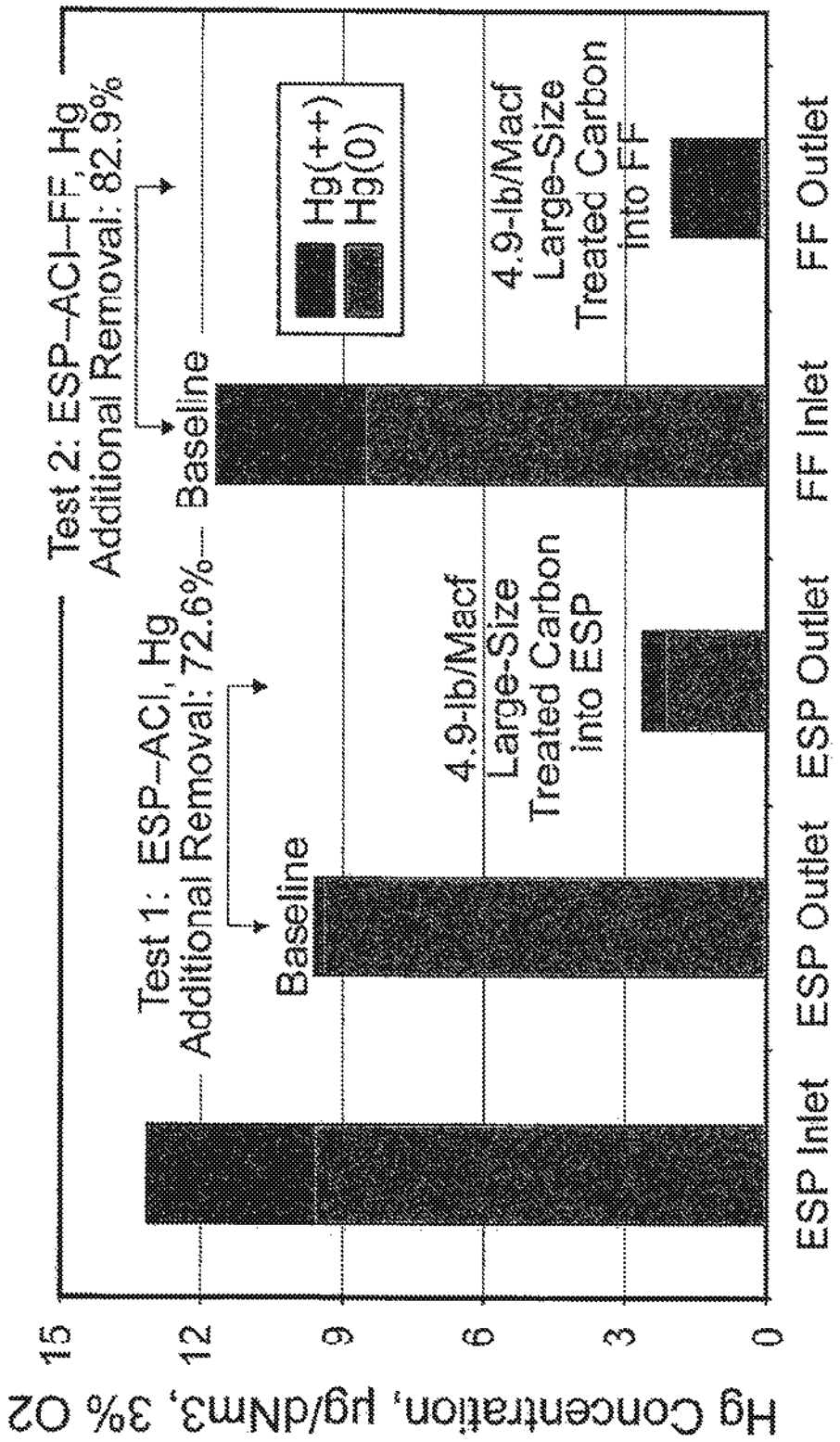

Hg Concentration, µg/dNm3, 3% O2
15
12
9
6
3
0
ESP Inlet
ESP Outlet
ESP Outlet
FF Inlet
FF Outlet
Test 1: ESP–ACI, Hg
Additional Removal: 72.6%
Baseline
4.9-lb/Macf
Large-Size
Treated Carbon
into ESP
Test 2: ESP–ACI–FF, Hg
Additional Removal: 82.9%
Baseline
4.9-lb/Macf
Large-Size
Treated Carbon
into FF
Hg(++)
Hg(0)

FIG. 6

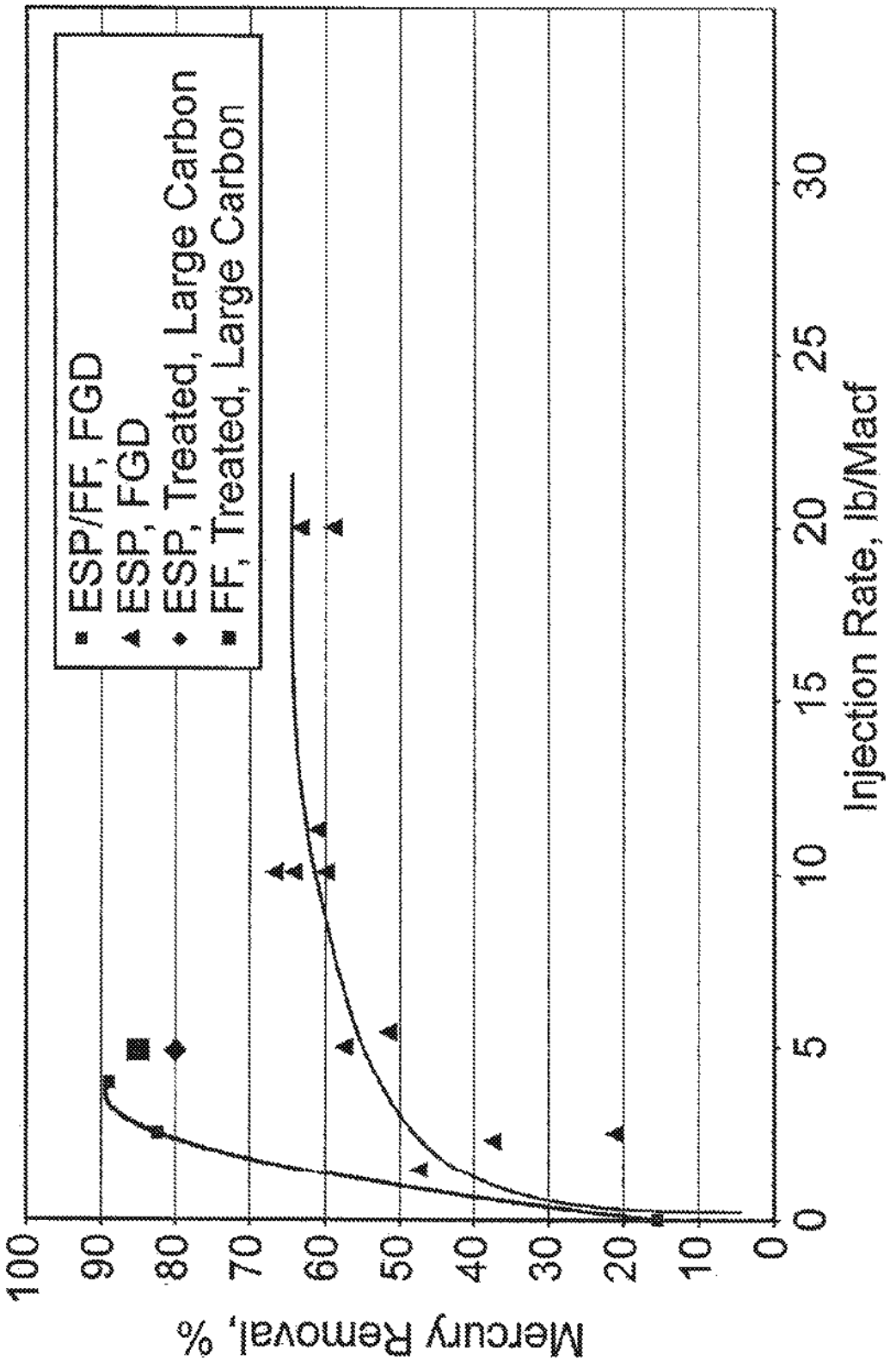

ESP/FF, FGD
ESP, FGD
ESP, Treated, Large Carbon
FF, Treated, Large Carbon
Mercury Removal, %
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Injection Rate, lb/Macf

FIG. 7

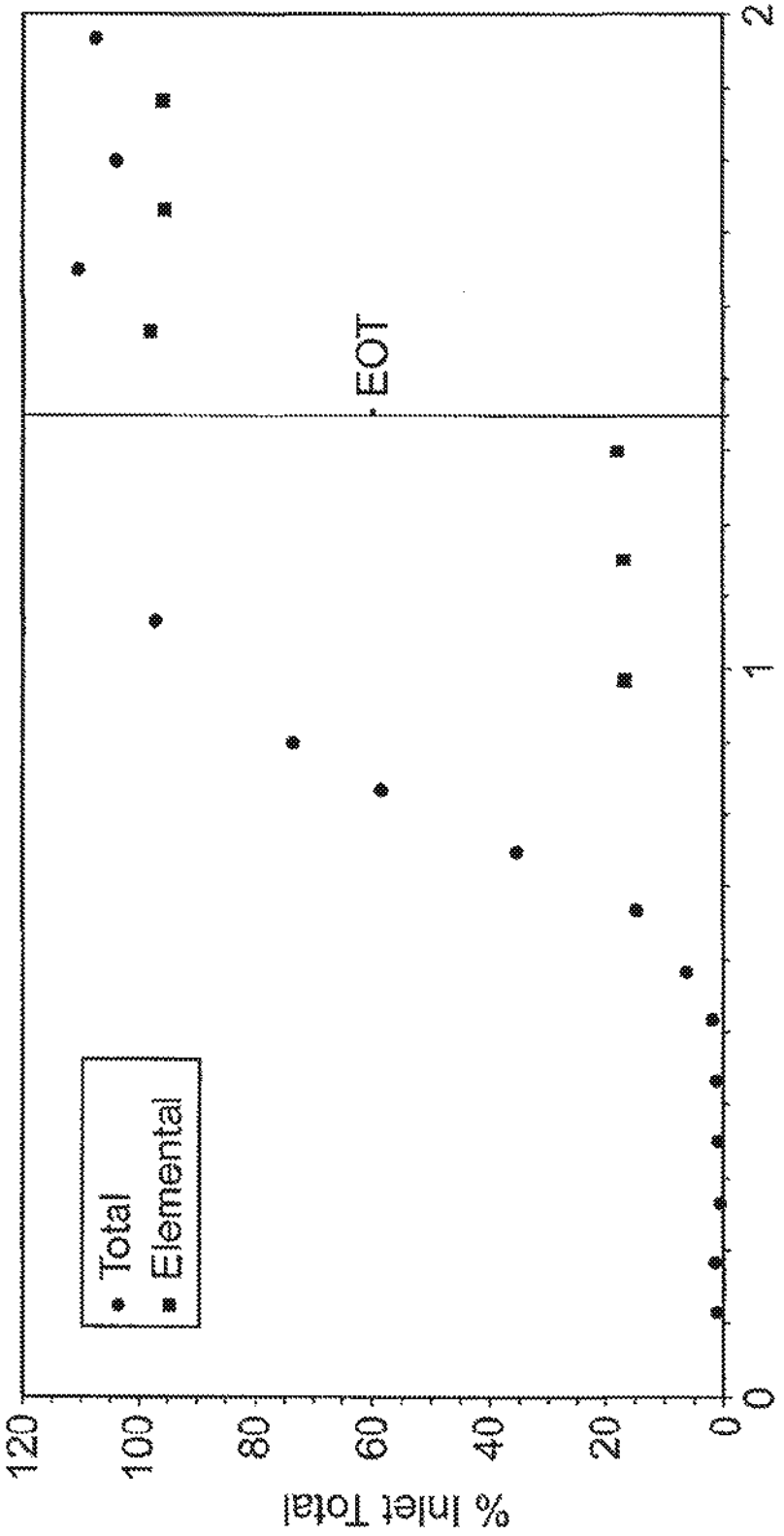

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 8

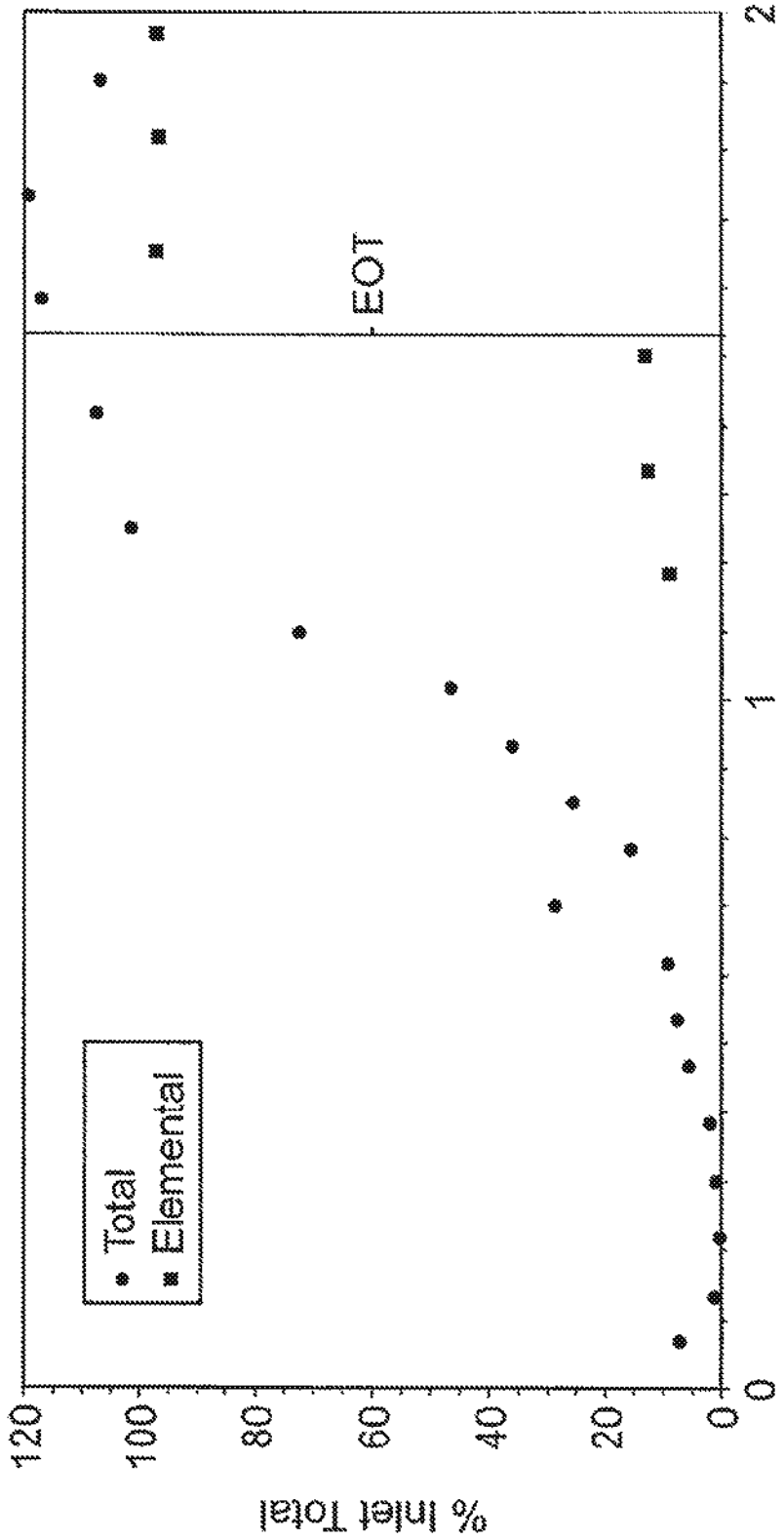

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 9

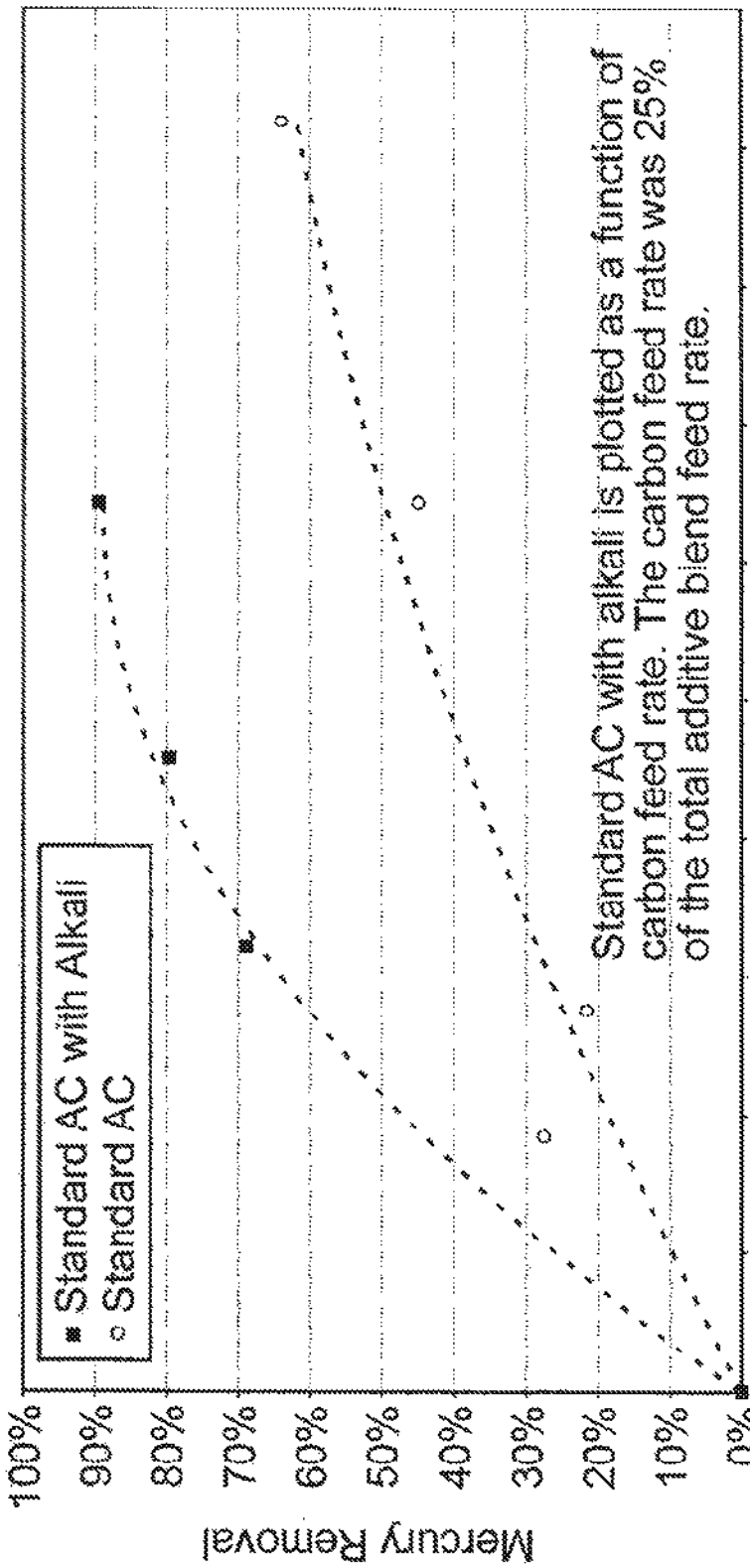

Mercury Removal
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
Carbon Injection Rate, lb/Macf
Standard AC with Alkali
Standard AC
Standard AC with alkali is plotted as a function of carbon feed rate. The carbon feed rate was 25% of the total additive blend feed rate.

FIG. 10

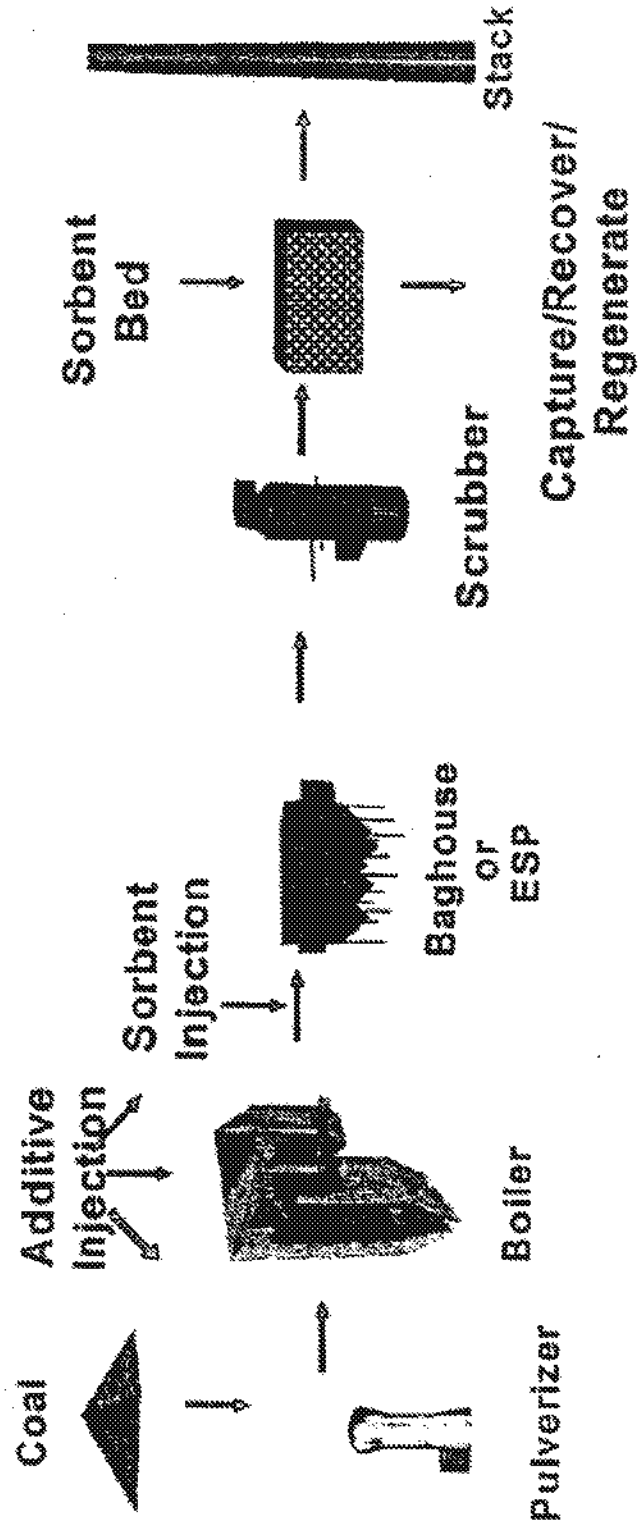

Coal
Pulverizer
Additive Injection
Boiler
Sorbent Injection
Baghouse or ESP
Scrubber
Capture/Recover/ Regenerate
Sorbent Bed
Stack

FIG. 11

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	John I. Fischer/Allison Johnson
Attorney Docket Number:	4820.001US10

Filed as Large Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**5860**

Electronic Acknowledgement Receipt

EFS ID:	32797267
Application Number:	15997091
International Application Number:	
Confirmation Number:	5161
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	John I. Fischer/Allison Johnson
Filer Authorized By:	John I. Fischer
Attorney Docket Number:	4820.001US10
Receipt Date:	04-JUN-2018
Filing Date:	
Time Stamp:	15:40:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$5860
RAM confirmation Number	060518INTEFSW00002452190743
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1		4820_001US10_Application_Track1-signed.pdf	4840628 dc5330a44c857339508a49b91d79509354c4a246	yes	85

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal of New Application	1	1
Application Data Sheet	2	9
Oath or Declaration filed	10	12
TrackOne Request	13	13
Specification	14	70
Claims	71	73
Abstract	74	74
Drawings-only black and white line drawings	75	85

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Information:

2	Fee Worksheet (SB06)	fee-info.pdf	38374 efe4816605019ac6e17f22a328c9d91aef875c27	no	2

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.