UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/209,163	08/22/2005	Edwin S. Olson	2380-00200

CONFIRMATION NO. 1534

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

POA ACCEPTANCE LETTER

OC000000093284567

Date Mailed: 08/08/2017

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/01/2017.

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**.

/tnguyen/

MODIFIED PTO/SB/80 (11-08)
Approved for use through 11/30/2011. 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 TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☒ Practitioners associated with the Customer Number: **21186**

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used.

Name	Registration Number		Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☒ The address associated with Customer Number: **21186**

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:
Midwest Energy Emissions Corp.
670 D Enterprise Dr
Lewis Center, OH 43035
United States of America

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	John Pavlish	Date:	6/9/2017
Name	John Pavlish	Telephone:	
Title	Chief Technology Officer		

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.**

MODIFIED PTO/SB/96 (07-09)
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 displays a valid OMB control number.

STATEMENT UNDER 37 C.F.R. 3.73(b)

Applicant/Patent Owner: Edwin S. Olson et al. Attorney Docket No. 4820.001US1
Application No./Patent No.: 11/209,163 Filed/Issue Date: August 22, 2005
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 it is:

1. ☒ the assignee of the entire right, title, and interest in;
2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or
3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

1. From: Inventors To: Energy & Environmental Research Center
The document was recorded in the United States Patent and Trademark Office at
Reel 016810, Frame 0286, or for which a copy thereof is attached.
2. From: Inventors To: Energy & Environmental Research Center
The document was recorded in the United States Patent and Trademark Office at
Reel 018937, Frame 0132, or for which a copy thereof is attached.
3. From: Inventors To: Energy & Environmental Research Center Foundation
The document was recorded in the United States Patent and Trademark Office at
Reel 019023, Frame 0539, or for which a copy thereof is attached.
4. From: University of North Dakota, Energy & Environmental Resch Center Foundation To: Energy, United States Department of
The document was recorded in the United States Patent and Trademark Office at
Reel 021154, Frame 0528, or for which a copy thereof is attached.
5. From: Inventor To: Energy and Environmental Research Center Foundation
The document was recorded in the United States Patent and Trademark Office at
Reel 033643, Frame 0538, or for which a copy thereof is attached.
6. From: Inventor To: Energy and Environmental Research Center Foundation
The document was recorded in the United States Patent and Trademark Office at
Reel 033643, Frame 0339, 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(b)(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/ August 1, 2017
Signature Date
Nicholas P. Lanzatella USPTO Reg. No. 63,803
Printed or Typed Name Title

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.**

MODIFIED PTO/SB/96 (07-09)
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 displays a valid OMB control number.

STATEMENT UNDER 37 C.F.R. 3.73(b)
Supplemental Sheet - Chain Continuation

Applicant/Patent Owner: Edwin S. Olson et al. Attorney Docket No. 4820.001US1
Application No./Patent No.: 11/209,163 Filed/Issue Date: August 22, 2005
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.)

7. From: Inventor To: Energy and Environmental Research Center Foundation
The document was recorded in the United States Patent and Trademark Office at
Reel 033643, Frame 0436, or for which a copy thereof is attached.

8 From: Inventor To: Energy and Environmental Research Center Foundation
The document was recorded in the United States Patent and Trademark Office at
Reel 033698, Frame 0612, or for which a copy thereof is attached.

9. 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 042647, Frame 0351, or for which a copy thereof is attached.

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

/Nicholas P. Lanzatella/

Signature — August 1, 2017 (Date)

Nicholas P. Lanzatella (Printed or Typed Name) — USPTO Reg. No. 63,803 (Title)

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.**

Electronic Acknowledgement Receipt

EFS ID:	29950032
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Mark Victor Muller/Robin Monsees
Filer Authorized By:	Mark Victor Muller
Attorney Docket Number:	2380-00200
Receipt Date:	01-AUG-2017
Filing Date:	22-AUG-2005
Time Stamp:	15:26:43
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		4820001US1_POA.pdf	3032593 74908ea6261dbb68c1fa948d1cdb4be02d66b4ff	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Power of Attorney	2	2
	Assignee showing of ownership per 37 CFR 3.73	3	4
Warnings:			
Information:			
	Total Files Size (in bytes):	3032593	

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.:	4820.001US1	Serial No.:	11/209,163
Filed:	August 22, 2005	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1797
Customer No.:	21186	Confirmation No.:	1534

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 Power of Attorney (1 pg.)
X Statement Under 37 CFR 3.73(b) (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/
Nicholas P. Lanzatella
Reg. No. 63,803

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patentee:	Edwin S. Olson, *et al.*	§	
		§	Group Art Unit: 1797
Patent No.:	7,435,286 B2	§	
		§	Examiner: Amber Rose Orlando
Issued:	October 14, 2008	§	
		§	Confirmation No: 1534
For:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY	§	

Mail Stop: Maintenance Fee
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF FILING

Pursuant to 37 C.F.R. §1.8, I hereby certify that this correspondence is being electronically submitted to the U.S. Patent and Trademark Office website, www.uspto.gov, on 1/31/12.

Edith Shek
Edith S. Shek

NOTIFICATION OF LOSS OF ENTITLEMENT TO SMALL ENTITY STATUS UNDER 37 C.F.R. § 1.27(g)

Sir:

Energy & Environmental Research Center Foundation is the Assignee of the entire right, title, and interest in and to the subject matter which is claimed. Assignee's rights are by virtue of an assignment of the patent application identified above, which Assignment was recorded with the U.S. Patent and Trademark Office on March 16, 2007, under Reel 019023 and Frame 0539.

Assignee hereby notifies the Patent and Trademark Office that it is not entitled to status as a small entity and that the claim for small entity status is hereby withdrawn.

Respectfully submitted,

CONLEY ROSE, P.C.

Date: 1-31-12

Rodney B. Carroll
Reg. No. 39,624

ATTORNEY FOR APPLICANT

5700 Granite Parkway, Suite 330
Plano, Texas 75024
Telephone: (972) 731-2288
Facsimile: (972) 731-2289

Electronic Acknowledgement Receipt

EFS ID:	11960846
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Rodney B. Carroll/Edith Shek
Filer Authorized By:	Rodney B. Carroll
Attorney Docket Number:	2380-00200
Receipt Date:	31-JAN-2012
Filing Date:	22-AUG-2005
Time Stamp:	15:24:52
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	Miscellaneous Incoming Letter	013112_LossofSmallEntityStatus.pdf	58705 8aa6808d1c4f63d00ebd1c65657cac48b930dcaa	no	2

Warnings:	
Information:	

Total Files Size (in bytes):	58705

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

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.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/209,163	10/14/2008	7435286	2380-00200	1534

23505 7590 09/24/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

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 208 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 Customer Service Center of the Office of Patent Publication at (571)-272-4200.

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

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

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
	1	N		-	-					
	2	N		-	-					
	3	N		-	-					
	4	N		-	-					
	5	N		-	-					
	6	N		-	-					
	7	N		-	-					
	8	N		-	-					
	9	N		-	-					
	10	N		-	-					
	11	N		-	-					
	12	N		-	-					
	13	N		-	-					
	14	-		-	-					
	15	N		-	-					
	16	N		-	-					
	17	N		-	-					
	18	N		-	-					
	19	-		-	-					
	20	N		-	-					
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	22	N		-	-					
	23	N		-	-					
	24	N		-	-					
	25	N		-	-					
	26	N		-	-					
	27	-		-	-					
	28	-		-	-					
	29	-		-	-					
1	30	✓	O	✓	=					
2	31	✓		✓	=					
14	32	✓		✓	=					
	33	N		-	-					
	34	-		-	-					
	35	-		-	-					
	36	-		-	-					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
	37	-		-	-					
7	38	✓		✓	=					
8	39	✓		✓	=					
9	40	✓		✓	=					
	41	-		-	-					
	42	-		-	-					
	43	-		-	-					
	44	-		-	-					
12	45	✓		✓	=					
19	46	✓		✓	=					
13	47	✓		✓	=					
	48	-		-	-					
15	49	✓		✓	=					
	50	-		-	-					
	51	-		-	-					
	52	-		-	-					
	53	N		-	-					
17	54	✓		✓	=					
	55	N		-	-					
	56	N		-	-					
	57	N		-	-					
	58	N		-	-					
	59	N		-	-					
	60	N		-	-					
	61	N		-	-					
21	62	✓		✓	=					
22	63	✓		✓	=					
16	64	✓		✓	=					
23	65			✓	=					
24	66			✓	=					
25	67			✓	=					
26	68			✓	=					
3	69			✓	=					
4	70			✓	=					
10	71			✓	=					
	72			✓	-					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	**Art Unit**
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
11	73			✓	=					
18	74			✓	=					
	75			✓	-					
27	76				=					
28	77				=					
29	78				=					
5	79				=					
20	80				=					
30	81				=					
6	82				=					

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

23505 7590 07/14/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

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

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1440	$300	$0	$1740	10/14/2008

EXAMINER	ART UNIT	CLASS-SUBCLASS
MILLER HARRIS, AMBER R	1797	095-142000

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 03-02 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 Conley Rose, P.C.
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 has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE
ENERGY & ENVIRONMENTAL RESEARCH CENTER FOUNDATION

(B) RESIDENCE: (CITY and STATE OR COUNTRY)
Grand Forks, North Dakota 58202 USA

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

4a. The following fee(s) are submitted:
☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 03-2769 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date August 20, 2008

Typed or printed name Timothy S. Westby Registration No. 52352

This collection of information 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 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, 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.

Electronic Patent Application Fee Transmittal

Application Number:	11209163
Filing Date:	22-Aug-2005
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Timothy S. Westby/Grace A. Wise
Attorney Docket Number:	2380-00200

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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	1440	1440
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1740**

Electronic Acknowledgement Receipt

EFS ID:	3812920
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby/Grace A. Wise
Filer Authorized By:	Timothy S. Westby
Attorney Docket Number:	2380-00200
Receipt Date:	20-AUG-2008
Filing Date:	22-AUG-2005
Time Stamp:	18:19:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1740
RAM confirmation Number	14041
Deposit Account	032769
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	IssueFeePayment.pdf	69904 f6c2a8e6b26aa0ac2acae90b5a21e56e6373b1b3	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	32386 761baf6c55d1b650b2e2c041e30934992032d31d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	102290		

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.

PTO/SB/08A (08-03)
Approved for use through 07/31/2006. 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.

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	~~Unassigned~~ 11/209,163
Filing Date	Herewith
First Named Inventor	Edwin S. Olson, et al.
Group Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	2380-00200

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.H./	AA	US-1,984,164	12-11-1934	Stock	
	AB	US-3,194,629	07-13-1965	Dreibelbis, et al	
	AC	US-3,662,523	05-16-1972	Revoir	
	AD	US-3,786,619	01-22-1974	Melkersson	
	AE	US-3,849,267	11-19-1974	Hilgen	
	AF	US-4,101,631	07-18-1978	Ambrsini, et al	
	AG	US-4,196,173	04-01-1980	deJong, et al.	
	AH	US-4,708,853	11-24-1987	Matviya	
	AI	US-4,786,483	11-22-1988	Audeh	
	AJ	US-4,814,152	03-21-1989	Yan	
	AK	US-4,889,698	12-26-1989	Moller	
	AL	US-4,956,162	09-11-1990	Smith	
	AM	US-5,505,766	04-09-1996	Chang	
	AN	US-5,607,496	03-04-1997	Brooks	
	AO	US-5,672,323	09-30-1997	Bhat	
	AP	US-5,695,726	12-09-1997	Lerner	
	AQ	US-5,827,352	12-27-1998	Altman	
	AR	US-5,891,324	04-06-1999	Ohtsuka	
	AS	US-6,027,551	02-22-2000	Hwang	
	AT	US-6,080,281	06-27-2000	Attia	
	AU	US-6,136,072	10-24-2000	Sjostrom	
	AV	US-6,214,304	04-10-2001	Rosenthal	
	AW	US-6,258,334	07-10-2001	Gadkaree	
	AX	US-6,383,981	05-07-2002	Blankenship	
	AY	US-6,528,030	03-04-2003	Madden et al.	
	AZ	US-2002/0150516	10-17-2002	Pahlman, et al.	
	AAA	US-2001/0003116	06-07-2001	Neufert	
/A.H./	ABB	US-2004/0003716	01-08-2004	Nelson, Jr.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where RelevantPassages or Relevant Figures Appear	T[6]
/A.H./		DE 34 26 059	01/1986			
/A.H./		JP 49-43197	11/1974			
/A.H./		JP 50-6438	03/1975			

/cm 7/31/08

*EXAMINER: Initial 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's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard St.16 if possible. 6 Applicant is to place a check mark here if English language translation is attached.

The 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 2 hours 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 FORM 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

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

23505 7590 07/14/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

EXAMINER	
MILLER HARRIS, AMBER R	
ART UNIT	PAPER NUMBER
1797	

DATE MAILED: 07/14/2008

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

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

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1440	$300	$0	$1740	10/14/2008

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 SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

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: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

23505 7590 07/14/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

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

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1440	$300	$0	$1740	10/14/2008

EXAMINER	ART UNIT	CLASS-SUBCLASS
MILLER HARRIS, AMBER R	1797	095-142000

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 03-02 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 has been filed for recordation as set forth in 37 CFR 3.11. 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. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

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

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

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

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information 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 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, 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.

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.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

23505 7590 07/14/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

EXAMINER	
MILLER HARRIS, AMBER R	
ART UNIT	PAPER NUMBER
1797	

DATE MAILED: 07/14/2008

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

The Patent Term Adjustment to date is 208 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 208 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Notice of Allowability	Application No.	Applicant(s)	
	11/209,163	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER MILLER HARRIS	1797	

-- 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 request for continued examination filed 05/13/2008*.

2. ☒ The allowed claim(s) is/are *30-32,38-40,45-47,49,54,62-71,73,74 and 76-82*.

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

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ 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. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

This action is in response to correspondence filed 05/14/2008.

Claims 76-82 are new.

Claims 72 and 75 are cancelled.

Claims 30-32, 38-40, 45-47, 49, 54, 62-71, 73, 74 and 76-82 are allowed.

Claims 30-32, 38-40, 45-47, 49, 54, 62-71, 73, 74 and 76-82 have been examined and are pending.

Continued Examination Under 37 CFR 1.114

1. 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 5/13/2008 has been entered.

Response to Arguments

1. Applicant's arguments, see pages 12-28, filed 05/13/2008, with respect to claims 30-32, 38-40, 45-47, 49, 54, 62-71, 73, 74 and 76-82, have been fully considered and are persuasive. The rejection of 30-32, 38-40, 45-47, 49, 54, 62-71, 73, 74 and 76-82 has been withdrawn.

Allowable Subject Matter

1. Claims 30-32, 38-40, 45-47, 49, 54, 62-71, 73, 74 and 76-82 are allowed.

2. The following is an examiner's statement of reasons for allowance: the sorbent being "a promoted halogenated carbon comprising active sites wherein the active sites comprise halide covalently-bound to the base-activated carbon" could not be found in prior art.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER MILLER HARRIS whose telephone number is (571)270-3149. The examiner can normally be reached on Mon-Thur (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Walter Griffin can be reached on (571) 272-1447. 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.

AH

/Walter D. Griffin/
Supervisory Patent Examiner, Art Unit 1797

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	**Art Unit**
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
	1	N		-	-					
	2	N		-	-					
	3	N		-	-					
	4	N		-	-					
	5	N		-	-					
	6	N		-	-					
	7	N		-	-					
	8	N		-	-					
	9	N		-	-					
	10	N		-	-					
	11	N		-	-					
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	13	N		-	-					
	14	-		-	-					
	15	N		-	-					
	16	N		-	-					
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	18	N		-	-					
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	24	N		-	-					
	25	N		-	-					
	26	N		-	-					
	27	-		-	-					
	28	-		-	-					
	29	-		-	-					
1	30	✓	O	✓	=					
2	31	✓		✓	=					
7	32	✓		✓	=					
	33	N		-	-					
	34	-		-	-					
	35	-		-	-					
	36	-		-	-					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
	37	-		-	-					
8	38	✓		✓	=					
9	39	✓		✓	=					
10	40	✓		✓	=					
	41	-		-	-					
	42	-		-	-					
	43	-		-	-					
	44	-		-	-					
14	45	✓		✓	=					
11	46	✓		✓	=					
15	47	✓		✓	=					
	48	-		-	-					
16	49	✓		✓	=					
	50	-		-	-					
	51	-		-	-					
	52	-		-	-					
	53	N		-	-					
18	54	✓		✓	=					
	55	N		-	-					
	56	N		-	-					
	57	N		-	-					
	58	N		-	-					
	59	N		-	-					
	60	N		-	-					
	61	N		-	-					
21	62	✓		✓	=					
22	63	✓		✓	=					
17	64	✓		✓	=					
23	65			✓	=					
24	66			✓	=					
25	67			✓	=					
26	68			✓	=					
3	69			✓	=					
4	70			✓	=					
12	71			✓	=					
	72			✓	-					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	**Art Unit**
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008	07/01/2008					
13	73			✓	=					
19	74			✓	=					
	75			✓	-					
27	76				=					
28	77				=					
29	78				=					
5	79				=					
20	80				=					
30	81				=					
6	82				=					

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	110/345.ccls. and remov$4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
L2	5	423/210.ccls. and remov$4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
L3	0	(halogenated carbon with halide with covalently$5).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:05
L4	0	(carbon with haldie with sorbent and reduc $ with mercury).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:06
L5	0	(carbon with haldie with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
L6	1	(carbon with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
S1	4	2004/0003716	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S2	1	"20040003716"	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:54
S3	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	OR	OFF	2007/07/24 10:18
S4	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S5	2	"6953494"	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S6	42	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" |	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48

		"4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494").URPN.				
S7	41	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494").URPN. and inflight	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48

S8	41	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494").URPN. and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:53
S9	50	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:54
S10	9	in-flight near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:24
S11	13	in-flight same (mercury and remov $5)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:41
S12	0	carbon and (in flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:42
S13	6	carbon and (in-flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:21
S14	9	in-flight near4 reaction and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:32
S15	5261	in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33

S16	118	in-flight and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33
S17	12	in-flight and (remov$4 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S18	0	In-Flight Modification Of Inorganic Particles Within A Reaction Product Flow	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S19	7	In-Flight Modification	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:53
S20	4	In-Flight Capture	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:42
S21	19	(sorbent near3 composition) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S22	252	(sorbent near3 Bromine OR iodine) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S23	6	(sorbent near3 (Bromine OR iodine)) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S24	0	In-Flight Modification and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:43
S25	9	(mercury near3 remov $4) same (surface reactions)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:44
S26	1227	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/25 13:56
S27	43	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2007/07/25 13:56
S28	64	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57
S29	7	sorbent and mercury and (surface reaction) and bromine	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57

S30	10	sorbent and (remov$4 near3 mercury) and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:55
S31	2	"5409522" and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:02
S32	0	"5409522" and (surface reaction) and (iodine or bromine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:03
S33	1	"20060048646" and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:20
S34	165	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:56
S35	46	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 16:44
S36	15	((bromine OR iodine) same (activated carbon) same react$4) and (remove near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 08:19
S37	1	"6848374" and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S38	0	"6848374" and (regenerat$)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S39	62	((regenerat$4) with sorbent) and (remov$4 near2 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:13
S40	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:38
S41	0	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regeneragt$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39
S42	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:55

S43	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenerat$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39
S44	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4 and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S45	34	(monitor$3 with mercury) and (remov $4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 10:00
S46	2	2004/0003716 and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S47	1	"20040003716" and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:55
S48	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S49	206	(remov$4 near2 mercury) and (bromine OR iodine) and monitor $3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S50	34	(remov$4 near2 mercury) and (bromine OR iodine) and (monitor$3 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:53
S51	74	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur $4) with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:54
S52	38	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur $4) with mercury) and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:05

S53	37	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:38
S54	1	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and regenerate	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:09
S55	2	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:39
S56	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:21
S57	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "50")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S58	1	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "60")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S59	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "70")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47
S60	4	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "80")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47

S61	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40") and "40"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:51
S62	6	(remov$4 near2 mercury) and (bromine OR iodine) and ("50" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:13
S63	1	(remov$4 near2 mercury) and (bromine OR iodine) and ("60" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:14
S65	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separation with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
S67	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separat $4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
S68	0	(remov$4 near2 mercury) and (bromine OR iodine) and (remov $4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:24
S69	8	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size greater)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04
S70	430744	alkaline	US-PGPUB; USPAT; USOCR	OR	OFF	2007/08/07 16:02
S71	1	alkaline and "11209163"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/08/07 16:02
S72	1077	(remov$4 near2 mercury) and alkaline	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04
S73	397	(remov$4 near2 mercury) and alkaline earth	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04
S74	1	(remov$4 near2 mercury) and (bromine OR iodine) and (separate near3 size)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:51

S75	29	(remov$4 near2 mercury) and (bromine OR iodine) and (separat $4 near3 size)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:52
S76	13	95/142.ccls. and remov $4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S77	1	"11209163"	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S78	103	95/134.ccls. and remov $4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S79	8	95/134.ccls. and remov $4 with mercury and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/17 11:12
S80	120	lime and remov$4 with mercury and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/17 11:13
S82	40	lime and remov$4 with mercury and halide and activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:13
S83	40	lime and remov$4 with mercury and halide and activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:15
S84	76	remov$4 with mercury and lime same activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:19
S85	20	remov$4 with mercury and lime same activated carbon same react$4	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:03
S86	25	110/345.ccls. and sorbent same mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:03
S87	119	423/210.ccls. and (sorbent or bromine or iodine) same mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:04
S88	4	active with site and remov$4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:49
S89	7	95/134.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:50
S90	1	95/142.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:56

S91	0	95/142.ccls. and alkaline with inject	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:57
S92	0	95/142.ccls. and alkaline with inject$4	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:57
S93	1	95/134.ccls. and alkaline with inject$4	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:58
S94	151	alkaline with inject$4 and remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:58
S95	21	alkaline with inject$4 and remov$4 with mercury and sorbent with inject$4	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:59
S96	3	alkaline with inject$4 and remov$4 with mercury and halide with inject$4	US-PGPUB; USPAT; USOCR	OR	OFF	2008/06/30 15:59

7/1/2008 1:08:53 PM
C:\Documents and Settings\amillerharris\My Documents\EAST\Workspaces\11209163.wsp

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
11209163	OLSON ET AL.
Examiner	**Art Unit**
AMBER MILLER HARRIS	1797

ORIGINAL

CLASS	SUBCLASS
95	142

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
95	134				
110	345				
423	210				

INTERNATIONAL CLASSIFICATION

CLAIMED	NON-CLAIMED
B 0 1 D 53 / 02 (2006.01.01)	
B 0 1 D 59 / 26 (2006.01.01)	
F 2 3 J 15 / 00 (2006.01.01)	
B 0 1 D 47 / 00 (2006.01.01)	

/AMBER MILLER HARRIS/ 07/01/2008 (Assistant Examiner) (Date)		**Total Claims Allowed:** 30
/Walter D. Griffin/ 7/2/2008 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

SEARCHED

Class	Subclass	Date	Examiner
110	345	7/24/2007	AH
423	210	7/25/2007	AH
95	134	7/25/2007	AH
110	345	1/17/2008	AH
423	210	1/17/2008	AH
95	134, 142	1/16/2008	AH
110	345	7/1/2008	AH
423	210	6/30/2008	AH
95	134, 142	6/30/2008	AH

SEARCH NOTES

Search Notes	Date	Examiner
IDS search	7/24/2007	AH
Inventor search	7/24/2007	AH
Class 110/345 searched for carbon sorbents used to remove mercury from a boiler system by injection within the stream	7/24/2007	AH
Class 423/210 searched for controlling the amount of sorbent entering the system	7/25/2007	AH
Class 95/134 searched for regeneration of the sorbent after mercury removal	7/25/2007	AH
Class 110 searched for a carbon sorbent, and promoter which is used to remove mercury from a flue gas stream by co-injection.	1/17/2008	AH
Class 423 searched for controls used to change the amount of sorbent entering the flue gas stream	1/17/2008	AH
Class 95 searched for a activated carbon sorbent with at least one promoter used to remove mercury from a flue gas stream.	1/16/2008	AH
Classes 95, 423 and 110 searched for a carbon sorbent having a halide covalently bonded on the active sites, and an alkaline sorbent being co-injected with the carbon sorbent into a mercury stream.	7/1/2008	AH

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
	SEE EAST SEARCH HISTORY	7/1/2008	AH

PTO/SB/30EFS (03/08)
Approved for use through 05/31/2008. OMB 0651-0031
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	11209163	Filing Date	2005-08-22	Docket Number (if applicable)	2380-00200	Art Unit	1797
First Named Inventor	Edwin S. Olson			Examiner Name	A. R. Miller Harris		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☒ Other Response filed on March 24, 2008

☐ Enclosed

☐ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

☒ The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 032769

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (03/08)
Approved for use through 05/31/2008. 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.

Signature of Registered U.S. Patent Practitioner			
Signature	/Timothy S. Westby/	Date (YYYY-MM-DD)	2008-05-13
Name	Timothy S. Westby	Registration Number	52352

This collection of information is required by 37 CFR 1.114. 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.

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

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:	11209163
Filing Date:	22-Aug-2005
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Timothy S. Westby
Attorney Docket Number:	2380-00200

Filed as Large Entity

Utility Filing Fees

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:				
Extension - 1 month with $0 paid	1251	1	120	120

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	1801	1	810	810
		Total in USD ($)		**930**

Electronic Acknowledgement Receipt

EFS ID:	3291572
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby
Filer Authorized By:	
Attorney Docket Number:	2380-00200
Receipt Date:	13-MAY-2008
Filing Date:	22-AUG-2005
Time Stamp:	14:44:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$930
RAM confirmation Number	86
Deposit Account	032769
Authorized User	

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

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	RCE.pdf	698771 bbfbe14abc66ed8a19e8fb52443ba9e80466dc3e	no	3
Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	8299 9e714e04d08172834aa0d99f3a2a8f8c9e7c6414	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	707070		

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.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
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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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/209,163	08/22/2005	

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	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 05/13/2008	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 30	Minus	** 57	= 0	X $ =		OR	X $50=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***4	= 0	X $ =		OR	X $210=	0
☐ 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	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/nicole c. lawrence/

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1709	
Examiner	:	Amber R. Miller Harris	

AMENDMENT AND RESPONSE
TO FINAL OFFICE ACTION DATED JANUARY 23, 2008

Mail Stop AF
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Att'y Docket No. 2380-00200
Customer No.: 23505
Date: March 24, 2008

Sir:

INTRODUCTORY COMMENTS

This paper is filed in response to the Final Office Action dated January 23, 2008. The Examiner is requested to enter the following amendments and consider the accompanying remarks. Reconsideration and allowance are respectfully requested.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 5 of this paper.

Remarks/Arguments begin on page 12 of this paper.

~~DO NOT ENTER: /A.H./~~
OK to enter RCE
RCE 5.13.08

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.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

23505 7590 04/21/2008

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

EXAMINER	
MILLER HARRIS, AMBER R	

ART UNIT	PAPER NUMBER
1797	

MAIL DATE	DELIVERY MODE
04/21/2008	PAPER

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.

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 11/209,163	**Applicant(s)** OLSON ET AL.	
	Examiner AMBER MILLER HARRIS	**Art Unit** 1797	

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

THE REPLY FILED 24 March 2008 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires _____months from the mailing date of the final rejection.
   b) ☒ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

   Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☒ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☒ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☒ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: *See Continuation Sheet*. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): a) ☒ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: _____.
   Claim(s) objected to: _____.
   Claim(s) rejected: *30-32, 38-40, 45-47, 49, 54 and 62-75*.
   Claim(s) withdrawn from consideration: _____.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
12. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
13. ☒ Other: See Continuation Sheet.

/Walter D. Griffin/
Supervisory Patent Examiner, Art Unit 1797

Continuation of 3. NOTE: The halogenated carbon comprising active sites wherein the active sites comprise halide covalently-bonded to the base-activated carbon would require further search. .

Continuation of 13. Other: Applicant's arguments filed 03/24/2008 have been fully considered but they are not persuasive. The arguments filed pertain to the amendments of the claims that will not be entered.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1709	
Examiner	:	Amber R. Miller Harris	

AMENDMENT AND RESPONSE
TO FINAL OFFICE ACTION DATED JANUARY 23, 2008

Mail Stop AF
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Att'y Docket No. 2380-00200
Customer No.: 23505
Date: March 24, 2008

Sir:

INTRODUCTORY COMMENTS

This paper is filed in response to the Final Office Action dated January 23, 2008. The Examiner is requested to enter the following amendments and consider the accompanying remarks. Reconsideration and allowance are respectfully requested.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 5 of this paper.

Remarks/Arguments begin on page 12 of this paper.

DO NOT ENTER: /A.H./

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1709	
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AMENDMENT AND RESPONSE
TO FINAL OFFICE ACTION DATED JANUARY 23, 2008

Mail Stop AF
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Att'y Docket No. 2380-00200
Customer No.: 23505
Date: March 24, 2008

Sir:

INTRODUCTORY COMMENTS

This paper is filed in response to the Final Office Action dated January 23, 2008. The Examiner is requested to enter the following amendments and consider the accompanying remarks. Reconsideration and allowance are respectfully requested.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 5 of this paper.

Remarks/Arguments begin on page 12 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please amend the specification as follows:

Please replace paragraph [0002] of the specification as filed with the following amended paragraph:

[0002] This invention was made with United States Government support under ~~the U.S. Environmental Protection Agency~~ Grant ~~Nos.~~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.

Please replace paragraph [0019] of the specification as filed with the following amended paragraph:

[0019] 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 ~~from~~ in a flue gas ~~at lower removal rates~~ 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.

Please replace paragraph [0071] of the specification as filed with the following amended paragraph:

[0071] 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. ~~In~~

~~Addition to halide ions, t~~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.

Please replace paragraph [0078] of the specification as filed with the following amended paragraph:

[0078] 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 ~~conjection~~ 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.

Please replace paragraph [0084] of the specification as filed with the following amended paragraph:

[0084] Finely powdered activated carbon (such as NORIT Darco FGD, NORIT Americas, Inc., Marshall, TX (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 ~~a~~ and passed out of the generator. The outlet from the gaseous bromine generator is

connected via a ¼ 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 ~~to~~ 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 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.

LISTING OF CLAIMS

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1-29. (Canceled).

30. (Currently Amended) A method for reducing mercury in ~~flue~~ mercury-containing gas to a desired level, the method comprising: preparing a sorbent having a sorbent composition;~~, injecting the sorbent into a mercury-containing flue gas stream at a sorbent injection rate, collecting greater than 70 wt % of the mercury in the flue gas on the sorbent to produce a cleaned flue gas, substantially recovering the sorbent from the cleaned flue gas, and monitoring the mercury content of the cleaned flue gas;~~

wherein preparing the sorbent comprises reacting a base activated carbon with at least one promoter selected from the group consisting of molecular halogens, halides, and combinations thereof to yield a promoted halogenated carbon comprising active sites wherein the active sites comprise halide covalently-bound to the base-activated carbon;

~~wherein at least part of preparing the sorbent comprises in-flight reaction of the base activated carbon or promoted carbon with at least one component within a transport line to yield the sorbent which is injected into the mercury-containing flue gas stream; and~~

injecting the sorbent into a mercury-containing gas stream at at least one sorbent injection location and at a sorbent injection rate, wherein the mercury-containing gas stream is a combustion gas or a gasification gas, and wherein the composition of the mercury-containing gas may vary with time;

optionally co-injecting an alkaline sorbent into the mercury-containing gas stream at at least one alkaline injection location and at an alkaline injection rate;

collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent to produce a cleaned gas;

~~wherein~~ monitoring the mercury content of the cleaned ~~flue~~ gas; and

~~is used to control~~ controlling, in response to the monitored mercury content of the cleaned gas, which may vary with the composition of the mercury-containing gas and operating conditions, the sorbent injection rate, the alkaline injection rate, the sorbent composition, or ~~both~~a combination thereof

so that the mercury content of the cleaned gas is maintained at substantially the desired level with minimal operating cost.

31. (Currently Amended) The method of claim 30 ~~further~~ comprising co-injecting an alkaline ~~component~~ sorbent into the mercury-containing ~~flue~~ gas stream whereby contaminants in the mercury-containing gas are consumed by the alkaline sorbent, thus maintaining active sites on the sorbent, and whereby oxidized mercury is captured from the mercury-containing gas stream.

32. (Currently Amended) The method of claim ~~30~~ 45 wherein ~~the monitored mercury content of the cleaned flue gas is used to~~ controlling the sorbent ~~injection rate~~composition comprises controlling at least one of the ratio of the at least one promoter to the activated carbon and the ratio of the alkaline injection rate to the sorbent injection rate,

the sorbent injection rate, the alkaline injection rate, the sorbent composition, or ~~both~~a combination thereof

33-37. (Canceled).

38. (Previously Presented) The method of claim 30 wherein preparing the sorbent further comprises reacting the activated carbon or the promoted carbon with a secondary component to enhance the reactivity and capacity of the sorbent.

39. (Previously Presented) The method of claim 38 wherein the secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

40. (Currently Amended) The method of claim 39 ~~further~~ comprising co-injecting an alkaline ~~component~~ sorbent into the ~~mercury~~ mercury-containing ~~flue~~ gas stream.

41-44. (Canceled).

45. (Currently Amended) The method of claim 30 wherein the monitored mercury content of the cleaned ~~flue~~ gas is used to control the composition of the sorbent.

46. (Currently Amended) The method of claim ~~40~~ 74 wherein the monitored mercury content is used to control at least one selected from the group consisting of ~~the composition of the sorbent and~~ the ~~amount of~~ alkaline ~~injected~~ injection rate into the ~~flue~~ mercury-containing gas relative to the ~~amount of the~~ base activated carbon injection rate, the promoted carbon injection rate, the secondary components injection rate, the sorbent injection rate, ~~or a~~and combinations thereof, to maintain the desired level of mercury in the cleaned gas stream.

47. (Currently Amended) The method of claim 45 further comprising injecting the activated carbon at an activated carbon injection rate and injecting the at least one promoter at a promoter injection rate into a transport line whereby in-flight reaction produces the promoted halogenated carbon ~~wherein the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon and the at least one promoter~~, 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, and wherein the ~~rate at which the~~ promoter injection rate ~~is added to the transport line~~ and the ~~rate of~~ sorbent injection rate into the ~~flue~~ gas are determined at least in part on the monitored mercury content of the cleaned ~~flue~~ gas.

48. (Canceled).

49. (Currently Amended) The method of claim 30 further comprising substantially recovering the sorbent from the cleaned gas and regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom ~~to~~ and recover capacity for capturing mercury, wherein the mercury-containing gas comprises ash and substantially recovering the sorbent from the cleaned gas comprises mechanically separating the sorbent particles from the ash.

50-53. (Canceled).

54. (Previously Presented) The method of claim 64 wherein the activated carbon has an average particle size greater than 40μm.

55-61. (Canceled).

62. (Currently Amended) The method of claim 30 wherein the mercury-containing gas is a flue gas stream ~~is~~ downstream of a boiler.

63. (Currently Amended) The method of claim 30 wherein monitoring the mercury content of the cleaned ~~flue~~ gas is performed substantially continuously.

64. (Currently Amended) The method of claim 49 wherein the activated carbon has an average particle size greater than that of the components of the mercury-containing ~~flue~~ gas stream such that substantially recovering the sorbent from the cleaned ~~flue~~ gas involves separation by physical means.

65. (Previously Presented) The method of claim 30 wherein the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof.

66. (Currently Amended) The method of claim 65 wherein the promoter is selected from the group consisting of Group V bromides, Group VI bromides~~Br_2, HBr,~~ and combinations thereof.

67. (Currently Amended) The method of claim ~~66~~ 30 wherein the promoter is reacted in the gas phase or as a vapor.

68. (Currently Amended) The method of claim ~~67~~ 30 wherein the sorbent has a composition comprising ~~promoter is added at~~ from about 1 to about 30 grams of promoter per 100 grams of activated carbon.

69. (Currently Amended) The method of claim 31 wherein the alkaline ~~component~~ sorbent is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

70. (Currently Amended) The method of claim 69 wherein the alkaline ~~component~~ sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

71. (Currently Amended) The method of claim 38 wherein ~~the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon, the promoted carbon, or both with at least one selected from the group consisting of the at least one promoter and the secondary component, and wherein~~ monitoring the mercury content of the cleaned ~~flue~~ gas is used to control the sorbent

composition by controlling the ratio of the secondary component to the activated carbon, the ratio of the at least one promoter to the activated carbon, or a combination thereof to optimize the number of active sites on the sorbent available for oxidizing and capturing the mercury in the mercury-containing gas stream, whereby the desired mercury level in the cleaned gas is substantially continuously maintained.

72. (Canceled).

73. (Previously Presented) The method of claim 38 wherein the at least one promoter and secondary component are combined with the base activated carbon substantially simultaneously.

74. (Currently Amended) The method of claim 49 further comprising reinjecting at least a portion of the regenerated sorbent particles into the mercury-containing ~~flue~~ gas.

75. (Canceled).

76. (New) The method of claim 30 wherein at least part of preparing the sorbent comprises at least one of: injecting the promoted halogenated carbon at a promoted carbon injection rate and injecting at least one secondary component at a secondary component injection rate into a transport line whereby the sorbent is produced in-flight; injecting the activated carbon at an activated carbon injection rate and injecting the at least one promoter at a promoter injection rate into a transport line whereby in-flight reaction produces the promoted halogenated carbon; and injecting activated carbon at an activated carbon injection rate, at least one secondary component at a secondary component injection rate, and at least one promoter at a promoter injection rate substantially simultaneously into a transport line whereby in-flight reaction produces the sorbent.

77. (New) The method of claim 76 wherein controlling, the sorbent composition comprises controlling the promoted halogenated carbon injection rate, the promoter injection rate, the alkaline injection rate, the optional secondary component injection rate, the activated carbon injection rate, or a combination thereof.

78. (New) The method of claim 30 wherein injecting the sorbent into a mercury-containing gas stream comprises injecting the sorbent into a mercury-containing gas stream having a temperature less than about 400°C.

79. (New) The method of claim 31 wherein the at least one alkaline injection location is upstream of the at least one sorbent injection location.

80. (New) The method of claim 74 comprising controlling the sorbent composition, the sorbent injection rate, the ratio of the alkaline injection rate to the sorbent injection rate, or a combination thereof to substantially maintain the desired level of mercury in the cleaned gas while minimizing the cost of removing the mercury from the mercury-containing gas stream.

81. (New) A method for removing mercury from a mercury-containing gas stream to produce a cleaned gas stream having a desired mercury level, the method comprising,

reacting an activated carbon with at least one promoter selected from molecular halogens, Group V halides, Group VI halides, hydrohalides, and combinations thereof and optionally at least one secondary component selected from Group V halides, Group VI halides, hydrohalides, and combinations thereof to produce a halogenated carbon sorbent comprising carbocation reactive sites that are capable of accepting electrons from neutral mercury atoms thereby forming oxidized mercury species that bind to the surface of the halogenated sorbent, wherein the halogenated carbon sorbent comprises a promoter to carbon ratio and optionally, a secondary component to carbon ratio;

injecting the halogenated carbon sorbent into a mercury-containing gas stream at a sorbent injection rate, wherein the mercury containing gas comprises flue gas, synthesis gas, fuel gas, or a combination thereof, and wherein the composition of the mercury-containing gas stream may vary with time;

injecting an alkaline sorbent into the mercury-containing gas stream at an alkaline injection rate, wherein the alkaline sorbent is capable of adsorbing oxidized mercury gas and of removing contaminants from the mercury-containing gas stream capable of consuming carbocation reactive sites of the halogenated carbon sorbent;

allowing the sorbents to interact with the mercury-containing gas stream for a residence time to produce a cleaned gas;

removing the halogenated sorbent from the cleaned gas;

monitoring the mercury content of the cleaned gas; and

maintaining the desired mercury level of the cleaned gas by optimizing the sorbent injection rate, the promoter to carbon ratio of the sorbent, the optional secondary component to carbon ratio of the sorbent, the alkaline injection rate, or a combination thereof such that operating costs for removing mercury from the mercury-containing gas stream are minimized.

82. (New) The method of claim 79 wherein the alkaline sorbent injection into the mercury-containing gas occurs upstream of the halogenated carbon sorbent injection into the mercury-containing gas stream.

REMARKS/ARGUMENTS

I. Status of the Claims

Claims 30-32, 40, 45-47, 49, 62-64, 66-71 and 74 are herein amended.

Claims 38-39, 54, 65 and 73 were previously presented.

New claims 76-82 are presented herein.

Claims 72 and 75 are herein canceled.

Claims 33-37, 41-44, 48, 50-53, and 55-61 were previously canceled.

As such, claims 30-32, 38-40, 45-47, 49, 54, 62-71, 73-74 and 76-82 are pending in this application. Claims 30 and 81 are independent claims.

Applicants acknowledge receipt of the Final Office Action dated January 23, 2008. Applicants believe all pending claims are allowable over the art of record and respectfully request reconsideration and allowance of all claims.

II. Claim Rejections 35 U.S.C. §103(a)

In the Final Office Action, claims 30, 32, 38, 39, 45-47, 62, 63, 65-68 and 71-73 are rejected under 35 U.S.C. §103(a) as being unpatentable over Srinivasachar *et al.*, U.S. 6,848,374 (hereinafter "*Srinivasachar*") in view of Vosteen *et al.*, U.S. 6,878,358 (hereinafter "*Vosteen*").

In the Final Office Action, claims 31 and 69 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 30 above, and further in view of Gadkaree *et al.*, U.S. 6,136,749 (hereinafter "*Gadkaree*").

In the Final Office Action, claim 70 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar, Vosteen*, and *Gadkaree* as applied to claim 31 and further in view of Moller et *al.*, EP 0 208 490 A1 (hereinafter "*Moller*").

In the Final Office Action, claim 40 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 39 and further in view of *Gadkaree.*

In the Final Office Action, claims 49 and 74 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 30 and further in view of Hwang *et al.*, U.S. 6,027, 551 (hereinafter "*Hwang*").

In the Final Office Action, claims 64 and 75 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar, Vosteen,* and *Hwang* as applied to claim 49 and further in view of Fristad *et al.*, U.S. 5,785,935 (hereinafter "*Fristad*").

In the Final Office Action, claim 54 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, *Vosteen, Hwang*, and *Fristad* as applied to claim 49 and further in view of Reiss *et al.*, U.S. 5,575,982 (hereinafter "*Reiss*").

Applicants respectfully traverse these rejections

A. Claims 30, 32, 38, 39, 45-47, 62-63, 65-68 and 71-73 are patentable over Srinivasachar and Vosteen

In the Final Office Action, the Examiner rejects claims 30, 32, 38, 39, 45-47, 62, 63, 65-68 and 71-73 under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* in view of *Vosteen*. Applicants respectfully traverse this rejection. Claim 30 is an independent claim from which claims 32, 38, 39, 45-47, 62-63, 65-68 and 71-73 either directly or indirectly depend.

Amended independent claim 30 recites, "A method for reducing mercury in mercury-containing gas to a desired level, the method comprising: preparing a sorbent having a sorbent composition; wherein preparing the sorbent comprises reacting a base activated carbon with at least one promoter selected from the group consisting of molecular halogens, halides, and combinations thereof to yield a *promoted halogenated carbon comprising active sites wherein the active sites comprise halide covalently-bound to the base-activated carbon*; injecting the sorbent into a mercury-containing gas stream at at least one sorbent injection location and at a sorbent injection rate, wherein the mercury-containing gas stream is a combustion gas or a gasification gas, and wherein the composition of the mercury-containing gas may vary with time; optionally co-injecting an alkaline sorbent into the mercury-containing gas stream at at least one alkaline injection location and at an alkaline injection rate; collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent to produce a cleaned gas; monitoring the mercury content of the cleaned gas; and controlling, in response to the monitored mercury content of the cleaned gas, which may vary with the composition of the mercury-containing gas composition and operating conditions, the sorbent injection rate, the alkaline injection rate, the sorbent composition, or a combination thereof so that the mercury content of the cleaned gas is *maintained at substantially the desired level with minimal operating cost*."

Support for Amendments to Independent Claim 30

Support for the removal of the term "flue" and the addition of the limitation, "wherein the mercury-containing gas is a combustion gas or a gasification gas" may be found in paragraph [0042] of the specification as filed, which recites, "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."

Support for "*halogenated* carbon" may be found throughout the specification as filed, for example, in paragraph [0083] of the specification as filed, which recites, "Preparation and Testing of Halogenated Carbon." Support for the amendment, "*comprising active sites comprising halide covalently-bound to the base-activated carbon"* may be found, for example, paragraph [0053] of the specification as filed, which recites, "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," in paragraph [0085] of the specification, which recites, "XPS spectra demonstrate that the brominated carbon contains both covalent carbon-bound (organic) bromide as well as anionic bromide," in paragraph [0071] of the specification which recites, "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," and in Figure 2 of the specification as filed.

Support for the amendments, "optionally co-injecting an alkaline sorbent into the mercury-containing gas stream at at least one alkaline injection location and at an alkaline injection rate" may be found throughout the specification as filed, for example from Figure 3 and the description thereof in paragraph [0062] which recites, "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." Support for "alkaline sorbent" may be found, for example, in paragraph [00111] of the specification as filed, which recites, "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."

Support for the amendments, "controlling, in response to the monitored mercury content of the cleaned gas, the sorbent injection rate, the alkaline injection rate, the sorbent composition, or a combination thereof so that the monitored mercury content of the cleaned gas, which may vary with the composition of the mercury-containing gas composition and operating conditions, is maintained at substantially the desired level with minimal operating costs," may be found throughout the specification as filed, for example in Figure 3 and the description thereof in paragraphs [0054]-[0062]. For example, paragraph [0054] recites, "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." Paragraphs [0060]-[0061] of the specification as filed, recite, "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*." Paragraph [0058] of the specification recites, "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."

Support for the limitations, "and wherein the composition of the mercury-containing gas may vary with time," and "which may vary with the composition of the mercury-containing gas composition and operating conditions" may be found, for example, in paragraph [0076] of the specification as filed, which recites, "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."

Support for the limitation, "at minimal operating cost" may be found, for example, in paragraph

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[0080] of the specification as filed, which recites, "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***." Paragraph [0019] of the specification as filed recites, "Through enhanced sorbent reactivity, mercury removal per gram of sorbent is increased, thereby ***decreasing the*** capital and ***operating costs*** by decreasing sorbent requirements."

No new matter is introduced by way of these amendments to independent claim 30.

Arguments

Furthermore, *Srinivasachar* fails to teach, "a promoted halogenated carbon *comprising active sites comprising halide covalently-bound to the base-activated carbon."* *Srinivasachar* states in column 6 lines 65-67 through column 7 line 22, "the sorbent particles 28 are sent along a path 38 from the silo 30 to an oxidizer unit 40, where the particles are contacted by an oxidizing agent 42 (e.g., ozone, hydrogen peroxide, hot air, concentrated nitric acid), making the outer surfaces of the particles hydrophilic. The treated sorbent may then be fed along a path 44 to the separation device 34 or sent along a path 46 to a blender 48 where a solution 50 is sprayed 52 on the sorbent particles by a sprayer 54 to deposit a halogen ***on the surface of the sorbent particles*** 28." *Srinivasachar* goes on to state that, "a halogen 58, such as chlorine, bromine, iodine, or fluorine, may also be deposited ***on the sorbent*** 28 by vaporizing the halogen 58 in a vaporizer 60 and ***condensing/***adsorbing it on the sorbent 28." *Srinivasachar* does not claim to react the halogens, halides, or combinations thereof but rather claims to "deposit" them on the surface. Claim 5 of *Srinivasachar* states that at least one of a halogen and an acidic species is deposited on the carbonaceous sorbent of the contact batch. *Srinivasachar* teaches that the oxidizing agents are added to increase hydrophilicity and, by definition, add oxygen to the carbon surface so that the surface binds to water or other polar species. The instant claim 30 teaches chemical modification of the carbon bonds thus promoting mercury-sorbent reactions via reactive sites i.e., sites having a positive charge (carbocation as mentioned in paragraph [0082] of the specification as filed. Thus, the promoters of claim 30 are promotors of reactivity by leading to the production of reactive sites. *Vosteen* is not cited by the Examiner for the purpose of making up for the lack of

teaching of "a promoted halogenated carbon *comprising active sites comprising halide covalently-bound to the base-activated carbon"* and, indeed, *Vosteen* fails to make up for this lack of teaching, as *Vosteen* does not disclose a sorbent.

Additionally, *Srinivasachar* fails to teach "collecting greater than 70 wt% of the mercury in the mercury-containing gas on the sorbent to produce a cleaned gas." *Srinivasachar* recites mercury removal efficiencies from an air stream in Table 1. *Srinivasachar* does not teach collecting greater than 70 wt% of the mercury in a combustion or gasification *mercury-containing gas* on a sorbent as in the instant independent claim 30. Furthermore, the data presented in Table 1 of the *Srinivasachar* patent reports mercury removal efficiencies ***from an air stream***. One of skill in the art would understand the incomparability of mercury removal efficiencies from an air stream and mercury removal from a mercury-containing gas from combustion or gasification, and the impact of the various and ever-changing components of such gas streams on mercury removal efficiencies. Thus, *Srinivasachar* does not disclose, "collecting greater than 70 wt% of the mercury *in the mercury-containing gas* on the sorbent to produce a cleaned gas," as in the instant claim 30. *Vosteen* is not cited for the purpose of making up the missing limitations, and indeed, does not disclose collecting mercury by utilization of a sorbent at all, let alone collecting greater than 70 wt% of the mercury thereon.

Amended independent claim 30 also recites the limitation, "controlling, in response to the monitored mercury content of the cleaned gas, the sorbent injection rate, the optional alkaline injection rate, the sorbent composition, or a combination thereof so that the mercury content of the cleaned gas is maintained at substantially the desired level with minimal operating cost." Neither *Srinivasachar* nor *Vosteen* teach controlling the sorbent injection rate, the sorbent composition, or a combination thereof so that the mercury content of the cleaned gas is maintained at substantially the desired level with minimal operating cost. The Examiner indicates that she believes that *Vosteen* may be combined with *Srinivasachar* to teach controlling the sorbent composition as the Examiner indicates that *Vosteen* teaches monitoring the cleaned gas and adjusting bromine injection in response thereto. *Vosteen* does not teach a sorbent, and the sorbent of *Srinivasachar* does not comprise halide covalently-bonded to the carbon, but rather *Srinivasachar* teaches a halide salt or halogen deposited *on* a sorbent. Therefore, a combination of the teachings of *Srinivasachar* with *Vosteen* would not lead to control of a *sorbent composition*, or a *sorbent* injection rate.

Because the cited references, *Srinivasachar* and *Vosteen* fail to disclose each and every element of the instant claim 30, as discussed above, the Applicants respectfully request removal of the 35

U.S.C. §103(a) rejection to the claim and allowance thereof. Because claims 32, 38, 39, 45-47, 62-63, 65-68 and 71-73 either directly or indirectly depend from independent claim 30, they carry with them all the limitations of parent claim 30 and are submitted to be allowable for at least the reasons given hereinabove with respect to claim 30. Applicants thus respectfully request removal of the 35 U.S.C. §103(a) rejections to claims 30, 32, 32, 38, 39, 45-47, 62-63, 65-68 and 71-73 and allowance thereof.

B. Claims 31 and 69 are patentable over Srinivasachar, Vosteen, and Gadkaree

In the Final Office Action, claims 31 and 69 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 30 above, and further in view of *Gadkaree*. Applicants respectfully traverse these rejections.

Claims 31 and 69 depend from independent claim 30, and thus comprise all the limitations of the parent claim. As discussed in Section IIA hereinabove, *Srinivasachar* and *Vosteen* fail to disclose all of the elements of claim 30. For at least the reasons presented hereinabove for independent claim 30, claims 31 and 69 are also patentable over *Srinivasachar* and *Vosteen*. As *Gadkaree* is not cited by the Examiner for making up for the lack of teachings by *Srinivasachar* and *Vosteen*, claims 31 and 69 are submitted to be allowable over *Srinivasachar*, *Vosteen*, and *Gadkaree*.

Furthermore, amended claim 31 recites, "The method of claim 30 comprising co-injecting an alkaline sorbent into the mercury-containing gas stream whereby contaminants in the mercury-containing gas are consumed by the alkaline sorbent, thus maintaining active sites on the sorbent, and whereby oxidized mercury is captured from the mercury-containing gas stream." Support for the limitation, "thus maintaining active sites on the sorbent, and whereby oxidized mercury is captured from the mercury-containing gas stream" may be found, for example, in paragraph [0024] of the specification as filed, which recites, "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," and in paragraph [00109] which recites, "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 capture some of the sulfur or selenium oxides in the flue gas that can have a detrimental effect on the sorbent capacity."

The Examiner states, on page 10 of the Final Office Action, that, "the Gadkaree reference discloses co-injecting an alkaline component into the mercury-containing flue gas stream." Applicants

respectfully traverse. In column 3 lines 54-65 of *Gadkaree*, to which the Examiner refers, *Gadkaree* discloses, "a co-catalyst can also be introduced into the carbon either with the precursor, or after activation....The second group enhances the activity of the activated carbon catalyst." *Gadkaree* does not disclose ***co***-injection of an alkaline ***sorbent*** with a mercury sorbent, but rather discloses injection of a *single* activated carbon catalyst comprising an alkali metal and/or alkaline earth halide. The co-catalyst of ***Gadkaree*** does not "improve the efficiency of mercury capture by capturing oxidized mercury and/or capturing gaseous components that might otherwise reduce sorbent capacity," as in the instant claim 31. Claim 69 depends from dependent claim 31. Thus, another element of claims 31 and 69 is not disclosed by the combination of *Srinivasachar*, *Vosteen*, and *Gadkaree*, and the cited references do not make obvious the invention as claimed in claims 31 and 69. Applicants thus respectfully request removal of the 35 U.S.C. §103(a) rejections to claims 31 and 69, and allowance thereof.

C. Claim 70 is patentable over Srinivasachar, Vosteen, Gadkaree, and Moller

In the Final Office Action, claim 70 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar, Vosteen*, and *Gadkaree* as applied to claim 31 and further in view of *Moller*. Applicants respectfully traverse this rejection.

Amended claim 70 recites, "The method of claim 69 wherein the alkaline sorbent is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof." As claim 70 depends from dependent claim 69, it is submitted to be allowable for all of the reasons presented hereinabove with regard to claim 69. Furthermore, in the Final Office Action, the Examiner states, "the Moller reference discloses the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (column 3, lines 1-19)." Applicants respectfully disagree.

Column 3, lines 1-19 of *Moller*, to which the Examiner refers, recites, "The hydrogen chloride in the gas reacts with the calcium hydroxide to form calcium chloride, which apparently is essential to the removal of mercury." *Moller* fails to disclose, "sodium carbonate, calcium oxide, lime, and combinations thereof." Thus, claim 70 is submitted to be non-obvious in light of *Srinivasachar*, *Vosteen*, *Gadkaree*, and *Moller* for all of the reasons presented hereinabove for claims 30, 31, and 69 as well as for the lack of disclosure of the specific alkaline components disclosed in claim 70. Applicants thus respectfully request removal of the 35 U.S.C. §103(a) rejection to claim 70 and allowance thereof.

D. Claim 40 is patentable over Srinivasachar, Vosteen, and Gadkaree

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In the Final Office Action, claim 40 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 39 and further in view of *Gadkaree*. Applicants respectfully traverse this rejection.

Amended claim 40 recites, "The method of claim 39 comprising co-injecting an alkaline sorbent into the mercury containing gas stream." Support for this amendment to claim 40 may be found, for example, in paragraph [00111] of the specification as filed, which recites, "mercury removals of approximately 90% were achieved with the co-injected *sorbents*."

Claim 40 is submitted to be allowable for the reasons presented with respect to claim 31 hereinabove in Section IIB.

E. Claims 49 and 74 are patentable over Srinivasachar, Vosteen, and Hwang

In the Final Office Action, claims 49 and 74 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Vosteen* as applied to claim 30 and further in view of *Hwang*. Claims 49 and 74 depend directly or indirectly from claim 30 and are submitted to be allowable over *Srinivasachar* and *Vosteen* for at least the reasons given in Section IIA hereinabove with respect to independent claim 30.

Furthermore, amended claim 49 recites, "The method of claim 30 further comprising substantially recovering the sorbent from the cleaned gas and regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom and recover capacity for capturing mercury, wherein the mercury-containing gas comprises ash and substantially recovering the sorbent from the cleaned gas comprises mechanically separating the sorbent particles from the ash." Support for the amendment, "substantially recovering the sorbent from the cleaned gas" may be found, for example, in original claim 30 which recited, "and substantially recovering the sorbent from the cleaned flue gas." Support for the amendment, "wherein the mercury-containing gas comprises ash and substantially recovering the sorbent from the cleaned gas comprises mechanically separating the sorbent particles from the ash," may be found, for example, in originally-filed claim 40. Amended claim 74 recites, "The method of claim 49 further comprising reinjecting at least a portion of the regenerated sorbent particles into the mercury-containing gas."

On page 12 of the Final Office Action, the Examiner states that "the Hwang reference discloses regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury (column 3, lines 53-60)." *Hwang* is not dealing with an activated carbon, however, and teaches away from the use of activated carbon. For example, in

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the Abstract, *Hwang* states, "mercury emission from a coal fired power plant is controlled by injecting into the flue gas unburned carbon purified from ash such as fly ash or wood ash... The unburned carbon collected from ash is significantly lower in cost compared to activated carbon presently used in such a process." *Hwang* does not disclose regeneration and reinjection of a sorbent comprising activated carbon as disclosed in the instant claims 49 and 74, and cannot disclose "wherein the mercury-containing gas comprises ash and substantially recovering the sorbent from the cleaned gas comprises mechanically separating the sorbent particles from the ash," as *Hwang*'s sorbent ***is*** ash.

For all of these reasons, Applicants respectfully request that the 35 U.S.C. §103(a) rejections to claims 49 and 74 be removed and the claims allowed.

F. Claim 64 is patentable over Srinivasachar, Vosteen, Hwang, and Fristad

In the Final Office Action, claims 64 and 75 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, *Vosteen,* and *Hwang* as applied to claim 49 and further in view of *Fristad.* Claim 75 is herein canceled.

Claim 64 indirectly depends from claim independent claim 30 and directly depends from claim 49, and is submitted to be allowable for at least the reasons presented hereinabove in Section IIA with regard to independent claim 30 and in Section IIE with regard to claim 49. Amended claim 64 recites, "The method of claim 49 wherein the activated carbon has an average particle size greater than that of the components of the mercury-containing gas stream such that substantially recovering the sorbent from the cleaned gas involves separation by physical means."

The Examiner states that the *Fristad* reference discloses the activated carbon has an average particle size greater than that of the components of the flue gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means (column 6, lines 55-65)." Applicants respectfully traverse. *Fristad* is concerned with the separation of solid phases and does not deal with any gaseous (i.e. mercury-containing gas) phase. *Fristad* also does not teach, an "activated carbon has an average particle size greater than that of the components of the mercury-containing gas stream," as *Fristad* discloses neither activated carbon nor mercury-containing ***gas.***

Thus, Applicants respectfully request removal of the 35 U.S.C. §103(a) rejection to claim 64 and allowance thereof.

G. Claim 54 is patentable over Srinivasachar, Vosteen, Hwang, Fristad, and Reiss.

In the Final Office Action, claim 54 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, *Vosteen, Hwang*, and *Fristad* as applied to claim 49 and further in view of Reiss *et al.*, U.S. 5,575,982 (hereinafter "*Reiss*"). Applicants respectfully traverse this rejection. Claim 54 depends from, and includes each and every limitation of, dependent claim 49. Therefore, claim 54 is submitted to be allowable for at least the reasons provided with respect to claim 49 in Section IIE hereinabove.

Furthermore, *Srinivasachar* not only does not teach, "an activated carbon having an average particle diameter of greater than 40μm," but indeed specifically teaches against the use of such an activated carbon. *Srinivasachar* teaches, see lines 30-38 in column 5 of *Srinivasachar*, "the contact batch of carbonaceous sorbent has a particle size distribution of carbonaceous sorbent of d_{50}<15 microns." In lines 47-52 of column 5, *Srinivasachar* states that, "the target particle size distribution is d_{50}<15microns, preferably d_{50}<8microns, and most preferably d_{50}<4micron." *Srinivasachar* does not contemplate, and indeed strictly teaches against, the use of larger particles, i.e. against "base activated carbon having an average particle diameter of greater than 40μm" as in the instant claim 54.

On page 14 of the Final Office Action, the Examiner cited *Reiss* as disclosing "the activated carbon has an average particle size greater than 40μm." On page 14 of the Final Office Action, the Examiner states that, "it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the *Srinivasachar* reference to include the activated carbon has an average particle size greater than 40μm (Reiss column 4, lines 59-65) because these particle diameters of the activated carbon can be effectively introduced into the exhaust gas stream and cause optimum adsorption." Applicants respectfully traverse. *Srinivasachar* states in lines 25-35 of column 1 that, "the utilization factor for activated carbon is limited by the relatively large particle size and low surface area which limits the adsorption of mercury. Using activated carbon with mean particle size of about 5 microns with a top size of about 10 microns would improve the mercury capture efficiency, but storage, handling, transport, and dispersion of these particles is extremely difficult. As a result, the use activated carbon for mercury capture is *too costly,*" (Emphasis added). *Srinivasachar* thus teaches away from the use of large activated carbon particles in his disclosure, and a combination of the teachings of *Reiss* with *Srinivasachar* is improper. Amended claim 30 also recites the limitation, "with minimal operating cost." One of skill in the art, upon reading *Srinivasachar* would not be motivated to combine the large particles of *Reiss* with the teachings of *Srinivasachar* and expect to incur "minimal operating costs," as *Srinivasachar* clearly teaches that larger activated carbon use is cost prohibitive.

Thus, there is no motivation to combine the teachings of the cited references to create a sorbent comprising an activated carbon that "has an average particle size greater than 40μm." Combination of the references would indeed be improper, as utilizing large particles in *Srinivasachar* is contradictory to the teachings therein and would alter the operation of the invention as disclosed by *Srinivasachar*.

Applicants thus respectfully request removal of the 35 U.S.C. §103(a) rejection to claim 54, and allowance thereof.

III. Other Claim Amendments

Claim 32 is amended herein to recite, "The method of claim 45 wherein controlling the sorbent composition comprises controlling at least one of the ratio of the at least one promoter to the activated carbon and the ratio of the alkaline sorbent to the activated carbon." Support for this amendment may be found, for example, in paragraph [0058] of the specification as filed, which recites, "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," and in paragraph [0062] which recites, "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." Paragraph [0073] of the specification as filed recites, "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."

Claims 45, 63, and 64 are amended to delete the word "flue." As mentioned hereinabove, support for the removal of the term "flue" in the claims may be found in paragraph [0042] of the specification as filed, which recites, "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."

Claim 46 is amended herein to recite, "The method of claim 74 wherein the monitored mercury content is used to control at least one selected from the group consisting of the alkaline injection rate into the mercury-containing gas relative to the base activated carbon injection rate, the promoted carbon injection rate, the secondary component injection rate, the sorbent injection rate, and combinations thereof, to maintain the desired level of mercury in the cleaned gas stream." Support for these amendments may be found in paragraphs [0058] and [0059] of the specification as filed, wherein it is stated that, "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."

Claim 47 has been amended herein for clarity.

Claim 62 has been amended to recite, "The method of claim 30 wherein the mercury-containing gas is a flue gas stream downstream of a boiler." Support for this amendment may be found in paragraph [00107] of the specification as filed, which recites, "In this example, the halogen/halide promoted carbon sorbent was injected into the flue gas after the boiler."

Claim 66 is herein amended to recite, "The method of claim 65 wherein the promoter is selected from the group consisting of Group V bromides, Group VI bromides and combinations thereof." Support for this limitation may be found for example, in originally filed claim 39 and Example 12 of the specification as filed.

Claim 67 has been amended to recite, "The method of claim 30 wherein the promoter is reacted in the gas phase or as a vapor." Support for this amendment may be found, for example, in original claim 43 as filed.

Claim 68 has been amended herein for clarity.

Claim 71 is herein amended to recite, "The method of claim 38 wherein monitoring the mercury content of the cleaned gas is used to control the sorbent composition by controlling the ratio of

the secondary component to the activated carbon, the ratio of the at least one promoter to the activated carbon, or a combination thereof to optimize the number of active sites on the sorbent available for oxidizing and capturing the mercury in the mercury-containing gas stream, whereby the desired mercury level in the cleaned gas is substantially continuously maintained." Support for these amendments to claim 71 may be found, for example, in paragraphs [0058]-[0060] of the specification as filed.

IV. New Claims

Claims 76-82 are new claims presented herein, which contain material to which the Applicants are entitled. No new matter is introduced by way of these new claims.

New claim 76 recites, "The method of claim 30 wherein at least part of preparing the sorbent comprises at least one of: injecting the promoted halogenated carbon at a promoted carbon injection rate and injecting at least one secondary component at a secondary component injection rate into a transport line whereby the sorbent is produced in-flight; injecting the activated carbon at an activated carbon injection rate and injecting the at least one promoter at a promoter injection rate into a transport line whereby in-flight reaction produces the promoted halogenated carbon; and injecting activated carbon at an activated carbon injection rate, at least one secondary component at a secondary component injection rate, and at least one promoter at a promoter injection rate substantially simultaneously into a transport line whereby in-flight reaction produces the sorbent."

Support for new claim 76 regarding in-flight contacting of various components, may be found, for example, in Figure 3 and the description thereof in paragraphs [0060]-[0061] of the specification as filed, which recite, "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.... 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 131b and 131c."

New claim 77 recites, "The method of claim 76 wherein controlling, the sorbent composition comprises controlling the promoted halogenated carbon injection rate, the promoter injection rate, the alkaline injection rate, the optional secondary component injection rate, the activated carbon injection

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rate, or a combination thereof." Support for this amendment may be found, for example, in paragraphs [0058]-[0059] of the specification as filed.

New claim 78 recites, "The method of claim 30 wherein injecting the sorbent into a mercury-containing gas stream comprises injecting the sorbent into a mercury-containing gas stream having a temperature less than about 400°C." Support for the limitation, "mercury-containing gas stream having a temperature up to about 400°C," may be found, for example, in paragraph [0019] of the specification as filed, which recites, "Both of the brominated sorbents exhibited excellent reactivity and good capacity at all temperatures, up to at least 400°C."

New claim 79 recites, "The method of claim 31 wherein the at least one alkaline injection location is upstream of the at least one sorbent injection location." Support for claim is found, for example, in Figure 3 (injection points 119 and 116) and the description thereof in paragraph [0055] of the specification as filed.

New claim 80 recites, "The method of claim 74 comprising controlling the sorbent composition, the sorbent injection rate, the ratio of the alkaline injection rate to the sorbent injection rate, or a combination thereof to substantially maintain the desired level of mercury in the cleaned gas while minimizing the cost of removing the mercury from the mercury-containing gas stream." Support for this claim may be found, for example, in paragraph [0062] of the specification as filed, which recites, "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," paragraph [0074] which recites, "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," and paragraph [0075] which recites, "This technology is obviously very simple to implement, and results in a great cost savings to facilities using this technology for mercury capture."

New claim 81 presented herein is an independent claim presented herein to capture an embodiment to which the Applicants are entitled. Support for this claim is found throughout the specification as filed, and specifically in Figure 3 and the description thereof in paragraphs [0058]-[0062] of the specification as filed.

New claim 82 recites, "The method of claim 79 wherein the alkaline sorbent injection into the mercury-containing gas occurs upstream of the halogenated carbon sorbent injection into the mercury-containing gas stream." Support for this amendment may be found, for example, in Figure 3 (see sorbent injection point 116 and alkaline sorbent injection point 119).

V. Amendments to the Specification

Paragraph 2 has been amended herein to correctly cite the federally sponsored research and development grant and contract numbers.

Paragraphs [0019], [0071], [0078], and [0084] are amended herein to correct minor typographical errors.

No new matter is introduced by these amendments to the specification.

CONCLUSION

Applicants respectfully request reconsideration, allowance of the pending claims and a timely Notice of Allowance be issued in this case. If the Examiner feels that a telephone conference would expedite the resolution of this case, the Examiner is respectfully requested to contact the undersigned.

In the course of the foregoing discussions, Applicants may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This discussion should not be interpreted to mean that the other limitations can be ignored or dismissed. The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other distinctions between the claims and the prior art that have yet to be raised, but which may be raised in the future.

If any fees are inadvertently omitted or if any additional fees are required or have been overpaid, please appropriately charge or credit those fees to Conley Rose, P.C. Deposit Account Number 03-2769.

Respectfully submitted,

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ATTORNEY FOR APPLICANTS

Electronic Acknowledgement Receipt

EFS ID:	3041395
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby/Neva Dare
Filer Authorized By:	Timothy S. Westby
Attorney Docket Number:	2380-00200
Receipt Date:	24-MAR-2008
Filing Date:	22-AUG-2005
Time Stamp:	15:05:26
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		2380-00200_RespOA_01-23-08.pdf	1063442 8a293f43f4dbe669bb8d5489b1ce09af88ccb8ca	yes	28

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment After Final	1	1
	Specification	2	4
	Claims	5	11
	Applicant Arguments/Remarks Made in an Amendment	12	28
Warnings:			
Information:			
	Total Files Size (in bytes):	1063442	

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.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. 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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/209,163	08/22/2005	

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	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 03/23/2008	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 30	Minus	** 57	= 0	X $ =		OR	X $50=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***4	= 0	X $ =		OR	X $210=	0
☐ 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	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/MAMYE WAGSTAFF/

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.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

23505 7590 01/23/2008

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EXAMINER	
MILLER HARRIS, AMBER R	
ART UNIT	**PAPER NUMBER**
1797	

MAIL DATE	DELIVERY MODE
01/23/2008	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	11/209,163	OLSON ET AL.	
	Examiner	Art Unit	
	Amber Miller-Harris	1797	

-- 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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *19 November 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ 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

4)☒ Claim(s) *30-32,38-40,45-47,49,54 and 62-75* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *30-32, 38-40, 45-47, 49, 54, and 62-75* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

This action is in response to the amendment filed on the 19th of November 2007.

Claims 1-29, 33-37, 41-44, 48, 50-53 and 55-61 have been cancelled.

Claims 65-75 are new.

Claims 30-32, 38-40, 45-47, 49, 54, and 62-75 have been rejected.

Claims 30-32, 38-40, 45-47, 49, 54, and 62-75 are pending and have been examined.

Claim Rejections - 35 USC § 103

The following is a quotation of 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 of this title, 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 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 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 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 30, 32, 38, 39, 45-47, 62, 63, 65- 68 and 71-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 in view of Vosteen et al. US 6,878,358.

Regarding claim 30, the Srinivasachar reference discloses a method for reducing mercury in flue gas comprising: preparing a sorbent having a sorbent composition injecting the sorbent into a mercury-containing flue gas stream at a sorbent injection rate, collecting greater than 70 wt-% of the mercury in the flue gas on the sorbent to produce a cleaned flue gas, substantially recovering the sorbent from the cleaned flue gas (column 6, lines 25-30) wherein preparing the sorbent comprises reacting a base activated carbon with at least one promoter selected from the group consisting of molecular halogens, halides, and combinations thereof to yield a promoted carbon, wherein at least part of preparing the sorbent comprises in-flight reaction of the base activated carbon or with at least one component within a transport line to yield the sorbent which is injected into the mercury-containing flue gas stream (column 6, lines 2-20). The reference does not disclose monitoring the mercury content of the cleaned flue gas, nor the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition or both.

The Vosteen reference discloses monitoring the mercury content of the cleaned flue gas, and the mercury content of the cleaned flue gas is used to control the bromine

injection rate, the bromine composition or both (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent injection rate, the sorbent composition or both must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to monitoring the mercury content of the cleaned flue gas, and the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition or both (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 32, the Srinivasachar reference does not disclose the monitored mercury content of the cleaned flue gas is used to control the sorbent injection rate.

The Vosteen reference discloses the monitored mercury content of the cleaned flue gas is used to control the bromine injection rate (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent injection rate, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the monitored mercury content of the cleaned flue gas is used to control the sorbent

injection rate (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 38, the Srinivasachar reference discloses contacting the activated carbon or the promoted carbon with a secondary component to enhance the reactivity and capacity of the sorbent. It would have been obvious to one having ordinary skill in the art at the time the invention was made that contacting the activated carbon or the promoted carbon with the secondary component would have caused a reaction between the two.

For claim 39, the Srinivasachar reference discloses the secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof (column 6, lines 2-20).

For claim 45, the Srinivasachar reference does not disclose the monitored mercury content of the cleaned flue gas is used to control the composition of the sorbent.

The Vosteen reference discloses the monitored mercury content of the cleaned flue gas is used to control the composition of the bromine (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent composition, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the

monitored mercury content of the cleaned flue gas is used to control the composition of the sorbent (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 46, the Srinivasachar reference does not disclose the monitored mercury content is used to control at least one selected from the group consisting of the composition of the sorbent and the amount of alkali injected into the flue gas relative to the amount of base activated carbon, the promoted carbon, the secondary components or a combination thereof.

The Vosteen reference discloses the monitored mercury content of the cleaned flue gas is used to control the injection rate of the bromine (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, at least one selected from the group consisting of the composition of the sorbent and the amount of alkali injected into the flue gas relative to the amount of base activated carbon, the promoted carbon, the secondary components or a combination thereof, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the monitored mercury content is used to control at least one selected from the group consisting of the composition of the sorbent and the amount of alkali injected into the flue gas relative to the amount of base activated carbon, the promoted carbon, the

secondary components or a combination thereof (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 47, the Srinivasachar reference discloses the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon and the at least one promoter, 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 (column 6, lines 2-20). The reference does not disclose the rate at which the promoter is added to the transport line and the rate of sorbent injection into the flue gas are determined at least in part on the monitored mercury content of the cleaned flue gas.

The Vosteen reference discloses the rate of bromine injection into the flue gas is determined at least in part on the monitored mercury content of the cleaned flue gas (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the rate at which the promoter is added to the transport line and the rate of sorbent injection, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the rate at which the promoter is added to the transport line and the rate of sorbent injection into the flue gas is determined at least in part on the monitored mercury content of the

cleaned flue gas (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 62, the Srinivasachar reference discloses the flue gas stream is downstream of a boiler (column 8, lines 20-22).

For claim 63, Srinivasachar reference does not disclose monitoring the mercury content of the cleaned flue gas is performed substantially continuously.

The Vosteen reference discloses monitoring the mercury content of the cleaned flue gas is performed substantially continuously (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include monitoring the mercury content of the cleaned flue gas is performed substantially continuously (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 65, the Srinivasachar reference discloses the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof (column 6, lines 2-20).

For claim 66, the Srinivasachar reference discloses the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof (column 6, lines 2-20).

For claim 67, the Srinivasachar reference discloses the promoter is reacted in the gas phase or as a vapor (column 6, lines 2-20).

For claim 68, the Srinivasachar reference discloses the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon (column 6, lines 2-20).

For claim 71, the Srinivasachar reference discloses the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon, the promoted carbon, or both with at least one selected from the group consisting of the at least one promoter and the secondary component (column 6, lines 2-20). The reference does not disclose the mercury content of the cleaned flue gas is used to control the sorbent composition.

The Vosteen reference discloses the monitored mercury content of the cleaned flue gas is used to control the composition of the bromine (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent composition, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the monitored mercury content of the cleaned flue gas is used to control the composition of the sorbent (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 72, the Srinivasachar reference discloses the secondary component is selected from the group consisting of I_2, HI, and combinations thereof (column 6, lines 2-20).

For claim 73, the Srinivasachar reference discloses the at least one promoter and secondary component are combined with the base activated carbon substantially simultaneously (column 6, lines 2-20).

Claims 31, and 69 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 and Vosteen et al. US 6,878,358 as applied to claim 30 above, and further in view of Gadkaree et al. US 6,136,749.

Regarding claim 31, the Srinivasachar et al. reference does not disclose co-injecting an alkaline component into the mercury containing flue gas stream.

The Gadkaree reference discloses co-injecting an alkaline component into the mercury containing flue gas stream (column 3, lines 54-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include co-injecting an alkaline component into the mercury containing flue gas stream (Gadkaree, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

For claim 69, the Srinivasachar reference discloses the alkaline component is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof (column 6, lines 2-20).

Claim 70 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374, Vosteen et al. US 6,878,358, and Gadkaree et al. US

6,136,749 as applied to claim 31 above, and further in view of Moller et al. EP 0 208 490 A1.

For claim 70, the Srinivasachar reference does not disclose the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

The Moller reference discloses disclose the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (column 3, lines 1-19).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof (Moller, column 3, lines 1-19) because this aids in the removal of mercury from the flue gas.

Claim 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 and Vosteen et al. US 6,878,358 as applied to claim 39 above, and further in view of Gadkaree et al. US 6,136,749.

For claim 40, the Srinivasachar reference does not disclose co-injecting an alkaline component into the mercury containing flue gas stream.

The Gadkaree reference discloses co-injecting an alkaline component into the mercury containing flue gas stream (column 3, lines 54-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include co-injecting

an alkaline component into the mercury containing flue gas stream (Gadkaree, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

Claims 49 and 74 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 and Vosteen et al. US 6,878,358 as applied to claim 30 above, and further in view of Hwang et al. 6,027,551.

For claim 49, the Srinivasachar reference does not disclose regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury.

The Hwang reference discloses regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury (column 3, lines 53-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury (Hwang, column 3, lines 53-60) because if regenerated carbon is used, this reduces the amount of new carbon needed, therefore cutting the cost of operation.

For claim 74, the Srinivasachar reference does not disclose re-injecting at least a portion of the regenerated sorbent particles into the flue gas.

The Hwang reference discloses re-injecting at least a portion of the regenerated sorbent particles into the flue gas (column 3, lines 53-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include re-injecting at least a portion of the regenerated sorbent particles into the flue gas (Hwang, column 3, lines 53-60) because if regenerated carbon is used, this reduces the amount of new carbon needed, therefore cutting the cost of operation.

Claims 64 and 75 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374, Vosteen et al. US 6,878,358 and Hwang et al. US 6,027,551 as applied to claim 49 above, and further in view of Fristad et al. US 5,785,935.

For claim 64, the Srinivasachar reference does not disclose the activated carbon has an average particle size greater than that of the components of the flue gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means.

The Fristad reference discloses the activated carbon has an average particle size greater than that of the components of the flue gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means (column 6, lines 55-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the activated carbon has an average particle size greater than that of the components of the flue gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means (Srinivasachar, column 6, lines 55-65) because

the particular technique of separation by physical means, is recognized as part of the ordinary capabilities of one skilled in the art.

For claim 75, the Srinivasachar reference discloses the flue gas comprises ash and substantially recovering the sorbent from the cleaned flue gas comprises mechanically separating the sorbent particles from the ash (column 10, lines 35-38).

Claim 54 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374, Vosteen et al. US 6,878,358, Hwang et al. US 6,027,551, and Fristad et al. US 5,785,935 as applied to claim 49 above, and further in view of Reiss et al. US 5,575,982.

For claim 54, the Srinivasachar reference does not disclose the activated carbon has an average particle size greater than 40 μm.

The Reiss reference discloses the activated carbon has an average particle size greater than 40 μm (Reiss, column 4, lines 59-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar reference to include the activated carbon has an average particle size greater than 40 μm (Reiss column 4, lines 59-65) because these particle diameters of the activated carbon can be effectively introduced into the exhaust gas stream and cause optimum adsorption.

Response to Arguments

Applicant's arguments filed 11/19/2007 have been fully considered but they are not persuasive.

For claim 30, the applicant contends that the Srinivasachar reference does not disclose "monitoring the mercury content of the cleaned flue gas", or "the mercury content of the cleaned flue gas being used to control the sorbent injection rate, the sorbent composition, or both." (Page 7, paragraphs 1 and 2).

Although this is true, the applicant's argument is not persuasive because the Vosteen reference discloses monitoring the mercury content of the cleaned flue gas, and the mercury content of the cleaned flue gas is used to control the bromine injection rate, the bromine composition or both (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent injection rate, the sorbent composition or both must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to monitoring the mercury content of the cleaned flue gas, and the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition or both (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 38, the applicant contends that the Srinivasachar reference does not teach "preparing the sorbent further comprises reacting the activated carbon or the promoted carbon with a secondary component to enhance the reactivity and capacity of the sorbent." (page 7, paragraph 4)

The applicant's argument is not persuasive because the Srinivasachar reference discloses "chlorine, bromine, iodine, or fluorine, may *also* be deposited on the sorbent". The examiner interprets this to mean that the chlorine, bromine, iodine or fluorine would be in addition to the treatments previously disclosed (column 6, lines 2-20).

For claim 31, the applicant contends that the Gadkaree reference does not disclose "co-injecting an alkaline component into the flue gas stream." (page 9, paragraph 3)

The applicant's argument is not persuasive because the Gadkaree reference does disclose injecting the alkaline component with the sorbent into the flue gas stream, therefore co-injecting. (column 3, lines 54-65)

For claims 32, 45, 47, 63, and 49, the applicant contends that the Vosteen reference does not disclose "monitoring the mercury content of the cleaned flue gas to control the rate of injection of the sorbent" (Page 10, paragraph 1).

The applicant's argument is not persuasive because, the Vosteen reference discloses the monitored mercury content of the cleaned flue gas is used to control the bromine injection rate (column 5, lines 47-63). It would be obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content within the cleaned flue gas, the sorbent injection rate, must be changed just as that of the bromine within the Vosteen reference.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the monitored mercury content of the cleaned flue gas is used to control the sorbent

injection rate (Vosteen column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

For claim 38, the applicant contends that the Fristad can not be combined with the Srinivasachar reference because the Srinivasachar reference discloses "the sorbent particles are engineered to be extremely small and therefore distinct from the ash and may be separated from the normal ask in the ash disposal system 136 as shown in Figs. 1-3" and this would teach away from the applicants method because "having a particle size greater than the components of the ash stream would change the principle operation of the primary reference" (page 15, paragraph 2). The Applicant also contends that "standard AC sorbents generally are of fine size with a mean particle diameter of less than 20 micrometers. 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" (Page 15, paragraph 2).

The applicant's arguments are not persuasive because separation by size, whether large particles from smaller particles or visa versa is well know to those having ordinary skill in the art, and would not teach away on the Srinivasachar reference to continue to separate different sized particles. Also the Reiss reference discloses "that it is particularly desirable to use an activated carbon which has an average particle diameter from 1 to 200 micrometers, preferably from 1 to 80 micrometers" in order to cause "an optimum adsortion within the time which is available for reaction" (column 4, lines 59-65). Therefore it would have been obvious to one having ordinary skill in the art

at the time the invention was made that injection of a AC sorbent with a mean particle diameter of greater than 20 micrometers, would have been within the capabilities of one having ordinary skill in the art at the time the invention was made.

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 Miller-Harris whose telephone number is (571) 270-3149. The examiner can normally be reached on Mon-Thur (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Walter Griffin can be reached on (571) 272-1447. 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.

AH

WALTER D. GRIFFIN
SUPERVISORY PATENT EXAMINER

Notice of References Cited	Application/Control No. 11/209,163	Applicant(s)/Patent Under Reexamination OLSON ET AL.	
	Examiner Amber Miller-Harris	Art Unit 1797	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	EP0208490A1	01-1987	EPO	Moller et al.	B 01 D 53/34
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
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	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.

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(54) A process for removal of mercury vapor and vapor of chlorodibenzodioxins and -furans from a stream of hot flue gas.

(57) Mercury vapor and/or vapor of chlorodibenzodioxins and/or vapor of chlorodibenzofurans are removed from a stream of hot flue gas together with acidic components of the flue gas in a spray absorption process. The absorbent used in said process is an aqueous liquid which besides alkaline components contains suspended activated carbon.

EP 0 208 490 A1

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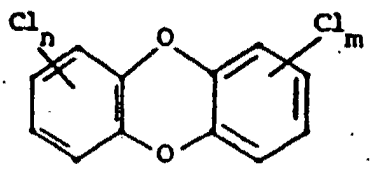
A process for removal of mercury vapor and vapor of chlorodibenzo-dioxins and -furans from a stream of hot flue gas.

FIELD OF THE INVENTION.

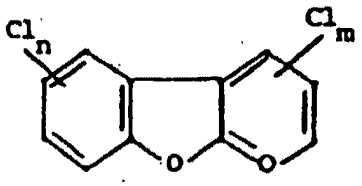
It is a well recognized fact that flue gases often contain mercury vapor in such amounts that their release into the atmosphere is regarded as being hazardous. This especially applies to flue gases from incineration plants where domestic refuse is incinerated but also flue gas formed by combustion of certain coals may contain mercury vapor in such amounts that it is highly desirable to remove a substantial part of said mercury vapor before releasing the flue gas into the atmosphere.

In the present specification and the attached claims the term mercury vapor means elementary mercury as well as mercury-containing chemical compounds in the vapor phase.

In recent years a growing concern has arisen as to the presence in flue gases of the toxic polychlorodibenzodioxines (PCDD) and polychlorodibenzofurans (PCDF). Said two series of compounds may be represented by the following formulae



PCDD



PCDF

wherein n and m each independently is an int ger from 0 through 4 provided that n + m is at least 2.

PCDD and PCDF are present in flue gases from incineration plants and in minor proportion also in the

flue gases from power plants. In flu gases th se compounds are primarily present in vapor phase and in the present specification the above abbr viations denot th compounds as vapors.

The extremely high toxicity of certain of these compounds makes it desirable to avoid their release into the atmosphere.

DESCRIPTION OF PRIOR ART.

Numerous methods have been suggested for removing or recovering mercury from gases. However, the majority of the prior art processes have been created with the purpose of removing mercury from relative small amounts of gas having high mercury concentration. These processes are not suitable for cleaning flue gas since costs of chemicals would be prohibitive or operation would be impracticable in connection with large volumes of flue gas.

Processes for removing mercury from air of relatively low mercury content have also been suggested. Such a process is disclosed in published European Patent Application No. 1.456. (Akzo N.V.). Said process which is described as particularly suitable for the removal of mercury from air which is vented from buildings, is based on the principle that mercury vapor is absorbed as mercury chloride when passing a bed of activated carbon having a specific chlorine content. According to the specification to said European application high moisture content of the gas from which mercury is to be removed, should be avoided since the effectiveness of the activated carbon is reduced thereby. From said specification it also appears that activated carbon used in a stationary bed without chlorine is unsatisfactory as absorbent for mercury and has a very low capacity for that purpose.

The process of said Europ an application seems unsuitable for treating flu gas sinc it would require the total amount of flue gas to be passed through a bed of activated carbon to which gaseous chlorine is added, which obviously involves the risk that a surplus of chlorine may be entrained with the flue gas to the atmosphere.

A process for removing mercury vapor from a hot hydrogene chloride-containing flue gas is disclosed in published European patent application no. 13.567, (Svenska Fläktfabriken). According to said process the gas which contains hydrogen chloride and minor amounts of mercury vapor, is contacted with powdered calcium hydroxide, preferably in a fluidized bed. The hydrogen chloride in the gas reacts with the calcium hydroxide to form calcium chloride which apparently is essential to the removal of mercury. Said process is restricted to gases having a substantial contents of hydrogen chloride. This condition will often be fulfilled by the flue gas from a waste incineration plant while flue gasses from other sources may be deficient in that respect.

US patent specification 4.273.747 (Rasmussen) discloses removal of mercury from hot waste gasses by atomizing an aqueous liquid into the waste gasses in the presence of fly ash suspended in the gas and subsequently separating the fly ash together with a substantial part of the mercury originally present as vapor. It is essential that by said treatment the gas stream is cooled from a temperature of at least 200°C to a temperature below 160°C. The aqueous liquid may be just water or it may be an aqueous solution or suspension of an alkaline compound, preferably calcium hydroxide.

Obviously said method will not be suitable in case it is not acceptable to cool the gas to the

extent required or if the amount of fly ash is insufficient due to the use of a preceding fly ash separation. Even when th conditions as to fly ash contents of the flue gas and cooling are satisfied it would in certain applications be desired to increase the efficiency of the removal of mercury vapor in said process.

Efforts to reduce the PCDD and PCDF levels in flue gas have hitherto mainly concentrated on thermal destruction. A reliable thermal destruction is, however, difficult to establish, since a very high temperature is required to ensure a complete destruction.

According to a paper of A.J. Teller and J. D. Lauber : "Control of Dioxin Emissions from Incineration" presented at the 76th annual meeting of the Air Pollution Control Association, Atlanta, Georgia, June 19 - 24, 1983, dioxin theoretic estimations indicate that emission may be reduced by condensing the dioxin thereof. However, A. Nottrodt et al: "Emissionen von polychlorierten Dibenzodioxinen und polychlorierten Dibenzofuranen aus Abfallverbrennungsanlagen", Müll und Abfall 11/84, p. 313-327 (Erich Schmidt Verlag GmbH Berlin, Bielefeld, München) state results showing high vapor phase concentrations after several wet scrubbings with flue gas temperatures lower than those obtained in the theoretic estimations made in said paper by Teller and Lauber.

Consequently a need excists for efficient measures for removing not only mercury vapor but also PCDD and PDCF vapors from flue gases.

SUMMARY OF THE INVENTION.

The present invention is directed to a novel process for efficient removal of mercury vapor and PCDD

and PCDF from a stream of hot flue gas, which process provides a simultaneous removal of acidic components of the flue gas.

It has turned out that incorporation of a relatively small amount of activated carbon in an alkaline feed suspension to be spraydried in a spray absorption process enables a surprising improvement of the ability of the process to remove mercury, PCDD and PCDF.

Consequently the process according to the invention is characterized in that an aqueous liquid which besides alkaline components comprises suspended activated carbon is spray dried in the flue gas which subsequently is freed from the resulting particulate material.

The amount of activated carbon to be used depends on the amount of mercury vapor as well as PCDD and PCDF in the flue gas, on the limits for emission which it is intended to meet, on the extent to which cooling of the gas is permissible, on the proportion of fly ash and the character thereof, etc.

Usually the amount of activated carbon will correspond to at least 5 mg per Nm^3 flue gas to be treated. For economic reasons the amount will usually not exceed 500 mg per Nm^3 flue gas, peferrably not 200 mg per Nm^3.

Since the prior art describes activated carbon as not being very suitable for absorption of mercury vapor when no chlorine is present and since high moisture conditions are described as harmful to mercury sorption by means of activated carbon together with chlorine it could not be predicted that a very efficient mercury removal is obtained by the very simple measures prescribed by the present process. It is also surprising that the rather small additions of activatet carbon to

the aqueous liquid to be atomized, which come into consideration by the present process, enables a reduction of PCDD and PCDF levels to extremely low values.

The preferred alkaline component for the simultaneous removal of acidic components of the gas is calcium hydroxide which by chemical reaction absorbs e.g. sulphur oxides and hydrogen chloride. However, it is to be observed that by the process of the invention presence of hydrogen chloride and consequently production of calcium chloride is not necessary to achieve an efficient removal of mercury vapor.

The fact that in the present process the activated carbon is initially present in aqueous suspension in the atomized droplets and subsequently is embedded in the particulate material comprising the reaction products of e.g. calcium hydroxide and the acidic components of the gas, apparently does not have any substantial adverse influence on the absorption ability of the activated carbon, as would have been expected.

The process of the present invention may be performed using those measures which are conventional in spray absorption processes for desulfurization of flue gases, e.g. as described in US patent 4,279,873 (Felsvang et al), incorporated herein by reference.

In the typical embodiment the process of the invention is performed on a stream of flue gas the fly ash of which has previously been removed in a particle collector, e.g. an electrostatic precipitator. However, the absorption of mercury vapor by activated carbon may be used as a supplement to the absorption by means of fly ash as described in the above cited US specification 4,273,747, in which case at least a portion of the fly ash present in the flue gas stream remains in said stream during the spray absorption process and is re-

covered together with the particulate material formed by the spray absorption process.

It is also possible to add fly ash to the liquid to be atomized, thereby utilizing the sorption ability of the fly ash to reduce the requirement for activated carbon.

Also other absorbents such as silicates may be added to the liquid to be atomized to minimize the requirement as to activated carbon.

As indicated above the amount of activated carbon necessary to achieve a substantial reduction of the concentration of mercury vapor and PCDD and PCDF in the flue gas is surprisingly small. The actual amounts to be used in each individual case may easily be fixed by a person skilled in the art on the basis of a few tests.

It is an important feature of the invention that by very simple measures a very flexible process is obtained since even flue gases with substantially varying levels of Hg, PCDD and PCDF may be coped with just by changing the amount of activate carbon added to the liquid to be atomized.

The particulate material formed in the spray absorption process and typically comprising calcium sulfite, calcium sulfate, calcium hydroxide and activated carbon and possibly fly ash is preferably separated from the flue gas in a baghouse which enables a prolonged contact between the particulate material and the flue gas.

In the following the process according to the invention will be further illustrated by means of examples.

In these examples analysis was performed on flue gas withdrawn by means of a heated probe with glass lining and equipped with a glass wool filter. The mercury was collected in two impinger flasks in series

containing an aqueous 5% potassium permanganat - nitric acid solution. Mercury was analyzed by flameless atomic absorption using $NaBH_4$ as a reductant (MHS-20, Mercury/ Hydride System by Perkin Elmer, ref. 338 - A2-M 294/ 12.79).

It is to be observed that methods previously used for determination of Hg in flue gases have not always been accurate and have often indicated values lower than the actual ones. Consequently the reults obtained as to removal of Hg vapor in the following examples may not be comparable with prior art results determined by means of less accurate methods of analysis.

EXAMPLE 1

Eight test runs were performed using a partial stream of the flue gas from an incineration plant wherein domestic waste was incinerated.

The spray absorption process was performed in a spray absorber the chamber of which comprised a cylindrical portion having a diameter of 1.2 m and a hight of 0.8 m, and a conical bottom portion the cone angle of which was 60°. The spray absorber was provided with a rotary atomizer. Downstream of the spray absorber particle separation was performed using a baghouse.

An aqueous suspension of slaked lime or an aqueous solution of sodium carbonate (solids content of the suspension or solution app. 5%) was used as feed for the atomizer.

The temperature of the flue gas when led to the spray absorber was 225-300°C and the amount of fly ash therein was 0.5-1.0 g/Nm^3 in run nos. 1-5 whereas run nos. 6-8 were performed using flue gas with substantially no fly ash. The flue gas was supplied in an amount of 300 kg/h.

The concentration of mercury vapor was measured upstream of the spray absorber, between the spray ab-

sorber and the baghouse filter and downstream of the baghouse filter.

Run nos. 1 and 7 were performed for comparison and no activated carbon was added to the feed suspension of slaked lime or feed solution of sodium carbonate. In runs 2 through 6 and in run 8 activated carbon was added to said feed solution in an amount of app. 2% by weight of the solids content, corresponding to 0,04-0,05 g/Nm^3 of flue gas.

The following results were obtained:

	Run no. 1	2	3	4	5	6	7	8
Upstream of spray absorber								
Hg vapor, µg/Nm^3	241	290	725	517	314	423	213	405
Absorbent	Slaked lime	Slaked lime + activated carbon	slaked lime + activated carbon	slaked lime + activated carbon	slaked lime + activated carbon	slaked lime + activated carbon	Na_2CO_3	Na_2CO_3 + activated carbon
Between spray absorber and baghouse								
Gas temperature, °C	130	130	100	160	175	165	130	130
Hg vapor, µg/Nm^3	77	46	not analysed	not analysed	not analysed	not analysed	not analysed	not analysed
Downstream the baghouse								
Hg vapor, µg/Nm^3	30	20	11	42	63	80	96	47
% removal	87.6	93	98.9	92.9	79.9	81.1	54.9	88.4

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The above results clearly indicate that activated carbon acts as a very efficient absorbent for mercury vapor when utilized in the process of the present invention.

EXAMPLE 2

Two further test runs was made in the same plant and under similar conditions as described in example 1, except that the flue gas temperature varied between 280 and 300°C.

The results obtained are listed in the following table:

	Run No. 9	Run No. 10
Upstream of spray absorber		
PCDD[1] +PCDF, µg/Nm^3	0.38	0.53
Absorbent	slaked lime	slaked lime + activated carbon
Between spray absorber and baghouse		
Gas temperature, °C	150	150
PCDD[1] +PCDF, µg/Nm^3	not analysed	0.28
Downstream the baghouse		
PCDD[1] +PCDF, µg/Nm^3	0.047	0.01
% removal	87.8	98.1

[1] The PCDD contents were approximat ly 35-45% of the total contents of PCDD and PCDF.

CLAIMS

1. A process for removal of mercury vapor and/or vapor of chlorodibenzodioxins and/or vapor of chlorodibenzofurans from a stream of hot flue gas combined with a simultaneous removal of acidic components of the flue gas, characterized in that an aqueous liquid, which besides alkaline components comprises suspended activated carbon is spray dried in the flue gas which subsequently is freed from the resulting particulate material.

2. The process of claim 1, wherein the amount of activated carbon in said aqueous liquid amounts to 5-500 mg per Nm^3 flue gas being treated.

3. The process of claim 1, wherein the amount of activated carbon in said aqueous liquid amounts to 5-200 mg per Nm^3 flue gas being treated.

4. The process of claim 1, wherein said alkaline components comprise calcium hydroxide in a quantity at least sufficient to neutralize a substantial part of the acidic components, such as sulfuroxides and hydrogen chloride, of the flue gas.

5. The process of claim 1, wherein said particulate material is recovered in a baghouse.

6. The process of claim 1, wherein at least a portion of any fly ash present in the flue gas stream remains in said stream during the spray absorption process and is recovered together with the particulate material formed by the spray absorption process.

7. The process of claim 1, wherein at least a portion of any fly ash present in the flue gas stream is collected from said stream before said aqueous liquid is spray dried therein, and at least a part of the collected fly ash is suspended in said aqueous liquid before spraying thereof.

European Patent Office

EUROPEAN SEARCH REPORT

Application number
0208490
EP 86 30 5054

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-4 049 399 (TELLER ENVIRONMENTAL SYSTEMS)		B 01 D 53/34
A	US-A-2 886 131 (J.R. CONLISK)		
D,A	US-A-4 273 747 (E. RASMUSSEN)		
A	US-A-4 246 242 (C.H.S. BUTLER)		
A	CHEMICAL ABSTRACTS, vol. 88, no. 2, 9th January 1978, page 125, abstract no. 9181j, Columbus, Ohio, US; T. HALMOE: "Micropollutants from an incineration plant lower than expected", & FAST AVFALL 1977, (1), 29-31		TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 01 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-08-1986	PYFFEROEN K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008						
	1	N		-						
	2	N		-						
	3	N		-						
	4	N		-						
	5	N		-						
	6	N		-						
	7	N		-						
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	25	N		-						
	26	N		-						
	27	-		-						
	28	-		-						
	29	-		-						
	30	✓	O	✓						
	31	✓		✓						
	32	✓		✓						
	33	N		-						
	34	-		-						
	35	-		-						
	36	-		-						

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CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008						
	37	-		-						
	38	✓		✓						
	39	✓		✓						
	40	✓		✓						
	41	-		-						
	42	-		-						
	43	-		-						
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	61	N		-						
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	64	✓		✓						
	65			✓						
	66			✓						
	67			✓						
	68			✓						
	69			✓						
	70			✓						
	71			✓						
	72			✓						

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007	01/17/2008						
	73			✓						
	74			✓						
	75			✓						

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

SEARCHED

Class	Subclass	Date	Examiner
110	345	7/24/2007	AH
423	210	7/25/2007	AH
95	134	7/25/2007	AH
110	345	1/17/2008	AH
423	210	1/17/2008	AH
95	134, 142	1/16/2008	AH

SEARCH NOTES

Search Notes	Date	Examiner
IDS search	7/24/2007	AH
Inventor search	7/24/2007	AH
Class 110/345 searched for carbon sorbents used to remove mercury from a boiler system by injection within the stream	7/24/2007	AH
Class 423/210 searched for controlling the amount of sorbent entering the system	7/25/2007	AH
Class 95/134 searched for regeneration of the sorbent after mercury removal	7/25/2007	AH
Class 110 searched for a carbon sorbent, and promoter which is used to remove mercury from a flue gas stream by co-injection.	1/17/2008	AH
Class 423 searched for controls used to change the amount of sorbent entering the flue gas stream	1/17/2008	AH
Class 95 searched for a activated carbon sorbent with at least one promoter used to remove mercury from a flue gas stream.	1/16/2008	AH

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	25	110/345.ccls. and sorbent same mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:03
L2	119	423/210.ccls. and (sorbent or bromine or iodine) same mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:04
S1	4	2004/0003716	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S2	1	"20040003716"	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:54
S3	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	OR	OFF	2007/07/24 10:18
S4	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S5	2	"6953494"	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S6	42	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494"). URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48

EAST Search History

S7	41	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494"). URPN. and inflight	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48
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S9	50	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:54
S10	9	in-flight near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:24
S11	13	in-flight same (mercury and remov$5)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:41
S12	0	carbon and (in flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:42
S13	6	carbon and (in-flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:21

EAST Search History

S14	9	in-flight near4 reaction and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:32
S15	5261	in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33
S16	118	in-flight and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33
S17	12	in-flight and (remov$4 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S18	0	In-Flight Modification Of Inorganic Particles Within A Reaction Product Flow	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S19	7	In-Flight Modification	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:53
S20	4	In-Flight Capture	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:42
S21	19	(sorbent near3 composition) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S22	252	(sorbent near3 Bromine OR iodine) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S23	6	(sorbent near3 (Bromine OR iodine)) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S24	0	In-Flight Modification and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:43
S25	9	(mercury near3 remov$4) same (surface reactions)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:44
S26	1227	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/25 13:56
S27	43	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2007/07/25 13:56
S28	64	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57

EAST Search History

S29	7	sorbent and mercury and (surface reaction) and bromine	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57
S30	10	sorbent and (remov$4 near3 mercury) and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:55
S31	2	"5409522" and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:02
S32	0	"5409522" and (surface reaction) and (iodine or bromine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:03
S33	1	"20060048646" and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:20
S34	165	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:56
S35	46	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 16:44
S36	15	((bromine OR iodine) same (activated carbon) same react$4) and (remove near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 08:19
S37	1	"6848374" and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S38	0	"6848374" and (regenerat$)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S39	62	((regenerat$4) with sorbent) and (remov$4 near2 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:13
S40	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:38
S41	0	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regeneragt$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39
S42	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:55
S43	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenerat$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39

EAST Search History

S44	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4 and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S45	34	(monitor$3 with mercury) and (remov$4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 10:00
S46	2	2004/0003716 and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S47	1	"20040003716" and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:55
S48	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S49	206	(remov$4 near2 mercury) and (bromine OR iodine) and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S50	34	(remov$4 near2 mercury) and (bromine OR iodine) and (monitor$3 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:53
S51	74	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:54
S52	38	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:05
S53	37	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:38
S54	1	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and regenerate	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:09
S55	2	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:39
S56	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:21

EAST Search History

S57	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "50")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S58	1	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "60")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S59	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "70")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47
S60	4	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "80")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47
S61	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40") and "40"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:51
S62	6	(remov$4 near2 mercury) and (bromine OR iodine) and ("50" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:13
S63	1	(remov$4 near2 mercury) and (bromine OR iodine) and ("60" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:14
S65	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separation with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
S67	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separat$4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
S68	0	(remov$4 near2 mercury) and (bromine OR iodine) and (remov$4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:24
S69	8	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size greater)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04
S70	430744	alkaline	US-PGPUB; USPAT; USOCR	OR	OFF	2007/08/07 16:02
S71	1	alkaline and "11209163"	US-PGPUB; USPAT; USOCR	OR	OFF	2007/08/07 16:02
S72	1077	(remov$4 near2 mercury) and alkaline	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04
S73	397	(remov$4 near2 mercury) and alkaline earth	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:04

EAST Search History

S74	1	(remov$4 near2 mercury) and (bromine OR iodine) and (separate near3 size)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:51
S75	29	(remov$4 near2 mercury) and (bromine OR iodine) and (separat$4 near3 size)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/08/07 16:52
S76	13	95/142.ccls. and remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S77	1	"11209163"	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S78	103	95/134.ccls. and remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/16 16:35
S79	8	95/134.ccls. and remov$4 with mercury and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/17 11:12
S80	120	lime and remov$4 with mercury and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2008/01/17 11:13
S82	40	lime and remov$4 with mercury and halide and activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:13
S83	40	lime and remov$4 with mercury and halide and activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:15
S84	76	remov$4 with mercury and lime same activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 11:19
S85	20	remov$4 with mercury and lime same activated carbon same react$4	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/01/17 15:03

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1709	
Examiner	:	Amber R. Miller Harris	

RESPONSE TO OFFICE ACTION DATED AUGUST 13, 2007

Mail Stop: Amendment
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Att'y Docket No. 2380-00200
Customer No.: 23505
Date: November 13, 2007

Sir:

INTRODUCTORY COMMENTS

This paper is filed in response to the Office Action dated August 13, 2007. The Examiner is requested to enter the following amendment and consider the accompanying remarks. Reconsideration and allowance are respectfully requested.

Amendment to the Claims begins on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

LISTING OF CLAIMS

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1-29. (Canceled).

30. (Currently Amended) A method for reducing mercury in flue gas comprising: preparing a sorbent having a sorbent composition, injecting the sorbent into a mercury-containing flue gas stream at a sorbent injection rate, 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[[.]], and monitoring the mercury content of the cleaned flue gas;

wherein preparing the sorbent comprises reacting ~~an~~ a base activated carbon with at least one ~~component~~promoter selected from the group consisting of molecular halogens, halides, and combinations thereof to yield a promoted carbon~~reaction product, ;and~~

wherein at least part of preparing the sorbent comprises in-flight reaction of the base activated carbon or promoted carbon with ~~the~~ at least one component within a transport line ~~from which the~~to yield the sorbent which ~~reaction product~~ is injected into the mercury-containing flue gas stream; and

wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both.

31. (Currently Amended) The method of claim ~~62~~ 30 further comprising co-injecting an ~~optional~~ alkaline component into the mercury containing flue gas stream.

32. (Currently Amended) The method of claim ~~62~~ 30 ~~further comprising monitoring the mercury content of the cleaned flue gas, regenerating the recovered sorbent, and using~~wherein the monitored mercury content of the cleaned flue gas is used to control the ~~rate of~~ sorbent injection ~~rate of the sorbent~~.

33-37. (Canceled).

38. (Currently Amended) The method of claim ~~62~~ 30 wherein preparing the sorbent ~~in-flight reaction~~ further comprises reacting the activated carbon or the promoted carbon, ~~the promoter, and~~ with ~~an optional~~ secondary component to enhance the reactivity and capacity of the sorbent.

39. (Currently Amended) The method of claim 38 wherein the ~~optional~~ secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

40. (Currently Amended) The method of claim 39 further comprising co-injecting an ~~optional~~ alkaline component into the mercury containing flue gas stream.

41-44. (Canceled).

45. (Currently Amended) The method of claim ~~32~~ 30 ~~further comprising using~~wherein the monitored mercury content of the cleaned flue gas is used to control the composition of the sorbent.

46. (Currently Amended) The method of claim 40 ~~further comprising~~wherein ~~monitoring the mercury content of the cleaned flue gas and using~~ the monitored mercury content is used to control at least one selected from the group consisting of the composition of the sorbent and the ~~alkaline-to-sorbent injection ratio~~amount of alkali injected into the flue gas relative to the amount of the base activated carbon, the promoted carbon, the secondary components, or a combination thereof.

47. (Currently Amended) The method of claim 45 wherein the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon and ~~a~~ the at least one promoter, 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, and wherein the rate at which the promoter is added to the transport line and the rate of sorbent injection into the flue gas are determined ~~by a digital computer based~~ at least in part on the monitored mercury content of the cleaned flue gas.

48. (Canceled).

49. (Currently Amended) The method of claim ~~62~~ 30 further comprising regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury.

50-53. (Canceled).

54. (Previously Presented) The method of claim 64 wherein the activated carbon has an average particle size greater than 40μm.

55-61. (Canceled).

62. (Previously Presented) The method of claim 30 wherein the flue gas stream is downstream of a boiler.

63. (Currently Amended) The method of claim ~~32~~ 30 ~~further comprising continuously~~ wherein monitoring the mercury content of the cleaned flue gas is performed substantially continuously.

64. (Currently Amended) The method of claim ~~62~~ 49 wherein the activated carbon has an average particle size greater than that of the components of the flue gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means.

65. (New) The method of claim 30 wherein the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof.

66. (New) The method of claim 65 wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

67. (New) The method of claim 66 wherein the promoter is reacted in the gas phase or as a vapor.

68. (New) The method of claim 67 wherein the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon.

69. (New) The method of claim 31 wherein the alkaline component is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

70. (New) The method of claim 69 wherein the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof.

71. (New) The method of claim 38 wherein the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon, the promoted carbon, or both with at least one selected from the group consisting of the at least one promoter and the secondary component, and wherein the mercury content of the cleaned flue gas is used to control the sorbent composition.

72. (New) The method of claim 38 wherein the secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

73. (New) The method of claim 38 wherein the at least one promoter and secondary component are combined with the base activated carbon substantially simultaneously.

74. (New) The method of claim 49 further comprising reinjecting at least a portion of the regenerated sorbent particles into the flue gas.

75. (New) The method of claim 64 wherein the flue gas comprises ash and substantially recovering the sorbent from the cleaned flue gas comprises mechanically separating the sorbent particles from the ash.

REMARKS/ARGUMENTS

I. Status of the Claims

Claims 30-32, 38-40, 45-47, 49, and 63-64 are herein amended.

Claims 1-13, 15-18, 20-26, 33, 53, and 55-61, which were previously withdrawn from consideration due to restriction requirement, are herein canceled to meet 37 CFR 1.75(b). Claims 14, 19, 27-29, 34-37, 41-44, 48, and 50-52 were previously canceled.

New claims 65-75 are presented herein.

As such, claims 30-32, 38-40, 45-47, 49, 54, and 62-75 are pending in this application. Claim 30 is an independent claim.

Applicants acknowledge receipt of the Office Action dated August 13, 2007. Applicants believe all pending claims are allowable over the art of record and respectfully request reconsideration and allowance of all claims.

II. Claim Objections

In the Office Action, claim 30 was objected to due to the presence of a period rather than a comma between "flue gas" and "wherein preparing the sorbent comprises." Claim 30 has been amended to correct this typographical error.

III. Claim Rejections 35 U.S.C. §112

In the Office Action, claim 30 was rejected under 35 U.S.C. §112 second paragraph for having insufficient antecedent basis for the term "base activated carbon" in line 6 of the claim. The claim has been amended to provide sufficient antecedent basis for the "base activated" carbon.

IV. Claim Rejections 35 U.S.C. §102

In the Office Action, claims 30, 38, 39, and 62 are rejected under 35 U.S.C. §102(e) as being anticipated by Srinivasachar *et al*, U.S. 6,848,374 (hereinafter "*Srinivasachar*"). Applicants respectfully traverse this rejection.

Amended claim 30 recites, "A method for reducing mercury in flue gas comprising: preparing a sorbent having a sorbent composition, injecting the sorbent into a mercury-containing flue gas stream at a sorbent injection rate, collecting greater than 70 wt-% of the mercury in the

flue gas on the sorbent to produce a cleaned flue gas, substantially recovering the sorbent from the cleaned flue gas, and ***monitoring the mercury content of the cleaned flue gas***; wherein preparing the sorbent comprises reacting a base activated carbon with at least one promoter selected from the group consisting of molecular halogens, halides, and combinations thereof to yield a promoted carbon; wherein at least part of preparing the sorbent comprises in-flight reaction of the base activated carbon or promoted carbon with at least one component within a transport line to yield the sorbent which is injected into the mercury-containing flue gas stream; and ***wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both***."

Support for the amendments, "monitoring the mercury content of the cleaned flue gas" and "wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both" may be found in the specification as filed, for example, paragraphs [0059], [0076], [0080], the description of Figure 3, and original claims 32, 45, and 47.

As the Examiner states on page 5 of the Office Action, the *Srinivasachar* reference "does not disclose monitoring the mercury content of the cleaned flue gas." Furthermore, *Srinivasachar* fails to disclose the limitation, "***wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both.***" According to MPEP 2131, "a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." As *Srinivasachar* fails to disclose each and every element of the claimed invention, the invention is not anticipated by the cited reference. It is respectfully requested that the §102 rejection to claim 30 be removed, and the claim allowed.

Amended claim 38 depends from independent claim 30 and adds the limitation, "wherein preparing the sorbent further comprises reacting the activated carbon or the promoted carbon with a secondary component to enhance the reactivity and capacity of the sorbent." The Examiner states, on page 3 of the Office Action, that "for claim 38, the Srinivasachar et al. reference discloses, the in-flight reaction comprising reacting the activated carbon, the promoter, and an option secondary component to enhance the reactivity and capacity of the sorbent (column 6, lines 2-20)." Applicants respectfully traverse. *Srinivasachar* discloses that "a halogen 58, such as bromine, chlorine, iodine or fluorine, may also be deposited on the sorbent 28 by vaporizing the

halogen 58 in a vaporizer 60 and condensing/adsorbing it on the sorbent 28." *Srinivasachar* nowhere discloses a *second* component in addition to the promoter, as in the instant claim 38. Thus, in addition to the missing limitations presented for independent claim 30 hereinabove, *Srinivasachar* also fails to disclose, "reacting the activated carbon or the promoted carbon with a *secondary component* to enhance the reactivity and capacity of the sorbent." Because claim 38 depends from claim 30, it carries with it each and every element of claim 30. Because *Srinivasachar* fails to disclose each and every element of claim 30, it consequently fails to disclose each and every element of claim 62 depending therefrom.

Amended claim 39 recites, "The method of claim 38 wherein the secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof." Support for the amendments may be found in original filed claim 39, for example. In the same manner as argued with respect for claim 38 *vide supra*, *Srinivasachar* fails to disclose each and every element, and thus fails to anticipate, amended claim 39.

Previously presented claim 62 depends from independent claim 30 and adds the limitation, "wherein the flue gas stream is downstream of a boiler." Because claim 62 depends from claim 30, it carries with it each and every element of claim 30. Because, as discussed above, *Srinivasachar* fails to disclose each and every element of claim 30, it consequently fails to disclose each and every element of claim 62 depending therefrom, and thus fails to anticipate claim 62.

As the *Srinivasachar* reference fails to disclose each and every element of claims 30, 38, 39, and 62, the reference fails to anticipate the claims. It is thus respectfully requested that the §102 rejections to claims 30, 38, 39, and 62 be removed and the claims allowed.

V. Claim Rejections 35 U.S.C. §103

A. Claim 31 is Patentable over Srinivasachar and Gadkaree.

In the Office Action, claim 31 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and Gadkaree, U.S. 6,136,749 (hereinafter "*Gadkaree*"). Applicants respectfully traverse this rejection.

Amended claim 31 recites, "The method of claim 30 further comprising co-injecting an alkaline component into the mercury containing flue gas stream."

The Examiner states on page 5 of the Office Action that, "regarding claim 31, the Srinivasachar et al. reference does not disclose co-injecting an optional alkaline component into the mercury containing flue gas stream." The Examiner also states, "the Gadkaree et al. reference discloses co-injecting an optional alkaline component into the mercury containing flue gas stream (column 3, lines 54-65)."

As discussed in Section IV hereinabove, the *Srinivasachar* reference fails to teach or suggest all of the claim limitations of independent claim 30, specifically the limitations, "***monitoring the mercury content of the cleaned flue gas"*** and "***wherein the mercury content of the cleaned flue gas is used to control sorbent injection rate, the sorbent composition, or both***." The secondary reference *Gadkaree* is not cited for the purpose of providing such missing elements of independent claim 30. Claim 31 depends from and thus incorporates all limitations of independent claim 30, which is herein submitted to be allowable. Therefore, Applicants respectfully submit that claim 31 is likewise patentable over *Srinivasachar* and *Gadkaree*.

Furthermore, it must be pointed out that *Gadkaree* does not disclose "***co-injecting*** an alkaline component into the flue gas stream." *Gadkaree* discloses (column 3 lines 54-65), "a co-catalyst can be introduced ***into the carbon*** either with the precursor, or after activation....the co-catalyst can be...(2) one or more alkali metal and/or alkaline earth metal halides." Thus, the catalyst of *Gadkaree* may comprise an alkali metal or alkaline earth metal halide, but this is distinct from ***co-***injecting an alkaline component ***with*** the sorbent (but separate therefrom) into the flue gas stream.

B. Claims 32, 45, 47, 63, and 49 are Patentable over Srinivasachar and Vosteen.

In the Office Action, claims 32, 45, 47, 63, and 49 are rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, Vosteen, U.S. 6,878,358 (hereinafter "Vosteen"), and Hwang, U.S. 6,027,551 (hereinafter "*Hwang*"). Applicants respectfully traverse this rejection.

Amended claim 32 recites, "The method of claim 30 wherein the monitored mercury content of the cleaned flue gas is used to control the sorbent injection rate."

On page 5 of the Office Action, the Examiner states, "regarding claim 32, the Srinivasachar et. al reference does not disclose monitoring the mercury content of the cleaned 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." The Examiner further states, "the Vosteen et al. reference discloses monitoring the mercury content of the cleaned flue gas to control the rate of injection of the sorbent (column 5, lines 47-63)". Applicants respectfully traverse that Vosteen discloses controlling the *sorbent* injection rate. *Vosteen* discloses a process for removing mercury from flue gases of high temperature plants, the process comprising adding a bromine compound to a multistage furnace or the flue gas downstream of the furnace, whereby the bromine, in the presence of sulphur, oxidizes mercury. *Vosteen* states, column 2 lines 57-61, "preferably, an aqueous solution of hydrogen bromide or an alkali metal bromide, in particular sodium bromide, or an aqueous solution of the alkali metal bromide is used." *Vosteen* does not disclose injection of a promoted carbon ***sorbent*** into a flue gas.

In column 5 lines 54-65, *Vosteen* discloses measuring the mercury content of the flue gas and using the mercury content to control the "amount of bromine fed and/or bromine compounds and/or the mixture of bromine compounds and if appropriate, sulphur substances and/or the mixture of sulphur substances." *Vosteen* never discloses "injecting the *sorbent* into a mercury-containing flue gas stream at a *sorbent* injection rate," as *Vosteen* does not disclose ***injection of sorbent***. Furthermore, as *Vosteen* does not prepare and ***inject a sorbent*** into a flue gas stream, *Vosteen* fails to disclose, "wherein the mercury content of the cleaned flue gas is used to control ***the sorbent injection rate, the sorbent composition, or both***."

On page 6 of the Office Action, the Examiner states that *Hwang* "discloses regenerating the recovered sorbent." *Hwang* is not cited for the purposes of making up for the missing limitations of *Srinivasachar* and *Vosteen*, particularly the limitation "wherein the monitored mercury content of the cleaned flue gas is used to control the sorbent injection rate." The combination of the prior art references does not disclose each and every element of the invention as disclosed in independent claim 30 so that the combination of *Srinivasachar*, *Vosteen*, and *Hwang* does not make obvious independent claim 30. As claim 32 depends from independent claim 30, it incorporates each and every limitation of claim 30. MPEP 2143.03 states that, "if an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. In re Fine, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)." Because the combination of the prior art cited does not teach or suggest each and every claim limitation, a *prima facie* case of obviousness

has not been established, and it is thus respectfully requested that the §103 rejection to claim 32 be removed and the claim allowed.

Amended claims 45, 49, and 63 depend from independent claim 30, and amended claim 47 depends from claim 45. Amended claim 45 recites, "The method of claim 30 wherein the monitored mercury content of the cleaned flue gas is used to control the composition of the sorbent." Support for this claim may be found in original claim 45.

Amended claim 47 recites, "The method of claim 45 wherein the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon and the at least one promoter, 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, and wherein the rate at which the promoter is added to the transport line and the rate of sorbent injection into the flue gas are determined at least in part on the monitored mercury content of the cleaned flue gas." Support for this claim may be found in original claim 47. Support for "in a transport line" may be found, for example, in paragraphs [0055]-[0056] and [0060].

Claims 49 and 63 have been minimally amended herein for clarity, and find support in original claims 49 and 63.

It is argued above in this Section that the combination of *Srinivasachar*, *Vosteen*, and *Hwang* fails to make obvious independent claim 30. By this same argument, claims 45, 47, 49, and 63 depending directly or indirectly therefrom are also nonobvious, for at least the reasons given above for claim 32. Removal of the §103 rejections to claims 45, 47, 49, and 63 is thus respectfully requested.

C. Claim 40 is Patentable over Srinivasachar and Gadkaree.

In the Office Action, claim 40 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and *Gadkaree*. The Examiner states on page 9 of the Office Action that "the Srinivasachar et al. reference does not disclose co-injection of an optional alkaline component into the mercury containing flue gas stream." The examiner further states that, "the Gadkaree et al. reference discloses co-injecting an optional alkaline component into the mercury containing flue gas stream (column 3, lines 54-65)." Applicants respectfully traverse this rejection.

As amended, claim 40 recites, "The method of claim 39 further comprising co-injecting an alkaline component into the mercury containing flue gas stream." Claim 39 depends from claim 38 which depends from independent claim 30.

As discussed with regard to claim 31 in Section VA hereinabove, the *Srinivasachar* reference fails to teach or suggest all of the claim limitations of independent claim 30, specifically the limitations, "***monitoring the mercury content of the cleaned flue gas***" and "***wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both***." The secondary reference *Gadkaree* is not cited for the purpose of providing such missing elements of independent claim 30. Claim 40 depends from and incorporates the limitations of independent claim 30. Thus, the Applicants respectfully submit that claim 40 is likewise patentable over *Srinivasachar* and *Gadkaree*.

Furthermore, it must be pointed out that *Gadkaree* does not disclose "***co-injecting*** an alkaline component into the flue gas stream." *Gadkaree* discloses (column 3 lines 54-65), "a co-catalyst can be introduced ***into the carbon*** either with the precursor, or after activation....the co-catalyst can be...(2) one or more alkali metal and/or alkaline earth metal halides." Thus, the catalyst of *Gadkaree*, which may be injected into a gas stream, may comprise an alkali metal or alkaline earth metal halide, but this is distinct from ***co-***injecting an alkaline component ***with*** the sorbent (but separate therefrom) ***into*** the flue gas stream.

D. Claim 46 is Patentable over Srinivasachar, Gadkaree, and Vosteen.

In the Office Action, claim 46 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, *Gadkaree*, and *Vosteen*. Applicants respectfully traverse this rejection.

Amended claim 46 recites, "The method of claim 40 wherein the monitored mercury content is used to control at least one selected from the group consisting of the composition of the sorbent and the amount of alkali injected into the flue gas relative to the amount of base activated carbon, promoted carbon, secondary components, or a combination thereof." Support for the limitation, "amount of alkali injected into the flue gas relative to the amount of base activated carbon, promoted carbon, secondary components, or a combination thereof" may be found in paragraph [0062] of the specification as filed.

The Examiner states, on page 10 of the Office Action, that "the Vosteen et al. reference discloses monitoring the mercury content of the cleaned flue gas and using the monitored mercury content to control the composition of the sorbent and the alkaline to sorbent ratio…Although the reference does not disclose specifically the alkaline-to-sorbent ratio, it does disclose mixtures of bromine and sulphur substances to be controlled." Applicants respectfully argue that Vosteen does not disclose controlling "the composition of the *sorbent* and the alkaline to *sorbent* ratio," as discussed further below.

As mentioned hereinabove in Section VB hereinabove with regard to claim 32, the combination of *Srinivasachar* and *Vosteen* fails to make obvious the invention as claimed in claim 32. Specifically, the combination fails to disclose, "wherein the mercury content of the cleaned flue gas is used to control ***the sorbent injection rate, the sorbent composition, or both***." As described in Section IV hereinabove, *Srinivasachar* does not disclose the limitation, "monitoring the mercury content of the cleaned flue gas," or the limitation, "***wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both.***" *Vosteen* fails to make up for the lack of teaching by *Srinivasachar*, as *Vosteen* does not disclose injecting a sorbent, and does not describe a method for controlling the composition of an ***injected sorbent*** based on the monitored flue gas mercury content." As mentioned in Section VC hereinabove, *Gadkaree* fails to make up for the lack of teachings and is not cited for the purpose of providing the missing limitations.

As the combination of the prior art references fails to teach or suggest each and every claim limitation, the prior art fail to make obvious the disclosed invention as claimed in claim 46. It is thus respectfully requested that the §103 rejection to claim 46 be removed, and the claim allowed.

E. Claim 64 is Patentable over Srinivasachar and Fristad.

In the Office Action, claim 64 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar* and Fristad, U.S. 5,185,935 (hereinafter "*Fristad*"). Applicants respectfully traverse this rejection.

Amended claim 64 recites, "The method of claim 49 wherein the activated carbon has an average particle size greater than that of the components of the flue gas stream such that

substantially recovering the sorbent from the cleaned flue gas involves separation by physical means."

Claim 64 depends indirectly from independent claim 30. As discussed in Section IV hereinabove, *Srinivasachar* fails to disclose the invention as claimed in claim 30. Particularly, *Srinivasachar* fails to disclose, "***monitoring the mercury content of the cleaned flue gas***" and "***wherein the mercury content of the cleaned flue gas is used to control the sorbent injection rate, the sorbent composition, or both***."

In the Office Action, the Examiner states (page 10) that, "Srinivasachar et al reference does not disclose the activated carbon having an average particle size greater than that of the components of the ash stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means." The Examiner further states that, "the Fristad et al. reference discloses the activated carbon having an average particle size greater than the components of the ash stream such that substantially recovering the sorbent from the cleaned flue gas involves separations by physical means."

It is noted that patent number 5,185,935 cited by the Examiner in the August 13th Office Action is an incorrect patent number. U.S. Patent No. 5,185,935 is a patent entitled, "Method and apparatus for separation measurement and alignment system" to Consolidation Coal Company.

Regardless, according to MPEP 2143.03, "if an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)." As *Srinivasachar* fails to make obvious independent claim 30, and *Fristad* is not cited by the Examiner for the purpose of providing the missing limitations, claim 64 depending from claim 30 is also nonobvious. It is thus respectfully requested that the §103 rejection to claim 64 be removed and the claim allowed.

Furthermore, the Examiner states, on page 11 of the Office Action, that, "it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the activated carbon having an average particle size greater than that of the components of the ash stream such that substantially recovering the sorbent from the cleaned flue gas involves separations by physical means." Applicants respectfully traverse.

According to MPEP 2143.01 (VI), the "If the proposed modification or combination would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959)."

Srinivasachar discloses "a contact batch of carbonaceous sorbent having a particle size distribution of carbonaceous sorbent of d_{50}, 15 microns." In embodiments, the contact batch has a d_{50} of less than 8 microns, and in some embodiments, less than 4 microns. See column 2 lines 19-27 and claims 1, 3, and 4. As *Srinivasachar* states in column 10, lines 35-38, "the sorbent particles 28 are engineered to be ***extremely small*** and are therefore distinct from the ash and may be separated from the normal ash in the ash disposal system 136 as shown in FIGS. 1-3." This is in direct opposition to the invention as claimed in the instant claim 64 which states, "wherein the activated carbon has an average particle size ***greater than that of the components*** of the flue gas stream." Modifying *Srinivasachar* to include activated carbon having a particle size greater than the components of the ash stream would change the principle of operation of the primary reference, and is thus prohibited under MPEP 2143.01 (VI).

In Example 6 of the specification as filed, it is stated that, "standard AC sorbents generally are of a fine size with a mean particle diameter of less than 20 micrometers. 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." Because the use of larger sized particles, i.e. activated carbon having "an average particle size ***greater than that of the components*** of the flue gas stream," would have been expected to have unsuitable effectiveness for removing mercury from a flue gas stream, and since *Srinivasachar* emphasizes "*extremely small* particles, one of ordinary skill in the art would not have been motivated to modify Srinivasachar with the teachings of *Fristad* to arrive at the claimed invention.

As there is no motivation to combine *Srinivasachar* and *Fristad,* the combination of the cited references is improper, and because the combination of the references (were it proper, but not conceding such) fails to disclose each and every element of the invention as claimed in claim 64, it is respectfully requested that the §103 rejection to claim 64 be removed and the claim allowed.

F. Claim 54 is Patentable over Srinivasachar, Fristad, and Reiss.

In the Office Action, claim 54 is rejected under 35 U.S.C. §103(a) as being unpatentable over *Srinivasachar*, *Fristad,* and Reiss *et al.,* U.S. 5,575,982 (hereinafter "*Reiss*"). Applicants respectfully traverse this rejection.

Claim 54 recites, "The method of claim 64 wherein the activated carbon has an average particle size greater than 40μm." As discussed with regard to claim 64 in Section IVF hereinabove, the combination of *Srinivasachar* and *Fristad* fails to make obvious claim 64. Furthermore, the combination of *Srinivasachar* with *Fristad* is improper under 2143.01 as the combination would change the principle of operation of the primary reference, *Srinivasachar*. On page 11 of the Office Action, the Examiner cites *Reiss* for disclosing, "an activated carbon having an average particle size greater than 40 micrometers." As *Reiss* is not cited by the Examiner to provide the missing limitations of *Srinivasachar* and *Fristad*, the combination of the cited references fails to make obvious the claimed invention. Furthermore, as discussed in Section IVE hereinabove with regard to combining *Srinivasachar* with *Fristad* in a §103 rejection to claim 64, a combination of *Srinivasachar* with *Reiss* is improper under 2143.01(VI) as such a combination would change the principle of operation of *Srinivasachar*. As such, it is respectfully requested that the §103 rejection to claim 54 be removed and the claim allowed.

V. New Claims

Claims 65-75 are new claims presented herein, which contain material to which the Applicants are entitled. Claim 65 is a new claim reciting, "The method of claim 30 wherein the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof." Support for this claim is found in the specification as filed, for example, in paragraph [0018] and original claim 35.

New claim 66 recites the limitation, "The method of claim 65 wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof." Support for this claim may be found in paragraphs [0053], [0064] and [0067] and original claims 13 and 15 of the specification as filed.

New claim 67 recites the limitation, "The method of claim 66 wherein the promoter is reacted in the gas phase or as a vapor." Support for this limitation may be found, for example, paragraph [0021] and original claims 9, 20, and 36 of the specification as filed.

New claim 68 recites the limitation, "The method of claim 67 wherein the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon." Support for this limitation is found throughout the specification as filed, for example, paragraphs [0016], [0025], and [0065] and original claims 3, 17 and 47.

New claim 69 recites the limitation, "The method of claim 31 wherein the alkaline component is selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof." Support for this limitation is found, for example, in paragraphs [0024] and original claim 5 of the specification as filed.

New claim 70 recites, "The method of claim 69 wherein the alkaline component is selected from the group consisting of sodium carbonate, calcium oxide, lime, and combinations thereof." Support for this claim may be found, for example, in paragraph [0024] and Example 11B of the specification as filed.

New claim 71 recites, "The method of claim 38 wherein the in-flight preparation of the sorbent comprises reacting within the transport line the activated carbon, the promoted carbon, or both with at least one selected from the group consisting of the at least one promoter and the secondary component, and wherein the mercury content of the cleaned flue gas is used to control the sorbent composition." Support for this new claim may be found in Figure 3 and the description thereof in paragraphs [0060]-[0062], as well as in paragraphs [0022] and [0075] of the specification as filed.

New claim 72 recites, "The method of claim 38 wherein the secondary component is selected from the group consisting of I_2, HI, and combinations thereof." Support for this claim is found, for example, in Example 4 and original claims 8 and 42 of the specification as filed.

New claim 73 recites, "The method of claim 38 wherein the at least one promoter and secondary component are combined with the base activated carbon substantially simultaneously." Support for this claim is found in paragraphs [0045] and [0061], Figure 3, and original claim 11 and 26 of the specification as filed.

New claim 74 recites, "The method of claim 49 further comprising reinjecting at least a portion of the regenerated sorbent particles into the flue gas." Support for this new claim may be found, for example, in paragraphs [0009], [0026], and [0079] and original claim 48 of the specification as filed.

New claim 75 recites, "The method of claim 64 wherein the flue gas comprises ash and substantially recovering the sorbent from the cleaned flue gas comprises mechanically separating the sorbent particles from the ash." Support for this new claim may be found in paragraphs [0026] and Example 6 paragraph [0094] of the specification as filed.

These new claims add no new matter to the disclosure and are embodiments to which the Applicants are entitled. As these new claims depend from independent claim 30 which is herein argued to be allowable over the cited prior art, the new claims are also believed to be allowable. It is thus respectfully requested that the Examiner allow new claims 65-75.

CONCLUSION

Applicants respectfully request reconsideration, allowance of the pending claims and a timely Notice of Allowance be issued in this case. If the Examiner feels that a telephone conference would expedite the resolution of this case, the Examiner is respectfully requested to contact the undersigned.

In the course of the foregoing discussions, Applicants may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This discussion should not be interpreted to mean that the other limitations can be ignored or dismissed. The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other distinctions between the claims and the prior art that have yet to be raised, but which may be raised in the future.

If any fees are inadvertently omitted or if any additional fees are required or have been overpaid, please appropriately charge or credit those fees to Conley Rose, P.C. Deposit Account Number 03-2769.

Respectfully submitted,

/Timothy S. Westby/

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Electronic Acknowledgement Receipt

EFS ID:	2458736
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby/Grace A. Wise
Filer Authorized By:	Timothy S. Westby
Attorney Docket Number:	2380-00200
Receipt Date:	13-NOV-2007
Filing Date:	22-AUG-2005
Time Stamp:	14:00:16
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		Resp_OA_Dated_August_13_2007.pdf	114011 f103e6d50259c7657437 4f229678629461824eb2	yes	19

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment - After Non-Final Rejection	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	19

Warnings:	
Information:	
Total Files Size (in bytes):	114011

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.

PTO/SB/06 (07-06)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/209,163	08/22/2005	

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	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 11/13/2007	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 25	Minus	** 57	= 0	X $ =		OR	X $50=	0
Independent (37 CFR 1.16(h))	* 1	Minus	***4	= 0	X $ =		OR	X $210=	0
☐ 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	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
dorretta brooks

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.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

23505 7590 08/13/2007

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EXAMINER	
MILLER HARRIS, AMBER R	

ART UNIT	PAPER NUMBER
1709	

MAIL DATE	DELIVERY MODE
08/13/2007	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	11/209,163	OLSON ET AL.	
	Examiner	Art Unit	
	Amber Miller-Harris	1709	

-- 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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 July 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ 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

4)☒ Claim(s) *1,2,4-12,15-18,20-26,30-33,38-40,45-47,49 and 53-64* is/are pending in the application.

4a) Of the above claim(s) *1-13, 15-18, 20-26, 33, 53, and 55-61* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *30-32,38-40,45-47,49,54 and 62-64* is/are rejected.

7)☐ Claim(s) *30* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *22 August 2005* 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *See Continuation Sheet*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :09/25/2006, 08/15/2006, 08/22/2005.

DETAILED ACTION

Election/Restrictions

Claims 1-13, 15-18, 20-26, 33, 53, and 55-61 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected inventions, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on July 12th, 2007.

Claim Objections

Claim 30 is objected to because of the following informalities: "flue gas. wherein preparing the sorbent comprises..." A comma should replace the period between gas and wherein in order to make the claim one sentence.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> 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.

Claim 30 recites the limitation "base activated carbon" in line 6. There is insufficient antecedent basis for this limitation in the claim. Claim 30 discloses only an activated carbon previously within the claim.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 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.

Claims 30, 38, 39 and 62 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Srinivasachar et al US 6,848,374.

For claim 30, the Srinivasachar et al. reference discloses a method for reducing mercury in flue gas comprising, preparing 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 (column 6, lines 25-30). Wherein preparing the sorbent comprises reacting an activated carbon with at least one component to yield a reaction product, and wherein at least part of preparing the sorbent comprising 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 (column 6, lines 2-20).

For claim 62, the Srinivasachar et al. reference discloses the flue gas stream is down stream of a boiler (column 8, lines 20-22).

For claim 38, the Srinivasachar et al. reference discloses, the in-flight reaction comprising reacting the activated carbon, the promoter, and an option secondary component to enhance the reactivity and capacity of the sorbent (column 6, lines 2-20).

For claim 39, the Srinivasachar et al. reference discloses, the optional secondary component being selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides and combinations thereof (column 6, lines 2-20).

Claim Rejections - 35 USC § 103

The following is a quotation of 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 of this title, 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 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 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 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 as applied in claim 62 above, further in view of Gadkaree et al. US 6,136,749.

Regarding claim 31, the Srinivasachar et al. reference odes not disclose co-injecting an optional alkaline component into the mercury containing flue gas stream.

The Gadkaree et al. reference discloses co-injecting an optional alkaline component into the mercury containing flue gas stream (column 3, lines 54-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include co-injecting an optional alkaline component into the mercury containing flue gas stream (Gadkaree et al, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

Claims 32, 45, 47, 63, and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 as applied in claim 62 above, further in view of Vosteen et al. US 6,878,358 and Hwang et al. US 6,027,551.

Regarding claim 32, the Srinivasachar et al. reference does not disclose monitoring the mercury content of the cleaned 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.

The Vosteen et al. reference discloses monitoring the mercury content of the cleaned flue gas and using the monitored mercury content of the cleaned flue gas to control the rate of injection of the sorbent (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include monitoring the mercury content of the cleaned flue gas and using the monitored mercury content of the cleaned flue gas to control the rate of injection of the sorbent (Vosteen et al. column 5, lines 47-63) because this allows the apparatus to have the maximum amount of mercury to be taken out of the stream as possible.

The Hwang et al. reference discloses regenerating the recovered sorbent (column 3, lines 53-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include regenerating the recovered sorbent (Hwang et al. column 3, lines 53-60) because, if regenerated carbon is used, this reduces the amount of new carbon needed, therefore cutting the cost of operation.

For claim 45, the Srinivasachar et al. reference does not disclose using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent.

The Vosteen et al. reference discloses using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent (Vosteen et al. column 5, lines 47-63) because this allows the apparatus to have the maximum amount of mercury to be taken out of the stream as possible.

For claim 47, the Srinivasachar et al. reference discloses in-flight preparation of the sorbent comprising reacting activated carbon and a promoter, 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, and 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 (column 6, lines 2-20). The reference does not disclose the rate of sorbent injection being determined by a digital computer based at least part on the monitored mercury content of the cleaned flue gas.

The Vosteen et al. reference discloses the rate of sorbent injection being determined by a digital computer based at least part on the monitored mercury content of the cleaned flue gas (column 5, lines 47-63). Although the reference does not explicitly state "a digital computer", but would perform the same function the Vosteen et al. reference describes a "control system" which one would know in the art can be considered "a digital computer".

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the rate of sorbent injection being determined by a digital computer based at least part on

the monitored mercury content of the cleaned flue gas (Vosteen et al. column 5, lines 47-63) because this allows the apparatus to have the maximum amount of mercury to be taken out of the stream as possible.

For claim 63, the Srinivasachar et al. reference does not disclose continuously monitoring the mercury content of the cleaned flue gas.

The Vosteen et al. reference discloses continuously monitoring the mercury content of the cleaned flue gas (column 5, lines 47-63).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include continuously monitoring the mercury content of the cleaned flue gas (Vosteen et al. column 5, lines 47-63) because this allows the system to know if the mercury level is fluctuating, and if so how to adjust the rate at which the sorbent is entering in the system.

For claim 49, the Srinivasachar et al. reference does not disclose regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury.

The Hwang et al. reference discloses regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury (column 3, lines 53-60).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include regenerating at least a portion of the recovered sorbent particles to substantially remove

contaminants therefrom to recover capacity for capturing mercury (Hwang, column 3, lines 53-60) because, if regenerated carbon is used, this reduces the amount of new carbon needed, therefore cutting the cost of operation.

Claims 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 as applied to claim 39 above, and further in view of Gadkaree et al. US 6,136,749.

For claim 40, the Srinivasachar et al. reference does not disclose co-injection an optional alkaline component into the mercury containing flue gas stream.

The Gadkaree et al. reference discloses co-injecting an optional alkaline component into the mercury containing flue gas stream (column 3, lines 54-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include co-injecting an optional alkaline component into the mercury containing flue gas stream (Gadkaree et al, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

Claims 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 and Gadkaree et al. US 6,136,749 as applied to claim 40 above, and further in view of Vosteen et al. US 6,878,358.

For claim 46, the Srinivasachar et al. reference does not disclose monitoring the mercury content of the cleaned flue gas and using the monitored mercury content to control the composition of the sorbent and the alkaline-to-sorbent injection ration.

The Vosteen et al. reference discloses monitoring the mercury content of the cleaned flue gas and using the monitored mercury content to control the composition of the sorbent and the alkaline-to-sorbent injection ration (column 5, lines 47-63). Although the reference does not disclose specifically the alkaline-to-sorbent ratio, it does disclose mixtures of bromine and sulfur substances to be *controlled.* The controlling device does provide the needed ability to do ratios of different substances needed within the sorbent.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include monitoring the mercury content of the cleaned flue gas and using the monitored mercury content of the cleaned flue gas to control the rate of injection of the sorbent (Vosteen et al. column 5, lines 47-63) because this allows the apparatus to have the maximum amount of mercury to be taken out of the stream as possible.

Claim 64 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 as applied in claim 62 above, further in view of Fristad et al. US 5,185,935.

Regarding claim 64, the Srinivasachar et al. reference does not disclose the activated carbon having an average particle size greater than that of the components of the as stream such that substantially recovering the sorbent from the cleaned flue gas involves separations by physical means.

The Fristad et al. reference discloses the activated carbon having an average particle size greater than that of the components of the as stream such that substantially

recovering the sorbent from the cleaned flue gas involves separations by physical means (column 6, lines 55-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the activated carbon having an average particle size greater than that of the components of the as stream such that substantially recovering the sorbent from the cleaned flue gas involves separations by physical means (Fristad, column 6, lines 55-65) because the particular technique of separation by physical means, was recognized as part of the ordinary capabilities of one skilled in the art.

Claim 54 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 and Fristad et al. US 5,185,935 as applied in claim 64 above, further in view of Reiss et al. US 5,575,982.

The Srinivasachar et al. reference does not disclose the activated carbon having an average particles size greater than 40 micrometers.

The Reiss et al. reference discloses the activated carbon having an average particles size greater than 40 micrometers (column 4, lines 59-65).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Srinivasachar et al. reference to include the activated carbon having an average particles size greater than 40 micrometers (Reiss et al. column 4, lines 59-65) because these particle diameters of the activated carbon can effectively be introduced into the exhaust gas stream and cause an optimum adsorption.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Amber Miller-Harris whose telephone number is (571) 270-3149. The examiner can normally be reached on Mon-Thur (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Walter Griffin can be reached on (571) 272-1447. 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.

AH

Walter D. Griffin

WALTER D. GRIFFIN
SUPERVISORY PATENT EXAMINER

SUPPLEMENTAL MODIFIED

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11209163
	Filing Date	2005-08-22
	First Named Inventor	Edwin S Olson
	Art Unit	1724
	Examiner Name	Robert A Hopkins
	Attorney Docket Number	2380-00200

CERTIFICATION STATEMENT

Please see 37 CFR 1 97 and 1.98 to make the appropriate selection(s):

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☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

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	/Timothy S. Westby/	Date (YYYY-MM-DD)	2006-08-15
Name/Print	Timothy S. Westby	Registration Number	52352

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	First Named Inventor	Edwin S. Olson
	Art Unit	1724
	Examiner Name	Robert A. Hopkins
	Attorney Docket Number	2360-00200

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☒ None

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Signature	/Timothy S Westby/	Date (YYYY-MM-DD)	2006-09-25
Name/Print	Timothy S Westby	Registration Number	52352

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	Art Unit	1724
	Examiner Name	Robert A. Hopkins
	Attorney Docket Number	2380-00200

U.S.PATENTS

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
/A.H./	1	4500327		1985-02-19	Nishino, et al.	

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/A.H./	1	6953494	B2	2005-10-11	Nelson, Jr.	

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	Filing Date	2005-08-22
	First Named Inventor	Edwin S. Olson
	Art Unit	1724
	Examiner Name	Robert A. Hopkins
	Attorney Docket Number	2380-00200

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Sheet 1 of 2

Complete if Known	
Application Number	Unassigned
Filing Date	Herewith
First Named Inventor	Edwin S. Olson, et al.
Group Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	2380-00200

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.H./	AA	US-1,984,164	12-11-1934	Stock	
	AB	US-3,194,629	07-13-1965	Dreibelbis, et al	
	AC	US-3,662,523	05-16-1972	Revoir	
	AD	US-3,786,619	01-22-1974	Melkersson	
	AE	US-3,849,267	11-19-1974	Hilgen	
	AF	US-4,101,631	07-18-1978	Ambrsini, et al	
	AG	US-4,196,173	04-01-1980	deJong, et al.	
	AH	US-4,708,853	11-24-1987	Matviya	
	AI	US-4,786,483	11-22-1988	Audeh	
	AJ	US-4,814,152	03-21-1989	Yan	
	AK	US-4,889,698	12-26-1989	Moller	
	AL	US-4,956,162	09-11-1990	Smith	
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	AN	US-5,607,496	03-04-1997	Brooks	
	AO	US-5,672,323	09-30-1997	Bhat	
	AP	US-5,695,726	12-09-1997	Lerner	
	AQ	US-5,827,352	12-27-1998	Altman	
	AR	US-5,891,324	04-06-1999	Ohtsuka	
	AS	US-6,027,551	02-22-2000	Hwang	
	AT	US-6,080,281	06-27-2000	Attia	
	AU	US-6,136,072	10-24-2000	Sjostrom	
	AV	US-6,214,304	04-10-2001	Rosenthal	
	AW	US-6,258,334	07-10-2001	Gadkaree	
	AX	US-6,383,981	05-07-2002	Blankenship	
	AY	US-6,528,030	03-04-2003	Madden et al.	
	AZ	US-2002/0150516	10-17-2002	Pahlman, et al.	
	AAA	US-2001/0003116	06-07-2001	Neufert	
/A.H./	ABB	US-2004/0003716	01-08-2004	Nelson, Jr.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where RelevantPassages or Relevant Figures Appear	T[6]
/A.H./		DE 34 26 059				
/A.H./		JP 49-43197				
/A.H./		JP 50-6438				

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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet	2	of	2

Complete if Known	
Application Number	Unassigned
Filing Date	Herewith
First Named Inventor	Edwin S. Olson, et al.
Group Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	2380-00200

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	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[2]
/A.H./		Dunham, G.E. et al., *Mercury Capture by an Activated Carbon in a Fixed-Bed Bench-Scale System*, Environmental Progress Vol. 17, No. 3, pp. 203-208	
		Felsvang, K. et al., *Mercury Reduction and Control Options*, The U.S. EPA–DOE–EPRI Combined Power Plant Air Pollutant Control Symposium: The Mega Symposium and The A&WMA Specialty Conference on Mercury Emissions: Fate, Effects and Control. August 20–23, 2001, Chicago, Illinois, pp. 1-19	
		Ghorishi, B; Guller, B.K. , *Sorption of Mercury Species by Activated Carbons and Calcium-Based Sorbents: Effect of Temperature, Mercury Concentration and Acid Gases*, Waste Manage. Res. 1998, 16, 6 582-593.	
		Lancia, A.; Musmarra, D.; Pepe, F.; Volpicelli, G., *Adsorption of Mercuric Chloride Vapours from Incinerator Flue Gases on Calcuim Hydroxide Particles*, Combust. Sci. & Technol. 1993, 93, 277.	
/A.H./		Olson, D.G.; et al., *The Reduction of Gas Phase Air Toxics from Combustion and Incineration Sources using the MET-Mitsui-BF Activated Coke Process*, Fuel Processing Technology, 65-66 (2000) 393-405.	

Examiner Signature	/Amber Miller-Harris/	Date Considered	04/30/2007

*EXAMINER: Initial 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's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard St.16 if possible. 6 Applicant is to place a check mark here if English language translation is attached.

The 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 2 hours 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 FORM 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

Notice of References Cited	Application/Control No. 11/209,163	Applicant(s)/Patent Under Reexamination OLSON ET AL.	
	Examiner Amber Miller-Harris	Art Unit 1709	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,848,374	02-2005	Srinivasachar et al.	110/345
*	B	US-6,878,358	04-2005	Vosteen et al.	423/210
*	C	US-2005/0019240	01-2005	Lu et al.	423/210
*	D	US-3,826,618	07-1974	Capuano	436/43
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007							
	1	N								
	2	N								
	3	N								
	4	N								
	5	N								
	6	N								
	7	N								
	8	N								
	9	N								
	10	N								
	11	N								
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	14	-								
	15	N								
	16	N								
	17	N								
	18	N								
	19	-								
	20	N								
	21	N								
	22	N								
	23	N								
	24	N								
	25	N								
	26	N								
	27	-								
	28	-								
	29	-								
	30	✓	O							
	31	✓								
	32	✓								
	33	N								
	34	-								
	35	-								
	36	-								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/30/2007	07/30/2007							
	37	-								
	38	✓								
	39	✓								
	40	✓								
	41	-								
	42	-								
	43	-								
	44	-								
	45	✓								
	46	✓								
	47	✓								
	48	-								
	49	✓								
	50	-								
	51	-								
	52	-								
	53	N								
	54	✓								
	55	N								
	56	N								
	57	N								
	58	N								
	59	N								
	60	N								
	61	N								
	62	✓								
	63	✓								
	64	✓								

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BIB DATA SHEET

CONFIRMATION NO. 1534

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/209,163	08/22/2005 RULE	095	1709	2380-00200

APPLICANTS

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

**** CONTINUING DATA ***************************

This appln claims benefit of 60/605,640 08/30/2004

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

09/22/2005

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /AMBER R MILLER HARRIS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		ND	7	54	4

ADDRESS

CONLEY ROSE, P.C.
David A. Rose
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HOUSTON, TX 77253-3267
UNITED STATES

TITLE

Sorbents for the oxidation and removal of mercury

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
3030	No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11209163	OLSON ET AL.
	Examiner	Art Unit
	Miller-Harris, Amber	1709

SEARCHED

Class	Subclass	Date	Examiner
110	345	7/24/2007	AH
423	210	7/25/2007	AH
95	134	7/25/2007	AH

SEARCH NOTES

Search Notes	Date	Examiner
IDS search	7/24/2007	AH
Inventor search	7/24/2007	AH
Class 110/345 searched for carbon sorbents used to remove mercury from a boiler system by injection within the stream	7/24/2007	AH
Class 423/210 searched for controlling the amount of sorbent entering the system	7/25/2007	AH
Class 95/134 searched for regeneration of the sorbent after mercury removal	7/25/2007	AH

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	6	(remov$4 near2 mercury) and (bromine OR iodine) and ("50" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:13
L3	1	(remov$4 near2 mercury) and (bromine OR iodine) and ("60" micrometers)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:14
L5	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separation with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
L7	0	(remov$4 near2 mercury) and (bromine OR iodine) and (separat$4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:23
L8	0	(remov$4 near2 mercury) and (bromine OR iodine) and (remov$4 with (physical means))	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:24
L9	8	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size greater)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:24
S1	4	2004/0003716	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S2	1	"20040003716"	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:54
S3	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	OR	OFF	2007/07/24 10:18
S4	8	(remov$5 near3 mercury) and (carbon same in-flight)	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S5	2	"6953494"	US-PGPUB; USPAT	ADJ	ON	2007/07/24 10:48
S6	42	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494"). URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48

EAST Search History

S7	41	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494"). URPN. and inflight	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48
S8	41	("1788466" | "1984164" | "20010002387" | "20030161771" | "20040013589" | "2511288" | "3194629" | "3662523" | "3849267" | "3956458" | "3961020" | "4040802" | "4075282" | "4174373" | "4196173" | "4394354" | "4427630" | "4500327" | "4578256" | "4708853" | "4889698" | "4917862" | "5179058" | "5202301" | "5288306" | "5320817" | "5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842").PN. OR ("6953494"). URPN. and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:53
S9	50	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:54
S10	9	in-flight near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:24
S11	13	in-flight same (mercury and remov$5)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:41
S12	0	carbon and (in flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 16:42
S13	6	carbon and (in-flight) near4 reaction	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:21

EAST Search History

S14	9	in-flight near4 reaction and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:32
S15	5261	in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33
S16	118	in-flight and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:33
S17	12	in-flight and (remov$4 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S18	0	In-Flight Modification Of Inorganic Particles Within A Reaction Product Flow	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:34
S19	7	In-Flight Modification	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:53
S20	4	In-Flight Capture	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:42
S21	19	(sorbent near3 composition) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S22	252	(sorbent near3 Bromine OR iodine) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S23	6	(sorbent near3 (Bromine OR iodine)) same (remov$4 near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 09:49
S24	0	In-Flight Modification and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:43
S25	9	(mercury near3 remov$4) same (surface reactions)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 10:44
S26	1227	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/25 13:56
S27	43	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2007/07/25 13:56
S28	64	sorbent and mercury and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57

EAST Search History

S29	7	sorbent and mercury and (surface reaction) and bromine	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 13:57
S30	10	sorbent and (remov$4 near3 mercury) and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:55
S31	2	"5409522" and (surface reaction)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:02
S32	0	"5409522" and (surface reaction) and (iodine or bromine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:03
S33	1	"20060048646" and in-flight	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:20
S34	165	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 14:56
S35	46	sorbent and (remov$4 near3 mercury) and (alkaline OR alkali) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/25 16:44
S36	15	((bromine OR iodine) same (activated carbon) same react$4) and (remove near3 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 08:19
S37	1	"6848374" and (alkaline OR alkali)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S38	0	"6848374" and (regenerat$)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:12
S39	62	((regenerat$4) with sorbent) and (remov$4 near2 mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:13
S40	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:38
S41	0	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regeneragt$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39
S42	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:55
S43	10	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenerat$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 09:39

EAST Search History

S44	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and regenera\t$4 and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S45	34	(monitor$3 with mercury) and (remov$4 near2 mercury) and (bromine OR iodine)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 10:00
S46	2	2004/0003716 and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:53
S47	1	"20040003716" and monitor$4	US-PGPUB; USPAT	OR	OFF	2007/07/26 10:55
S48	5	((regenerat$4) with sorbent) and (remov$4 near2 mercury) and (bromine OR iodine) and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S49	206	(remov$4 near2 mercury) and (bromine OR iodine) and monitor$3	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:42
S50	34	(remov$4 near2 mercury) and (bromine OR iodine) and (monitor$3 with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:53
S51	74	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury)	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 13:54
S52	38	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:05
S53	37	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:38
S54	1	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and regenerate	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 14:09
S55	2	(remov$4 near2 mercury) and (bromine OR iodine) and ((monitor$3 or measur$4) with mercury) and sorbent and measur$4 and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:39
S56	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 08:21

EAST Search History

S57	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "50")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S58	1	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "60")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:45
S59	2	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "70")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47
S60	4	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "80")	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/26 15:47
S61	5	(remov$4 near2 mercury) and (bromine OR iodine) and (particle size near4 "40") and "40"	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/30 07:59

PTO/SB/06 (12-04)
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875 Effective December 8, 2004

Application or Docket Number: 11209163

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	150.00		N/A	300.00
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	$250		N/A	$500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	$100		N/A	$200
TOTAL CLAIMS (37 CFR 1.16(i))	57 minus 20 =	37	X$ 25 =		OR	X$50 =	1700
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	1	X100 =			X200 =	200
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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))			+180=			+360=	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2900

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 46	Minus	** 57	* 0	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	* 0	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

7/9/07

AMENDMENT B

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 46	Minus	** 57	*	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	*	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					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 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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1724	
Examiner	:	Amber R. Miller Harris	

Customer No.: 23505
Atty. Dkt. No.: 2380-00200
Date: July 9, 2007

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

RESPONSE TO RESTRICTION REQUIREMENT

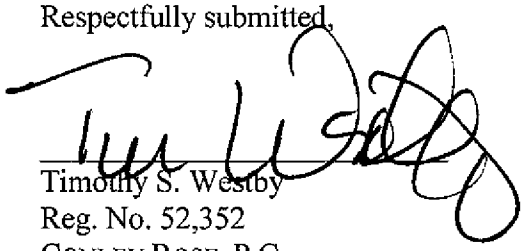
Dear Sir:

Responsive to the Office Action (Election/Restrictions) dated June 7, 2007, pursuant to the above-referenced application, Applicants elect without traverse the claims of Group II consisting of Claims 30-32, 38-40, 45-47, 49, 54, and 62-64, drawn to the method for reducing mercury in flue gas, classified in class 95, subclass 134. Applicants reserve the right to re-file the non-elected claims in one or more divisional applications at a later time.

Applicants, through undersigned counsel, welcome a telephone conference if the Examiner believes this will expedite prosecution of the application by clarifying any outstanding questions or issues.

The Commissioner is hereby authorized to charge any fee connected with this communication to Account Number 03-2769 and enter any time extension(s) necessary to prevent this case from being abandoned.

Respectfully submitted,



Timothy S. Westby
Reg. No. 52,352
CONLEY ROSE, P.C.
P.O. Box 3267
Houston, Texas 77253-3267
(713) 238-8000
ATTORNEY FOR APPLICANTS

Electronic Acknowledgement Receipt

EFS ID:	1950758
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby/Grace A. Wise
Filer Authorized By:	Timothy S. Westby
Attorney Docket Number:	2380-00200
Receipt Date:	09-JUL-2007
Filing Date:	22-AUG-2005
Time Stamp:	16:08:47
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	Response to Election / Restriction Filed	RespRestReq.pdf	35559 2b42974bf7bd2b5f9a7445e9beb4b0e5a82416ca	no	2

Warnings:

Information:	
Total Files Size (in bytes):	35559

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

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/209,163	08/22/2005	Edwin S. Olson	2380-00200	1534

23505 7590 06/07/2007

CONLEY ROSE, P.C.
David A. Rose
P. O. BOX 3267
HOUSTON, TX 77253-3267

EXAMINER	
MILLER HARRIS, AMBER R	
ART UNIT	**PAPER NUMBER**
1709	

MAIL DATE	DELIVERY MODE
06/07/2007	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	11/209,163	OLSON ET AL.	
	Examiner	Art Unit	
	Amber R. Miller-Harris	1709	

-- 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 1 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *22 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ 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

4)☒ Claim(s) *1-13,15-18,20-26,30-33,38-40,45-47,49 and 53-64* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *1-13, 15-18, 20-26, 30-33, 38-40, 45-47, 49, 53-64* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ 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).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-13, 15-18, 20-26, 33, 53, 55, and 56-61 drawn to the composition of a promoted carbon sorbent, and the method of making the promoted carbon sorbent, classified in class 502, subclass 417.

II. Claims 30-32, 38-40, 45-47, 49, 54, and 62-64, drawn to the method for reducing mercury in flue gas, classified in class 95, subclass 134.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I. and II. are related as product and process of use. The inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product. See MPEP § 806.05(h). In the instant case the product as claimed can be used in a materially different process such as the adsorption of volatile organic compounds.

3. Restriction for examination purposes as indicated is proper because all these inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and examination burden if restriction were not required because one or more of the following reasons apply:

(a) the inventions have acquired a separate status in the art in view of their different classification;

(b) the inventions have acquired a separate status in the art due to their recognized divergent subject mater:

(c) the inventions require a different field of search (for example, searching different classes/subclasses or electronic resources, or employing different search quires);

(d) the prior art applicable to one invention would not likely be applicable to another invention;

(e) the inventions are likely to raise different non-prior art issues under 35 U.S.C 101 and/or 35 U.S.C. 112, first paragraph.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of invention to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention.**

The election of an invention may be made with or with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144.

If claims are added after the election, applicant must indicate which of these claims are readable on the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

4. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Amber R. Miller-Harris whose telephone number is (571) 272-3149. The examiner can normally be reached on Mon-Fri 8-5 (Alt Fri Off).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Walter Griffin can be reached on (571) 272-1447. 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.

AH

Walter D. Griffin

WALTER D. GRIFFIN
SUPERVISORY PATENT EXAMINER

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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Bib Data Sheet

CONFIRMATION NO. 1534

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/209,163	08/22/2005 RULE	095	1709	2380-00200

APPLICANTS

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

**** CONTINUING DATA ***************************

This appln claims benefit of 60/605,640 08/30/2004

**** FOREIGN APPLICATIONS *********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 09/22/2005

		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed	☐ yes ☒ no	ND	7	54	4
35 USC 119 (a-d) conditions met	☐ yes ☐ no ☐ Met after Allowance				
Verified and Acknowledged	Examiner's Signature Initials				

ADDRESS
23505

TITLE

Sorbents for the oxidation and removal of mercury

FILING FEE RECEIVED		
3030	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	11/209,163	Confirmation No. 1534
Applicant	:	Edwin S. Olson, *et al.*	
Filed	:	August 22, 2005	
For	:	Sorbents for the Oxidation and Removal of Mercury	
TC/A.U.	:	1724	
Examiner	:	Robert A. Hopkins	

Customer No.: 23505
Atty. Dkt. No.: 2380-00200
Date: February 27, 2007

PRELIMINARY AMENDMENT

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

Sir:

Applicant requests that the above-identified application be amended as follows prior to consideration on the merits:

Amendments to the Claims are reflected in the listing of the claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 9 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Currently Amended) A promoted carbon sorbent 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~~wherein the sorbent is effective for the removal of mercury from a gas stream located downstream of a boiler, said removal of mercury yielding a cleaned gas stream, and wherein the composition of the promoted carbon sorbent is controlled by the mercury content of the cleaned gas stream.

2. (Original) The promoted carbon sorbent of claim 1 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 40 micrometers, and combinations thereof, and the promoter is selected from the group consisting of molecular halogens, Group V halides, Group VI halides, hydrohalides, and combinations thereof.

3. (Currently Amended) The promoted carbon sorbent of claim 2 wherein the sorbent ~~comprises from about 1 to about 30 grams promoter per 100 grams of base activated carbon~~comprises an activated carbon matrix in a fixed or a moving bed structure.

4. (Currently Amended) The promoted carbon sorbent of claim ~~3~~ 2 further comprising an optional secondary component comprising a halogen or a hydrohalide such that the reactivity and mercury capacity of the sorbent are enhanced.

5. (Currently Amended) The promoted carbon sorbent of claim ~~4~~ 2 further comprising an optional alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

6. (Currently Amended) The promoted carbon sorbent of claim 4 wherein the concentration of the optional secondary component on the finished sorbent is within the range of from about 1 wt-% to about 15 wt-% of the concentration of the promoter on the finished sorbent.

7. (Currently Amended) The promoted carbon sorbent of claim ~~6~~ 4 wherein the optional

secondary component is selected from the group consisting of Group V halides, Group VI halides, HI, HBr, HCl, and combinations thereof.

8. (Original) The promoted carbon sorbent of claim 7 wherein the optional secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

9. (Currently Amended) The promoted carbon sorbent of claim 8 wherein the ~~9~~promoter is substantially in vapor form when combined with the base activated carbon.

10. (Original) The promoted carbon sorbent of claim 8 wherein the promoter is combined with an organic solvent prior to reaction with the base activated carbon.

11. (Original) The promoted carbon sorbent of claim 8 wherein the promoter and optional secondary component are combined with the base activated carbon substantially simultaneously.

12. (Currently Amended) The promoted carbon sorbent of claim ~~8~~ 2 further comprising 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.

13. (Original) The promoted carbon sorbent of claim 12 wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

14. (Canceled) The promoted carbon sorbent of claim 3 further comprising 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.

15. (Currently Amended) The promoted carbon sorbent of claim ~~14~~ 12 further comprising an optional alkaline component comprising an alkaline or alkaline earth element wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

16. (Currently Amended) A method of preparing a promoted carbon sorbent comprising providing ~~a~~ an ~~granular~~ activated carbon; and forming a reaction product by 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 downstream of a boiler, thus yielding a cleaned gas stream, and wherein the composition of the sorbent is adjusted based upon the mercury content of the cleaned gas stream.

17. (Original) The method of claim 16 wherein the reaction product comprises from about 1 to about 30 grams promoter per 100 grams activated carbon.

18. (Currently Amended) The method of claim ~~16~~ 53 wherein the reaction product has an average particle size distribution greater than about 40 micrometers.

19. (Canceled) The method of claim 16 wherein the promoter is selected from the group consisting of molecular halogens, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

20. (Currently Amended) The method of claim ~~19~~ 17 wherein the promoter is in the gas phase when contacting the activated carbon.

21. (Currently Amended) The method of claim ~~19~~ 17 wherein the promoter is in an organic solvent when contacting the activated carbon.

22. (Original) The method of claim 20 wherein the promoter is selected from the group consisting of Br_2, a Group V bromide, a Group VI bromide, and combinations thereof.

23. (Currently Amended) The method of claim ~~18~~ 17 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

24. (Currently Amended) The method of claim 20 further comprising 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.

25. (Original) The method of claim 24 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

26. (Currently Amended) The method of claim 24 wherein the promoter and optional secondary component are contacted substantially simultaneously with the activated carbon.

27. (Canceled) The method of claim 24 wherein the optional secondary component comprises I_2 or HI.

28. (Canceled) The method of claim 20 further comprising 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.

29. (Canceled) The method of claim 24further comprising 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.

30. (Currently Amended) A method for reducing mercury in flue gas comprising: ~~providing~~ preparing 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, wherein preparing the sorbent comprises reacting an activated carbon with at least one component to yield a reaction product, and wherein at least part of preparing the sorbent comprises 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.

31. (Currently Amended) The method of claim ~~30~~ 62 further comprising co-injecting an optional alkaline component into the mercury containing flue gas stream.

32. (Currently Amended) The method of claim ~~30~~ 62 further comprising monitoring the mercury content of the cleaned 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.

33. (Currently Amended) The method of claim ~~30~~ 16 further comprising preparing ~~wherein~~ the ~~injected~~ sorbent ~~is prepared~~ in-flight by reacting ~~an~~ the activated carbon, ~~and a~~ the promoter, and an optional secondary component to enhance the reactivity and mercury capacity of the sorbent~~within a pneumatic transport line from which the reaction product is injected to the mercury-containing flue gas stream~~.

34. (Canceled) The method of claim 33 wherein the promoter is selected from the group consisting of molecular halogens, halides, and combinations thereof.

35. (Canceled) The method of claim 34 wherein the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof.

36. (Canceled) The method of claim 35 wherein the promoter is reacted in the gas phase or as a vapor.

37. (Canceled) The method of claim 36 wherein the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon.

38. (Currently Amended) The method of claim ~~37~~ 62 wherein the ~~injected sorbent is prepared~~ in-flight reaction comprises ~~by~~ reacting ~~an~~ the activated carbon, ~~a~~ the 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~~.

39. (Original) The method of claim 38 wherein the optional secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

40. (Original) The method of claim 39 further comprising co-injecting an optional alkaline component into the mercury containing flue gas stream.

41. (Canceled) The method of claim 39 wherein the optional secondary component is added at from about 1 to about 15 wt-% of the promoter content.

42. (Canceled) The method of claim 41 wherein the optional secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

43. (Canceled) The method of claim 42 wherein the optional secondary component is added in the gas phase or as a vapor.

44. (Canceled) The method of claim 41 further comprising 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.

45. (Original) The method of claim 32 further comprising using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent.

46. (Currently Amended) The method of claim 40 further comprising monitoring the mercury content of the cleaned flue gas and using the monitored mercury content to control the composition of the sorbent and the alkaline-to-sorbent injection ratio.

47. (Currently Amended) The method of claim 45 wherein the ~~injected sorbent is prepared~~ in-

flight preparation of the sorbent comprises ~~by~~ reacting ~~an~~ the 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.

48. (Canceled) A method for reducing the mercury content of a gas stream comprising the steps of injecting a powdered activated carbon sorbent having a mass-mean particle size >40μm into a gas stream containing mercury and ash particles, capturing mercury from the gas stream on the sorbent particles, mechanically separating the sorbent particles from the ash particles, and re-injecting the separated sorbent particles into the gas stream.

49. (Currently Amended) The method of claim ~~48~~ 62 further comprising regenerating at least a portion of the recovered sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury.

50. (Canceled) The method of claim 48 further comprising co-injecting into the gas stream an alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

51. (Canceled) The method of claim 48 wherein the powdered activated carbon sorbent further comprises a promoter selected from the group consisting of halides, halogens, and combinations thereof.

52. (Canceled) The method of claim 51 further comprising co-injecting into the gas stream an alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

53. (Currently Amended) The method of claim ~~48~~ 16 wherein the ~~particulate~~ activated carbon ~~sorbent~~ has ~~a mass mean~~an average particle size ~~>60μm~~greater than that of the components of the gas stream such that the promoted carbon sorbent produced therefrom can be substantially separated by physical means from the cleaned gas stream.

54. (Currently Amended) The method of claim ~~52~~ 64 wherein the ~~particulate~~ activated carbon ~~sorbent~~ has ~~a mass mean~~an average particle size ~~>~~greater than ~~60~~40μm.

55. (New) The promoted carbon sorbent of claim 3 wherein the structure is selected from the group consisting of moving fiber screens and monoliths.

56. (New) The promoted carbon sorbent of claim 5 wherein the ratio of base activated carbon, the promoter, and the optional alkaline component is chosen for optimum economic removal of mercury from the gas stream.

57. (New) The method of claim 16 further comprising continuously monitoring the mercury content of the cleaned gas stream.

58. (New) The method of claim 16 wherein the sorbent comprises an activated carbon matrix in a fixed or a moving bed structure.

59. (New) The method of claim 58 wherein the structure is selected from the group consisting of moving fiber screens and monoliths.

60. (New) The promoted carbon sorbent prepared by the method of claim 57.

61. (New) The method of claim 16 wherein the ratio of activated carbon to promoter is adjusted for optimization of economic removal of mercury from the gas stream.

62. (New) The method of claim 30 wherein the flue gas stream is downstream of a boiler.

63. (New) The method of claim 32 further comprising continuously monitoring the mercury content of the cleaned flue gas.

64. (New) The method of claim 62 wherein the activated carbon has an average particle size greater than that of the components of the gas stream such that substantially recovering the sorbent from the cleaned flue gas involves separation by physical means.

REMARKS/ARGUMENTS

The Applicants have added new claims 55-64 and preliminarily amended claims 1, 3-7, 12, 15-16, 18, 20-21, 23-24, 26, 30-33, 38, 47, 49, 53-54 to clarify the invention. Claims 9 and 46 are amended herein to correct typographical errors. Claims 14, 19, 27-29, 34-37, 41-44, 48, and 50-52 are canceled herein. It is respectfully submitted that the Application, as amended, is in condition for allowance. By virtue of this Preliminary Amendment, claims 1-13, 15-18, 20-26, 30-33, 38-40, 45-47, 49, and 53-64 are currently pending. Please note that amended claims 1, 16, and 30 are amended independent claims. The Applicants respectfully request consideration and allowance of the present claims.

CONCLUSION

If any fees are inadvertently omitted or if any additional fees are required or have been overpaid, please appropriately charge or credit those fees to Conley Rose, P.C. Deposit Account Number 03-2769.

Respectfully submitted,

Timothy S. Westby
PTO Reg. No. 52,352
CONLEY ROSE, P.C.
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Houston, TX 77253-3267
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(713) 238-8008 (Fax)

ATTORNEY FOR APPLICANTS

Electronic Acknowledgement Receipt

EFS ID:	1548099
Application Number:	11209163
International Application Number:	
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby/Grace A. Wise
Filer Authorized By:	Timothy S. Westby
Attorney Docket Number:	2380-00200
Receipt Date:	27-FEB-2007
Filing Date:	22-AUG-2005
Time Stamp:	15:16:49
Application Type:	Utility

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)
1		PreliminaryAmendment.pdf	295579	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Claims	2	8
	Applicant Arguments/Remarks Made in an Amendment	9	9
Warnings:			
Information:			
	Total Files Size (in bytes):	295579	

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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
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875 Effective December 8, 2004

Application or Docket Number: 112-0963

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	150.00		N/A	300.00
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	$250		N/A	$500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	$100		N/A	$200
TOTAL CLAIMS (37 CFR 1.16(i))	57 minus 20 =	* 37	X$ 25 =		OR	X$50 =	1700
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 1	X100 =			X200 =	200
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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))			+180=			+360=	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2900

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 46	Minus	** 57	= 0	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					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".
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11209163
Filing Date	2005-08-22
First Named Inventor	Edwin S. Olson
Art Unit	1724
Examiner Name	Robert A. Hopkins
Attorney Docket Number	2380-00200

U.S.PATENTS

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	6953494	B2	2005-10-11	Nelson, Jr.	

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U.S.PATENT APPLICATION PUBLICATIONS

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
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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]
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11209163
	Filing Date	2005-08-22
	First Named Inventor	Edwin S. Olson
	Art Unit	1724
	Examiner Name	Robert A. Hopkins
	Attorney Docket Number	2380-00200

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Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11209163
Filing Date	2005-08-22
First Named Inventor	Edwin S. Olson
Art Unit	1724
Examiner Name	Robert A. Hopkins
Attorney Docket Number	2380-00200

CERTIFICATION STATEMENT

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SIGNATURE

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Signature	/Timothy S. Westby/	Date (YYYY-MM-DD)	2006-09-25
Name/Print	Timothy S. Westby	Registration Number	52352

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Electronic Acknowledgement Receipt

EFS ID:	1216722
Application Number:	11209163
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby
Filer Authorized By:	
Attorney Docket Number:	2380-00200
Receipt Date:	25-SEP-2006
Filing Date:	22-AUG-2005
Time Stamp:	14:25:31
Application Type:	Utility
International Application Number:	

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part	Pages
1	Information Disclosure Statement (IDS) Filed	2380-00200_SupplIDS.pdf	137254	no	3

Warnings:	
Information:	
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Total Files Size (in bytes):	137254

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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.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	11209163
Filing Date	2005-08-22
First Named Inventor	Edwin S. Olson
Art Unit	1724
Examiner Name	Robert A. Hopkins
Attorney Docket Number	2380-00200

U.S.PATENTS

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	4500327		1985-02-19	Nishino, et al	

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

U.S.PATENT APPLICATION PUBLICATIONS

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
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NON-PATENT LITERATURE DOCUMENTS

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11209163
	Filing Date	2005-08-22
	First Named Inventor	Edwin S. Olson
	Art Unit	1724
	Examiner Name	Robert A. Hopkins
	Attorney Docket Number	2380-00200

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11209163
	Filing Date	2005-08-22
	First Named Inventor	Edwin S Olson
	Art Unit	1724
	Examiner Name	Robert A Hopkins
	Attorney Docket Number	2380-00200

CERTIFICATION STATEMENT

Please see 37 CFR 1 97 and 1.98 to make the appropriate selection(s):

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☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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SIGNATURE

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Signature	/Timothy S. Westby/	Date (YYYY-MM-DD)	2006-08-15
Name/Print	Timothy S. Westby	Registration Number	52352

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Electronic Acknowledgement Receipt

EFS ID:	1154333
Application Number:	11209163
Confirmation Number:	1534
Title of Invention:	Sorbents for the oxidation and removal of mercury
First Named Inventor:	Edwin S. Olson
Customer Number:	23505
Filer:	Timothy S. Westby
Filer Authorized By:	
Attorney Docket Number:	2380-00200
Receipt Date:	15-AUG-2006
Filing Date:	22-AUG-2005
Time Stamp:	14:16:40
Application Type:	Utility
International Application Number:	

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part	Pages
1	Information Disclosure Statement (IDS) Filed	2380-00200_SuppIDS.pdf	141347	no	3

Warnings:	
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New Applications Under 35 U.S.C. 111
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REMARKS: **Serial No. 11/209,163, filed August 22, 2005**
Please find the following attached hereto: ***Transmittal Form (1 p.); Application Data Sheet (3 p.); Declaration (1 p.); and Notice to File Missing Parts of Nonprovisional Application (2 p.)***

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DATE: November 22, 2005 ATTORNEY DOCKET NO. 2380-00200

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TRANSMITTAL FORM

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Total Number of Pages in This Submission	7	Application Number	11/209,163
		Filing Date	August 22, 2005
		First Named Inventor	Edwin S. Olson
		Art Unit	
		Examiner Name	
		Attorney Docket Number	2380-00200

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- ☐ Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- ☐ Proprietary Information
- ☐ Status Letter
- ☐ Other Enclosure(s) *(please identify below):*
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  - *Declaration (1 p.)*
  - *Notice to File Missing Parts of Nonprovisional Application (2 p.)*

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm	CONLEY ROSE, P.C.		
Signature			
Printed name	Timothy S. Westby		
Date	November 22 2005	Reg. No.	55,352

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or Printed Name	R. Elizabeth Skaggs		
Signature	R. Elizabeth Skaggs	Date	November 22, 2005

PAGE 2/8 * RCVD AT 11/22/2005 3:09:40 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/34 * DNIS:2738300 * CSID:7132388008 * DURATION (mm-ss):02-14

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Alexandria, Virginia 22313-1450
www.uspto.gov

TSW

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/209,163	08/22/2005	Edwin S. Olson	2380-00200

23505
CONLEY ROSE, P.C.
P. O. BOX 3267
HOUSTON, TX 77253-3267

RECEIVED
SEP 30 2005
CONLEY ROSE P.C.-HOU

CONFIRMATION NO. 1534
FORMALITIES LETTER

Date Mailed: 09/26/2005

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$130** for a Large Entity

- **$130** Surcharge.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents

P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 2 - COPY TO BE RETURNED WITH RESPONSE

PTO/SB/01A (08-03)
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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 below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 11/209,163, filed on August 22, 2005.

☐ as amended on (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

All statements made herein of my/own knowledge are true, all statements made herein 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 are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Edwin S. Olson	Date: Nov 21, 2005	
Signature: Edwin S Olson	Citizen of: US	
Inventor two: Michael J. Holmes	Date: November 21, 2005	
Signature: Michael J Holmes	Citizen of: US	
Inventor three: John H. Pavlish	Date: November 21, 2005	
Signature: John H Pavlish	Citizen of: US	
Inventor four:	Date: _____, 2005	
Signature:	Citizen of:	

☐ Additional inventors are being named on _____ additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 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 1.14. 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.

163266.01/2380.00200

Application Data Sheet

APPLICATION INFORMATION

Application Type::	Regular
Subject Matter::	Utility
Title::	Sorbents for the Oxidation and Removal of Mercury
Attorney Docket Number::	2380-00200
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	10
Total Drawing Sheets::	7
Small Entity?::	No
Licensed US Govt. Agency::	Yes
Contract or Grant Numbers::	R 827649-01 and CR 830929-01

APPLICANT INFORMATION

Applicant Authority type::	Inventor
Primary Citizenship Country::	US
Status::	Full Capacity
Given Name::	Edwin S.
Family Name::	Olson
Name Suffix::	Ph.D.
City of Residence::	Grand Forks
State or Province of Residence::	ND
Country of Residence::	US
Street of mailing address::	223 Circle Hills Drive
City of mailing address::	Grand Forks
State or Province of mailing address::	ND
Country of mailing address::	US
Postal or Zip Code of	

PAGE 3/8 * RCVD AT 11/22/2005 3:09:40 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/34 * DNIS:2738300 * CSID:7132388008 * DURATION (mm-ss):02-14

mailing address::	58201
Applicant Authority type::	Inventor
Primary Citizenship Country::	US
Status::	Full Capacity
Given Name::	Michael J.
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City of mailing address::	Thompson
State or Province of mailing address::	ND
Country of mailing address::	US
Postal or Zip Code of mailing address::	58278
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Primary Citizenship Country::	US
Status::	Full Capacity
Given Name::	John H.
Family Name::	Pavlish
Name Suffix::	
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State or Province of Residence::	MN
Country of Residence::	US
Street of mailing address::	42204 210th Street Southwest
City of mailing address::	East Grand Forks
State or Province of	

PAGE 4/8 * RCVD AT 11/22/2005 3:09:40 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/34 * DNIS:2738300 * CSID:7132388008 * DURATION (mm-ss):02-14

mailing address::	MN
Country of mailing address::	US
Postal or Zip Code of mailing address::	56721

CORRESPONDENCE INFORMATION

Correspondence Customer Number:: 23505

REPRESENTATIVE INFORMATION

Representative Customer Number:: 23505

DOMESTIC PRIORITY INFORMATION

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	Non-Provisional of	60/605,640	08/30/2004

ASSIGNEE INFORMATION

Assignee name::	Energy & Environmental Research Center Foundation
Street of mailing address::	P.O. Box 9018
City of mailing address::	Grand Forks
State or Province of mailing address::	ND
Country of mailing address::	US
Postal or Zip Code of mailing address::	58202-9018

PAGE 5/8 * RCVD AT 11/22/2005 3:09:40 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/34 * DNIS:2738300 * CSID:7132388008 * DURATION (mm-ss):02-14

PATENT APPLICATION SERIAL NO. _____

US DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

11/30/2005 MNGUYEN 00000009 032769 11209163
01 FC:1051 130.00 DA

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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/209,163	08/22/2005	Edwin S. Olson	2380-00200

CONFIRMATION NO. 1534

23505
CONLEY ROSE, P.C.
P. O. BOX 3267
HOUSTON, TX 77253-3267

FORMALITIES LETTER

Date Mailed: 09/26/2005

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FILED UNDER 37 CFR 1.53(b)

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- The oath or declaration is missing. *A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

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- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

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- **$130** Surcharge.

Replies should be mailed to: Mail Stop Missing Parts
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P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 3 - OFFICE COPY

PTO/SB/05 (05-04))
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	2380-00200
First Inventor	Edwin S. Olson, et al.
Title	Sorbents for the Oxidation and Removal of Mercury
Express Mail Label No.	EL 967180618 US

ADDRESS TO: Commissioner for Patents
P. O. Box 1450
Arlington VA 22313-1450

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing*
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☒ Specification [Total Pages 36 Both the claims and abstract must start on a new page (for information on the preferred arrangement see MPEP 608.01(a))
4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 7
5. Oath and Declaration [Total Sheets]
   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☒ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, items a. - c. are required)*
   i. ☐ Computer Readable Form (CRF)
   iii. ☐ Transfer Request (37 CFR 1.821(e))
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____
10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney *(when there is an assignee)*
11. ☐ English Translation Document *(if applicable)*
12. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☒ Copies of foreign patent documents, publications, & other information
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. ☐ Nonpublication Request under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-Part (CIP) of prior application No.:
Prior application information: *Examiner* Art Unit:

19. CORRESPONDENCE ADDRESS

☒ *Customer Number of Bar Code Label* **23505** or ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

Name (Print/Type)	Timothy S. Westby	Registration No. (Attorney/Agent)	52,352
Signature		Date	August 22, 2005

The collection of information is required by 37 CFR 1.53(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 1.14. 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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PTO/SB/17 (12-04V2))
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U.S. Patent and Trademark office; U.S. DEPARTMENT OF COMMERCE
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Effective on 12/08/04.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($)2,900.00

Complete if Known	
Application Number	Unassigned
Filing Date	Concurrently Herewith
First Named Inventor	Edwin S. Olson, et at.
Examiner Name	Unassigned
Art Unit	Unassigned
Attorney Docket No.	2380-00200

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify):_____

☒ Deposit Account Deposit Account Number: **03-2769** Deposit Account Name: **Conley Rose, P.C.**

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☒ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☒ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	300	150	500	250	200	100	$1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
54	- 20 or HP =	34	x	$50.00	=	$1700.00

HP = highest number of total claims paid for, if greater than 20

Indep. Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
4	- 3 or HP =	1	x	$200.00	=	$200.00

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims

Fee ($)	**Fee Paid ($)**

3. APPLICATION SIZE FEE

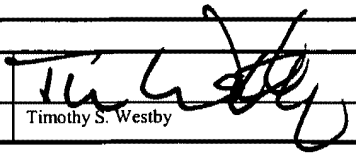
If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**		**Fee ($)**		**Fee Paid ($)**
43	- 100 =	0	/ 50 =	0	(round up to a whole number) x	0	=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge):_____	

SUBMITTED BY

Signature		Registration No. (Attorney/Agent)	52,352	Telephone	(713) 238-8000
Name (Print/Type)	Timothy S. Westby			Date	August 22, 2005

This collection of information is required by 37 CFR 1.136. 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, 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..**

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 60/605,640 filed August 30, 2004, the disclosure of which is hereby incorporated by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] This invention was made with United States Government support under the U.S. Environmental Protection Agency Grant Nos. R 827649-01 and CR 830929-01. The United States Government has certain rights in this invention.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

[0003] 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.

Background of the Invention

[0004] 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

[0005] 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.

[0006] 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.

[0007] 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

[0008] 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.

[0009] 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

PAC ET AL. EXHIBIT 1021
Page 237

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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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

PAC ET AL. EXHIBIT 1021
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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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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 from a flue gas at lower removal rates with substantially lower sorbent requirements. Through enhanced sorbent reactivity, mercury removal per gram of sorbent is increased, thereby decreasing the capital and operating costs by decreasing sorbent requirements.

[0020] In an embodiment, a method is provided for reducing mercury in flue gas comprising

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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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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

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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.

[0026] 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, 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.

[0027] 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.

[0028] 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

[0029] For a more detailed description of the preferred embodiments of the present invention, reference will now be made to the accompanying drawings.

[0030] Figure 1 schematically illustrates methods for preparation of promoted carbon sorbents in accordance with the present invention.

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[0031] Figure 2 illustrates a proposed mechanistic model of the chemical reactions resulting in the oxidation and capture of mercury.

[0032] Figure 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.

[0033] Figure 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.

[0034] Figure 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.

[0035] Figure 6 is a bar chart illustrating pilot-scale mercury removal results, including large-size sorbent results.

[0036] Figure 7 is a diagram illustrating the effects of sorbent size and injection rate on mercury removal for ESPs and fabric filters.

[0037] Figure 8 is a diagram illustrating the breakthrough curves for a brominated NORIT Darco FGD sorbent with inert sand.

[0038] Figure 9 is a diagram illustrating the breakthrough curves for brominated NORIT Darco FGD sorbent with a co-injected alkali material.

[0039] Figure 10 is a plot of mercury removal vs. carbon injection rate with and without co-injection of alkali material.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] 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.

[0041] 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

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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.

[0042] 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.

[0043] Referring now to Figure 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.

[0044] Referring still to Figure 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.

[0045] Referring still to Figure 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.

[0046] Referring still to Figure 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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).

[0051] 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.

[0052] Referring now to Figure 2, there is illustrated a theory developed from scientific evidence to explain the nature of the promoting compounds. For example, as illustrated in Figure 2, hydrogen

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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.

[0053] It has now been found that the formation of the new bromide compound with carbon increases their reactivity toward mercury and other pollutants. Additionally, 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.

[0054] Referring now to Figure 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.

[0055] 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

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gas source 170 (connection from source 170 to line 118 not shown). Although gas sources 170 and 171 are shown in Figure 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.

[0056] For clarity, single injection points 116 or 119 are shown in Figure 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.

[0057] 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.

[0058] 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.

[0059] 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

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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.

[0060] Referring still to Figure 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 121b 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 121c 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 Figure 3) may then be provided if necessary as mentioned with respect to embodiments discussed with reference to Figure 1.

[0061] 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 131b and 131c.

[0062] 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..

[0063] 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.

[0064] 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.

[0065] 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 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.

[0066] 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.

[0067] 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

[0068] 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

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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.

[0069] 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. 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

[0070] 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.

[0071] 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. In Addition to halide ions, 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, the modified cationic carbon has a high chemical potential for oxidation of the mercury. Thus, an entirely new model is

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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

[0072] 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

[0073] 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.

[0074] 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 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

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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

[0075] 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

[0076] 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.

[0077] 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

[0078] 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 conjection 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

[0079] 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

[0080] 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

[0081] 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,

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Pb, Bi, Cd, Ag, Cu, Zn, or other contaminants, will also react with the oxidation sites generated on the carbon.

[0082] 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

[0083] 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

[0084] Finely powdered activated carbon (such as NORIT Darco FGD, NORIT Americas, Inc., Marshall, TX (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 a passed out of the generator. The outlet from the gaseous bromine generator is connected via a ¼ 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 to that the excess of nitrogen is released after the bromine is transfer 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 bromine to 20 kg of carbon (2–5 wt. %). When the reaction is

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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.

[0085] 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

[0086] 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.

[0087] 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 FL 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 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.

[0088] Referring now to Figure 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. Figure 4 illustrates the breakthrough curves for 5 wt/wt% brominated NORIT Darco FGD sorbent (37 mg + 113 mg sand)

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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).

[0089] Figure 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

[0090] 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

[0091] 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.

[0092] 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.

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Example 5 - Liquid Phase Phosphohalogenation

[0093] 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

[0094] 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

[0095] 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 1/4 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

[0096] 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

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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.

[0097] 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

[0098] 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.

[0099] 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

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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.

[00100] 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

[00101] Results are illustrated in Figure 6. As can be observed in Figure 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 Figure 6 (and throughout) "Macf" (and "MACF") indicates million actual cubic feet (1 MACF is about 0.028 million actual cubic meters or "MACM").

[00102] Referring now to Figure 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 Figure 7 (and throughout) "Macf" (and "MACF") indicates million actual cubic feet.

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Example 7 - Liquid Phase (Organic Solvent) Halogenation

[00103] 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

[00104] 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.

[00105] 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, FL, 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

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and carbon fiber sorbents by treatment with molecular bromine in solution or in dry beds as described above.

Example 9 - Fluidized/Ebullated Bed Preparation

[00106] 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

[00107] 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).

[00108] 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

[00109] 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

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mercury that may be released from the sorbent, or to capture some of the sulfur or selenium oxides in the flue gas that can have a detrimental effect on the sorbent capacity.

[00110] 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 Figure 8, and the breakthrough curve for the mixture with CaO is shown in Figure 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

[00111] 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 Figure 10. As shown in Figure 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.

[00112] 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

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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

[00113] 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

[00114] 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

[00115] 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

[00116] 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.

[00117] 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

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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

[00118] 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.

[00119] 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.

Table 1

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

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[00120] 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.

[00121] 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 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.

[00122] 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.

[00123] 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.

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WE CLAIM:

1. A promoted carbon sorbent 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.

2. The promoted carbon sorbent of claim 1 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 40 micrometers, and combinations thereof, and the promoter is selected from the group consisting of molecular halogens, Group V halides, Group VI halides, hydrohalides, and combinations thereof.

3. The promoted carbon sorbent of claim 2 wherein the sorbent comprises from about 1 to about 30 grams promoter per 100 grams of base activated carbon.

4. The promoted carbon sorbent of claim 3 further comprising an optional secondary component comprising a halogen or a hydrohalide such that the reactivity and mercury capacity of the sorbent are enhanced.

5. The promoted carbon sorbent of claim 4 further comprising an optional alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

6. The promoted carbon sorbent of claim 4 wherein 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.

7. The promoted carbon sorbent of claim 6 wherein the optional secondary component is selected from the group consisting of Group V halides, Group VI halides, HI, HBr, HCl, and combinations thereof.

8. The promoted carbon sorbent of claim 7 wherein the optional secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

9. The promoted carbon sorbent of claim 8 wherein the promoter is substantially in vapor form when combined with the base activated carbon.

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10. The promoted carbon sorbent of claim 8 wherein the promoter is combined with an organic solvent prior to reaction with the base activated carbon.

11. The promoted carbon sorbent of claim 8 wherein the promoter and optional secondary component are combined with the base activated carbon substantially simultaneously.

12. The promoted carbon sorbent of claim 8 further comprising 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.

13. The promoted carbon sorbent of claim 12 wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

14. The promoted carbon sorbent of claim 3 further comprising 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.

15. The promoted carbon sorbent of claim 14 further comprising an optional alkaline component comprising an alkaline or alkaline earth element wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

16. A method 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.

17. The method of claim 16 wherein the reaction product comprises from about 1 to about 30 grams promoter per 100 grams activated carbon.

18. The method of claim 16 wherein the reaction product has an average particle size distribution greater than about 40 micrometers.

19. The method of claim 16 wherein the promoter is selected from the group consisting of molecular halogens, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

20. The method of claim 19 wherein the promoter is in the gas phase when contacting the

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activated carbon.

21. The method of claim 19 wherein the promoter is in an organic solvent when contacting the activated carbon.

22. The method of claim 20 wherein the promoter is selected from the group consisting of Br_2, a Group V bromide, a Group VI bromide, and combinations thereof.

23. The method of claim 18 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

24. The method of claim 20 further comprising 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.

25. The method of claim 24 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

26. The method of claim 24 wherein the promoter and optional secondary component are contacted simultaneously with the activated carbon.

27. The method of claim 24 wherein the optional secondary component comprises I_2 or HI.

28. The method of claim 20 further comprising 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.

29. The method of claim 24 further comprising 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.

30. A method 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.

31. The method of claim 30 further comprising co-injecting an optional alkaline component into the mercury containing flue gas stream.

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32. The method of claim 30 further comprising 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.

33. The method of claim 30 wherein 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.

34. The method of claim 33 wherein the promoter is selected from the group consisting of molecular halogens, halides, and combinations thereof.

35. The method of claim 34 wherein the promoter is selected from the group consisting of Br_2, HBr, Group V bromides, Group VI bromides, and combinations thereof.

36. The method of claim 35 wherein the promoter is reacted in the gas phase or as a vapor.

37. The method of claim 36 wherein the promoter is added at from about 1 to about 30 grams per 100 grams of activated carbon.

38. The method of claim 37 wherein 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.

39. The method of claim 38 wherein the optional secondary component is selected from the group consisting of iodine, hydrohalides, Group V halides, Group VI halides, and combinations thereof.

40. The method of claim 39 further comprising co-injecting an optional alkaline component into the mercury containing flue gas stream.

41. The method of claim 39 wherein the optional secondary component is added at from about 1 to about 15 wt-% of the promoter content.

42. The method of claim 41 wherein the optional secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

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43. The method of claim 42 wherein the optional secondary component is added in the gas phase or as a vapor.

44. The method of claim 41 further comprising 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.

45. The method of claim 32 further comprising using the monitored mercury content of the cleaned flue gas to control the composition of the sorbent.

46. The method of claim 40 further comprising monitoring the mercury content of the clean flue gas and using the monitored mercury content to control the composition of the sorbent and the alkaline-to-sorbent injection ratio.

47. The method of claim 45 wherein 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.

48. A method for reducing the mercury content of a gas stream comprising the steps of injecting a powdered activated carbon sorbent having a mass-mean particle size >40μm into a gas stream containing mercury and ash particles, capturing mercury from the gas stream on the sorbent particles, mechanically separating the sorbent particles from the ash particles, and re-injecting the separated sorbent particles into the gas stream.

49. The method of claim 48 further comprising regenerating the sorbent particles to substantially remove contaminants therefrom to recover capacity for capturing mercury.

50. The method of claim 48 further comprising co-injecting into the gas stream an alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

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51. The method of claim 48 wherein the powdered activated carbon sorbent further comprises a promoter selected from the group consisting of halides, halogens, and combinations thereof.

52. The method of claim 51 further comprising co-injecting into the gas stream an alkaline component selected from the group consisting of alkali elements, alkaline earth elements, alkali salts, alkaline earth salts, and combinations thereof.

53. The method of claim 48 wherein the particulate activated carbon sorbent has a mass-mean particle size >60μm.

54. The method of claim 52 wherein the particulate activated carbon sorbent has a mass-mean particle size >60μm.

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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.

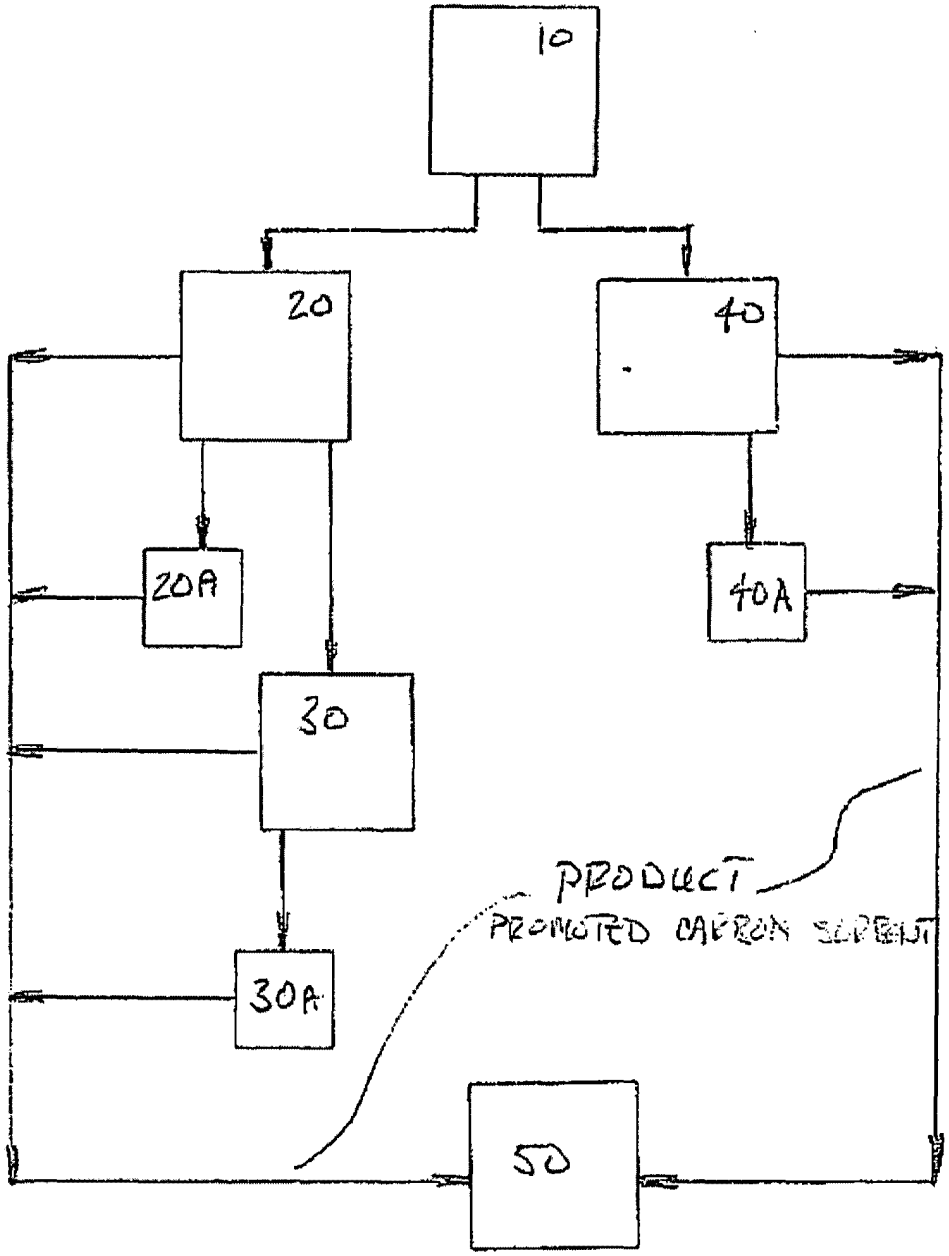


FIG. 1

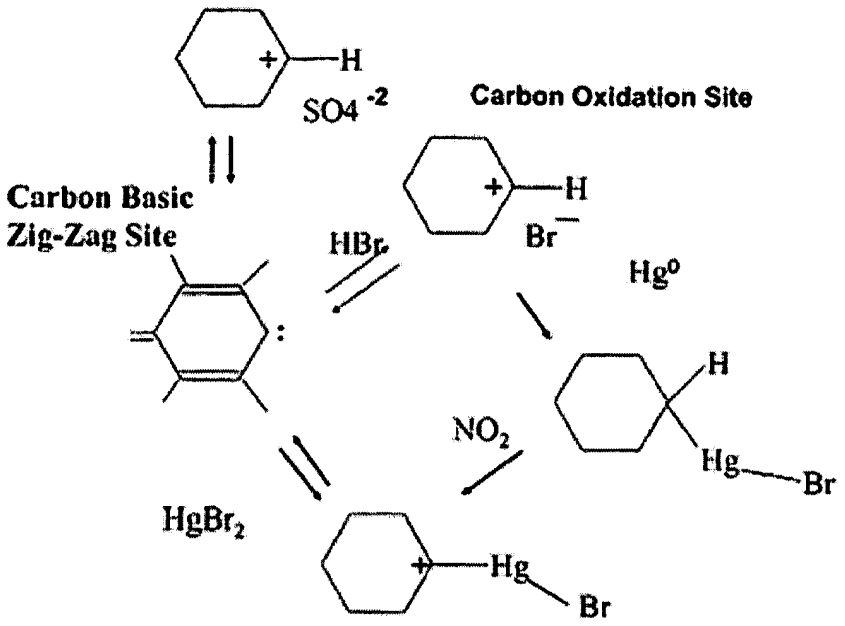

Carbon Oxidation Site
SO4 -2
Carbon Basic
Zig-Zag Site
HBr
Br
Hg°
NO2
HgBr2
Hg
Br

FIG. 2

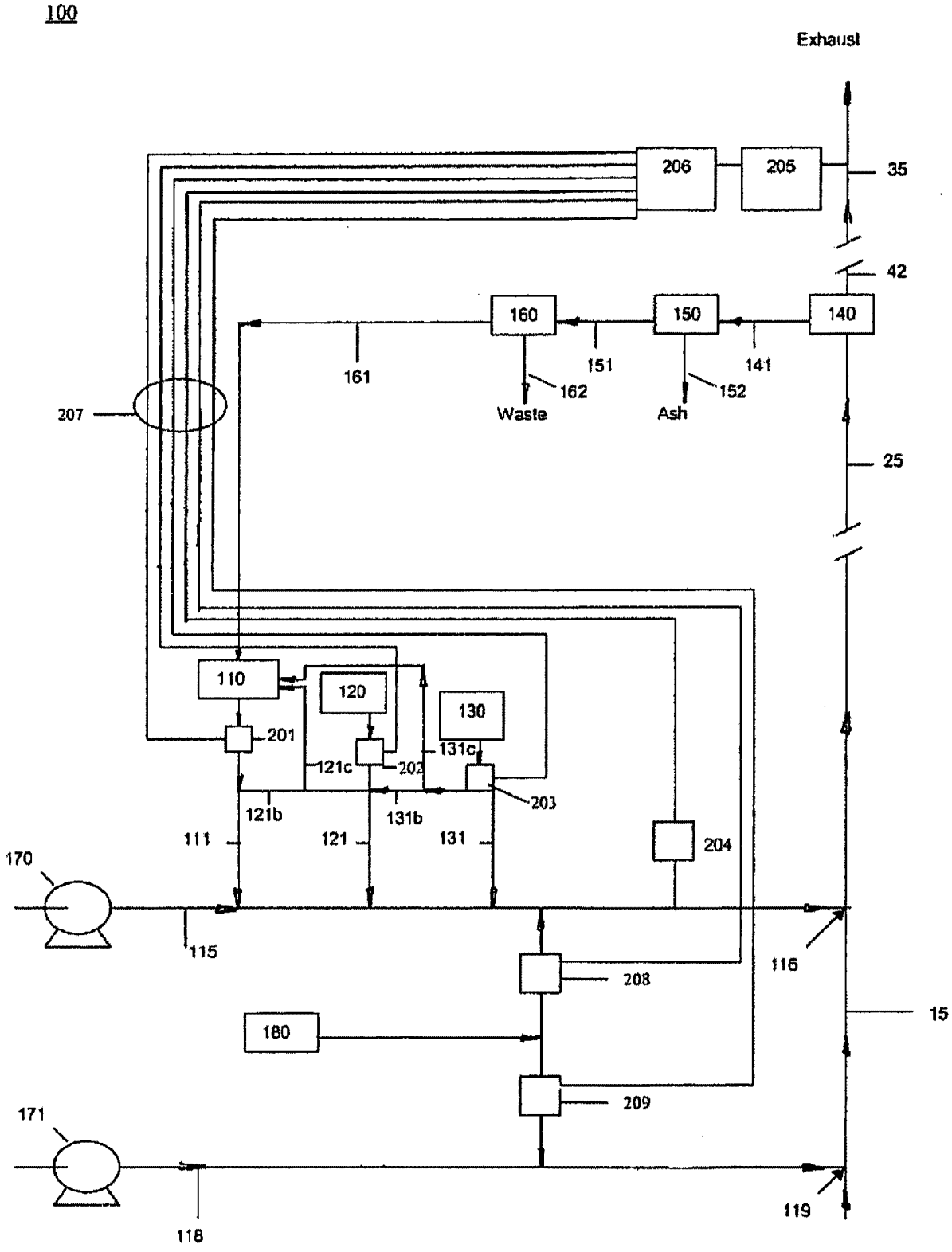

100
Exhaust
206
205
35
42
160
150
140
161
151
141
162
152
Waste
Ash
207
25
110
120
130
201
202
131c
121c
203
121b
131b
111
121
131
204
170
115
116
208
15
180
209
171
118
119

FIG. 3

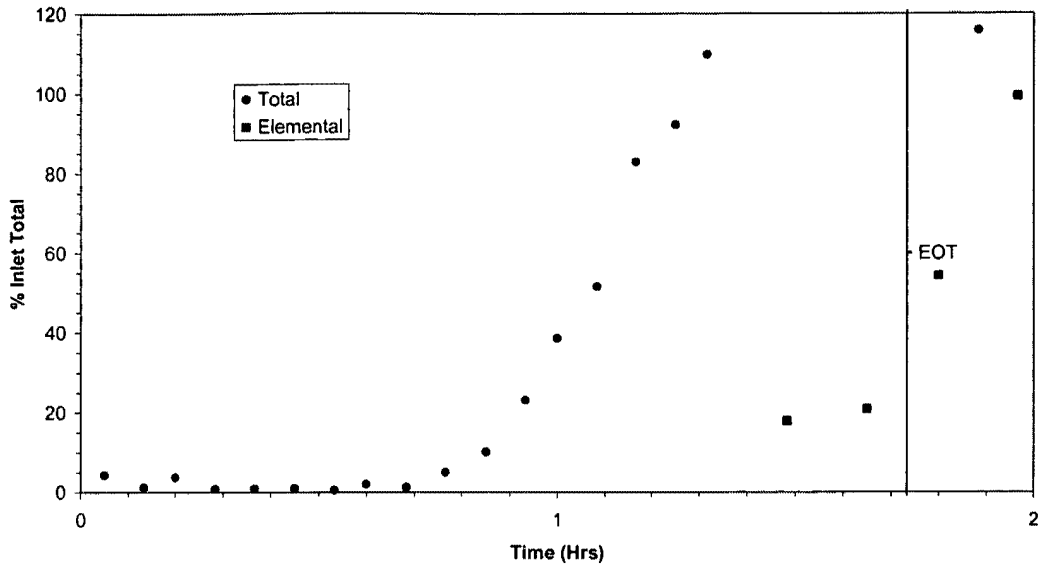

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 4

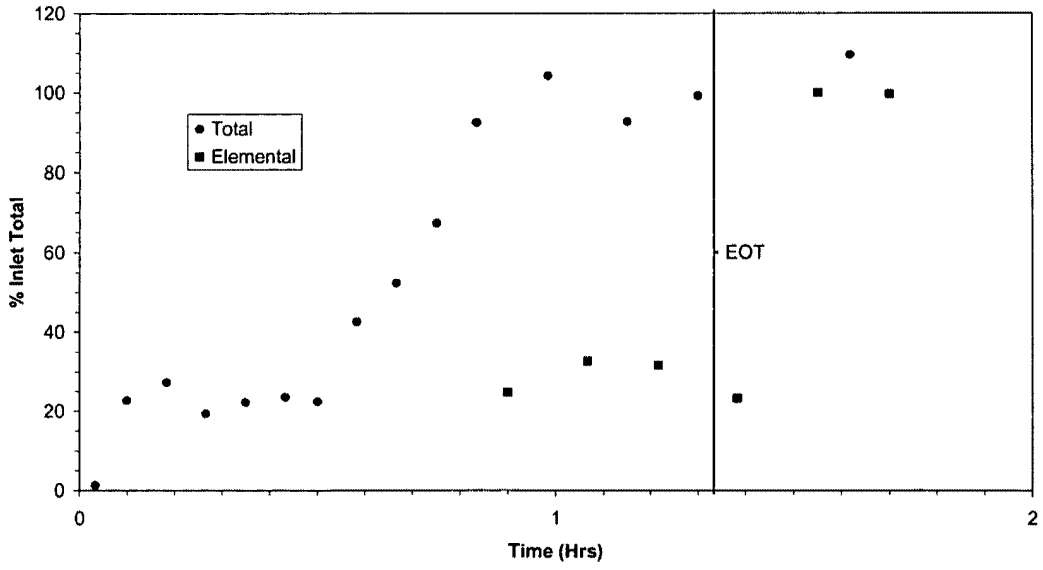

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 5

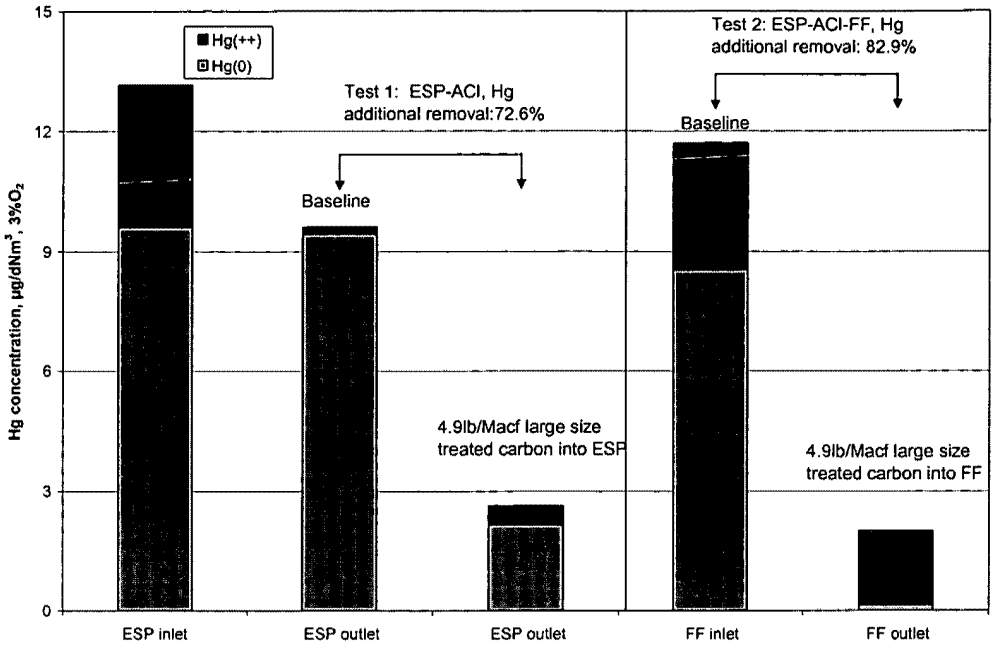

Hg(++)
Hg(0)
Test 1: ESP-ACI, Hg
additional removal:72.6%
Baseline
Test 2: ESP-ACI-FF, Hg
additional removal: 82.9%
Baseline
4.9lb/Macf large size
treated carbon into ESP
4.9lb/Macf large size
treated carbon into FF
Hg concentration, µg/dNm3, 3%O2
15
12
9
6
3
0
ESP inlet
ESP outlet
ESP outlet
FF inlet
FF outlet

FIG. 6

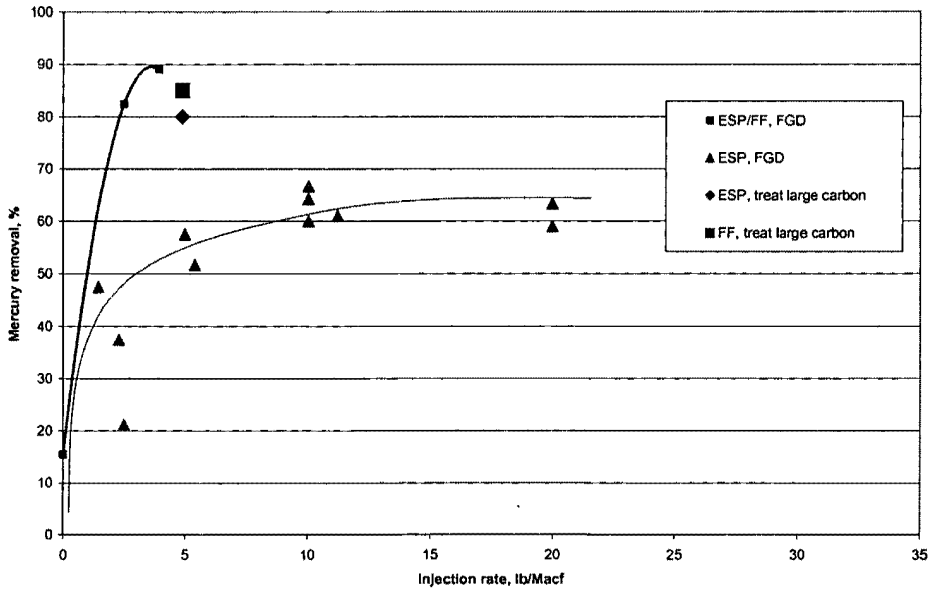

ESP/FF, FGD
ESP, FGD
ESP, treat large carbon
FF, treat large carbon
Mercury removal, %
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
Injection rate, lb/Macf

FIG. 7

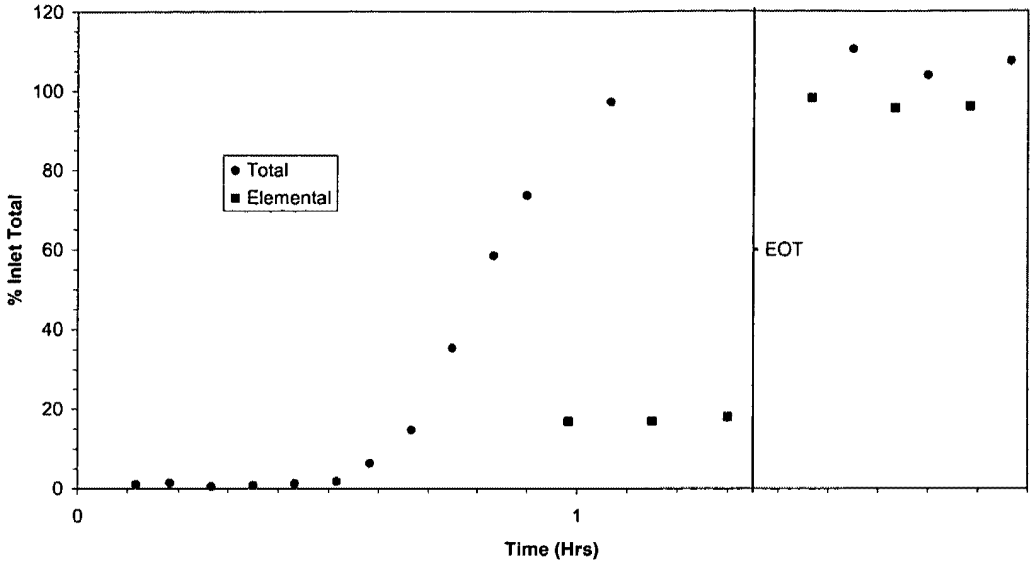

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
Time (Hrs)

FIG. 8

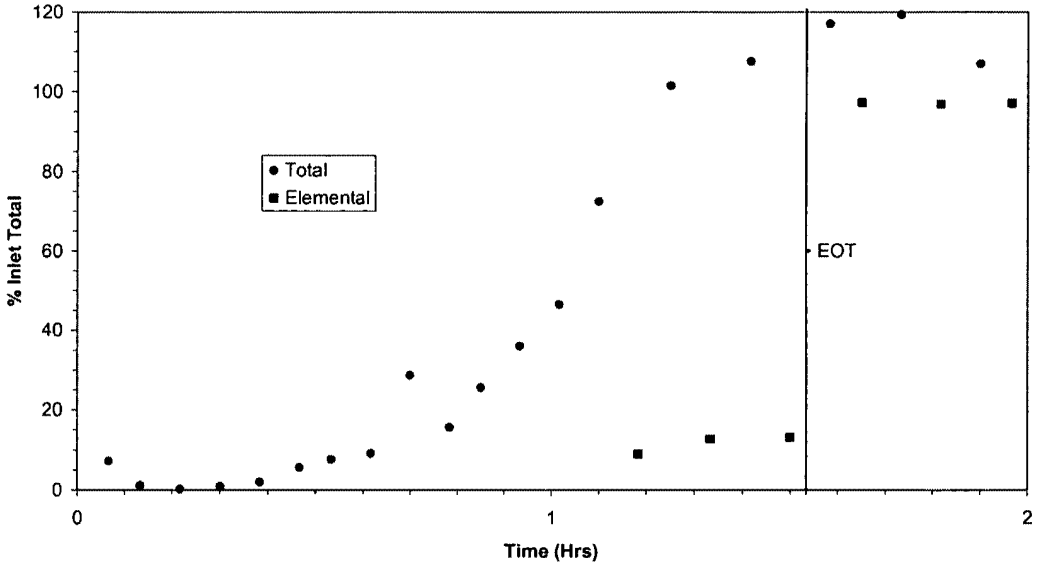

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 9

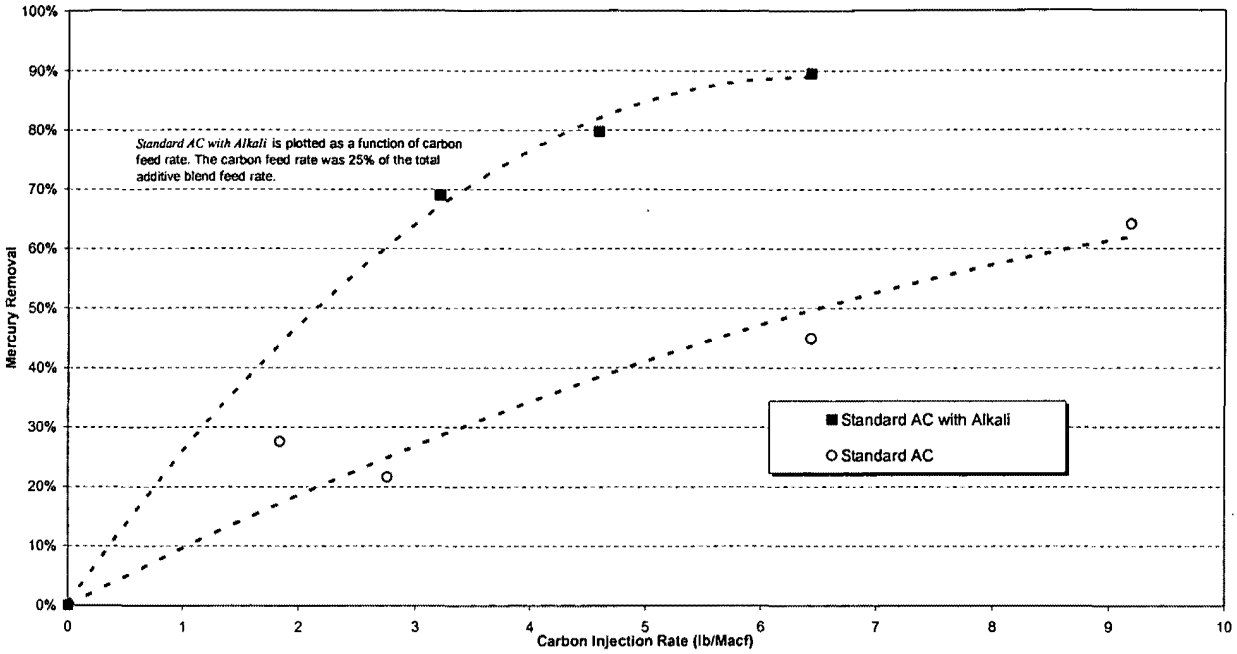

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mercury Removal
0
1
2
3
4
5
6
7
8
9
10
Carbon Injection Rate (lb/Macf)
Standard AC with Alkali is plotted as a function of carbon feed rate. The carbon feed rate was 25% of the total additive blend feed rate.
Standard AC with Alkali
Standard AC

FIG. 10

PATENT APPLICATION SERIAL NO _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

08/25/2005 HMARZI1 00000076 032769 11209163

01 FC:1011	300.00	DA
02 FC:1111	500.00	DA
03 FC:1311	200.00	DA
04 FC:1201	200.00	DA
05 FC:1202	1700.00	DA

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 466-267/69033

PTO/SB/06 (12-04)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875 Effective December 8, 2004

Application or Docket Number: 10209163

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	150.00		N/A	300.00
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	$250		N/A	$500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	$100		N/A	$200
TOTAL CLAIMS (37 CFR 1.16(i))	54 minus 20 =	* 34	X$ 25 =		OR	X$50 =	1700
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	* 1	X100 =			X200 =	200
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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))			+180=			+360=	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2900

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(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 ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X$ 25 =		OR	X$50 =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X100 =		OR	X200 =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					+180=		OR	+360=	
					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 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.

Application Data Sheet

APPLICATION INFORMATION

Application Type::	Regular
Subject Matter::	Utility
Title::	Sorbents for the Oxidation and Removal of Mercury
Attorney Docket Number::	2380-00200
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	10
Total Drawing Sheets::	7
Small Entity?::	No
Licensed US Govt. Agency::	Yes
Contract or Grant Numbers::	R 827649-01 and CR 830929-01

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Postal or Zip Code of	

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State or Province of	

mailing address:: MN

Country of mailing address:: US

Postal or Zip Code of mailing address:: 56721

CORRESPONDENCE INFORMATION

Correspondence Customer Number:: 23505

REPRESENTATIVE INFORMATION

Representative Customer Number:: 23505

DOMESTIC PRIORITY INFORMATION

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	Non-Provisional of	601/605,640	08/30/2004

ASSIGNEE INFORMATION

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City of mailing address:: Grand Forks

State or Province of mailing address:: ND

Country of mailing address:: US

Postal or Zip Code of mailing address:: 58202-9018

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	Unassigned	Confirmation No. Unassigned
Applicant	:	Edwin S. Olson, et al.	
Filed	:	Concurrently Herewith	
For	:	Sorbents for The Oxidation and Removal of Mercury	
TC/A.U.	:	Unassigned	
Examiner	:	Unassigned	

INFORMATION DISCLOSURE STATEMENT

Customer No.: 23505
Atty. Dkt. No.: 2380-00200
Date: August 22, 2005

Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

Sir:

This Information Disclosure Statement, including completed Form PTO-1449, comprises a list of pertinent art of which Applicants are aware.

The submission of this Information Disclosure Statement and the references submitted therewith is not an admission that the art cited is "prior" with respect to the present invention, nor is it a representation, that no better art exists. Applicants hereby reserve the right to swear behind or otherwise disprove any alleged "prior" nature of any art cited should the facts support and the situation warrant such an action. It is submitted that the art cited does not constitute a bar to the patentability of Applicants' invention under 35 U.S.C. § 102 or § 103.

This Information Disclosure Statement is being filed concurrently with the above-referenced patent application, therefore, no fee is due for the filing of these papers.

Respectfully submitted,

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ATTORNEY FOR APPLICANTS

PTO/SB/08A (08-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet	1	of	2

Complete if Known	
Application Number	Unassigned
Filing Date	Herewith
First Named Inventor	Edwin S. Olson, et al.
Group Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	2380-00200

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code [2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA	US-1,984,164	12-11-1934	Stock	
	AB	US-3,194,629	07-13-1965	Dreibelbis, et al	
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	AN	US-5,607,496	03-04-1997	Brooks	
	AO	US-5,672,323	09-30-1997	Bhat	
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	AQ	US-5,827,352	12-27-1998	Altman	
	AR	US-5,891,324	04-06-1999	Ohtsuka	
	AS	US-6,027,551	02-22-2000	Hwang	
	AT	US-6,080,281	06-27-2000	Attia	
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	AY	US-6,528,030	03-04-2003	Madden et al.	
	AZ	US-2002/0150516	10-17-2002	Pahlman, et al.	
	AAA	US-2001/0003116	06-07-2001	Neufert	
	ABB	US-2004/0003716	01-08-2004	Nelson, Jr.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number [4] Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where RelevantPassages or Relevant Figures Appear	T[6]
		DE 34 26 059				
		JP 49-43197				
		JP 50-6438				

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Sheet	2	of	2

Complete if Known	
Application Number	Unassigned
Filing Date	Herewith
First Named Inventor	Edwin S. Olson, et al.
Group Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	2380-00200

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	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[2]
		Dunham, G.E. et al., *Mercury Capture by an Activated Carbon in a Fixed-Bed Bench-Scale System*, Environmental Progress Vol. 17, No. 3, pp. 203-208	
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Process for separating out and disposing organic pollutants, in particular polychlorinated dibenzodioxines (PCDD) from flue gases

Patent number:	DE3426059
Publication date:	1986-01-16
Inventor:	SEIPENBUSCH JUERGEN DIPL ING (DE); CLEVE URBAN DIPL ING (DE)
Applicant:	PETERSEN HUGO VERFAHRENSTECH (DE)
Classification:	
- international:	B01D53/34
- european:	B01D53/70; B01D53/72
Application number:	DE19843426059 19840714
Priority number(s):	DE19843426059 19840714

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Abstract of **DE3426059**

The invention relates to a process for separating out and disposing organic pollutants, in particular polyhalogenated, aromatic compounds from flue gases or other exhaust gases by thermal decomposition of the pollutants at temperatures above 1,000 DEG C, the organic pollutants first being removed from the flue gas absorptively, preferably by means of an activated charcoal filter, then being desorbed at elevated temperatures and then being removed from the desorption gas, which makes up only a fraction of the volume of the flue gas, by incineration at temperatures from 1,000 to 1,400 DEG C. The heating of the desorption gas is carried out using external heat. Expediently, the heat content of the hot combustion gas is utilised, for example to preheat the combustion air.

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Prüfungsantrag gem. § 44 PatG ist gestellt

(54) Verfahren zur Abscheidung und Beseitigung von organischen Schadstoffen, insbesondere von polychlorierten Dibenzodioxinen (PCDD) aus Rauchgasen

Die Erfindung betrifft ein Verfahren zur Abscheidung und Beseitigung von organischen Schadstoffen, insbesondere polyhalogenierten, aromatischen Verbindungen aus Rauchgasen oder sonstigen Abgasen durch thermische Zersetzung der Schadstoffe bei Temperaturen von über 1000°C, wobei die organischen Schadstoffe aus dem Rauchgas zunächst adsorptiv, vorzugsweise mittels eines Aktivkohlefilters, entfernt, danach bei erhöhten Temperaturen desorbiert und aus dem Desorptionsgas, das nur einen Bruchteil des Volumens des Rauchgases ausmacht, durch Verbrennung bei Temperaturen von 1000 bis 1400°C entfernt werden. Die Aufheizung des Desorptionsgases erfolgt mittels Fremdwärme. Zweckmäßig wird der Wärmeinhalt des heißen Verbrennungsgases, beispielsweise zur Vorwärmung der Verbrennungsluft ausgenutzt.

DE 3426059 A1

Patentansprüche

1. Verfahren zur Abscheidung und Beseitigung von schwer zersetzlichem organischen Schadstoffen, insbesondere polyhalogenierten aromatischen Verbindungen aus Rauchgasen durch Erhitzen des schadstoffhaltigen Rauchgases auf Temperaturen von $\geq$ 1000°C, dadurch gekennzeichnet, dass die Schadstoffe aus dem Rauchgas adsorptiv entfernt, die adsorptiv gebundenen Schadstoffe durch Erhitzen auf höhere Temperaturen desorbiert und das Desorptionsgas durch Zuführung von Fremdwärme auf Temperaturen von über 1000°C, vorzugsweise 1000 bis 1400°C bei einer zur Spaltung der Schadstoffe ausreichenden Verweilzeit erhitzt werden.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die organischen Schadstoffe durch Adsorption mittels Aktivkoks oder Aktivkohle aus dem Rauchgas entfernt werden.

3. Verfahren nach einem der Ansprüche 1 oder 2, dadurch gekennzeichnet, dass die Desorption der organischen Schadstoffe bei Temperaturen im Bereich von 350 bis 750° zusammen mit anderen absorbiereten Schadstoffen vorgenommen wird.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass die thermische Spaltung der Schadstoffe im Desorptionsgas in einer Spaltkammer erfolgt.

5. Verfahren nach einem der Ansprüche 1 oder 2, dadurch gekennzeichnet, dass die Desorption und die thermische Zersetzung der Schadstoffe mittels des auf die Zersetzungstemperaturen aufgeheizten Desorptionsgases vorgenommen wird.

6. Verfahren nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, dass das aus der thermischen Zersetzung der Schadstoffe resultierende heiße Abgas unter Ausnutzung seines Wärmeinhalts, vorzugsweise zur Vorwärmung der Verbrennungsluft anderer Gase, oder zur Nutzung im Wasserdampfkreislauf abgekühlt wird.

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13.Juli 1984
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Verfahren zur Abscheidung und Beseitigung von organischen Schadstoffen, insbesondere von polychlorierten Dibenzodioxinen (PCDD) aus Rauchgasen

Die Erfindung betrifft ein trockenes Verfahren zur Abscheidung von in Rauchgasen oder in sonstigen Abgasen enthaltenen organischen schwer zersetzlichen Schadstoffen, insbesondere von polychlorierten Dibenzodioxinen.

Bei der Verbrennung von Industrie- und Hausmüll in Müllverbrennungsanlagen entstehen verschiedene organische Schadstoffe, vor allem aromatischer Natur wie

Polyzyklische aromatische Kohlenwasserstoffe (PAK)

polychlorierte Biphenyle (BCB)
polychlorierte Dibenzodioxine (PCDD)
polychlorierte Dibenzofurane (PCDF)

Wegen der bekannten gesundheitsschädlichen Wirkung ist die Beseitigung dieser Substanzen deshalb von besonderem Interesse, da sie nur schwer abbaubar sind und deswegen die Gefahr einer möglichen Anreicherung in der Natur besteht.

Die Beseitigung der organischen Schadstoffe ist durch Zerstörung der Molekülstrukturen bei hohen Spalttemperaturen meist im Bereich von über 1000°C möglich. Hierbei spielen Spalttemperaturen und die Verweilzeit der organischen Schadstoffe im hohen Temperaturbereich, die meist einige Sekunden betragen soll, eine wesentliche Rolle.

Aus diesem Grund werden Sonderabfälle, vor allem Abfälle aus der chemischen Produktion, vor allem in Sondermüll-Verbrennungsanlagen, die mit Verbrennungs-Reaktionstemperaturen von über etwa 1100°C arbeiten, bei Verweilzeiten der Rauch-/Abgase in diesem hohen Temperaturbereich von bis zu 6 Sekunden verbrannt.

Bau und Betrieb solcher Abfallverbrennungsanlagen sind im Vergleich zu normalen Haus/Industrie-Müllverbrennungsanlagen sehr kostenaufwendig und wirtschaftlich nur dann vertretbar, wenn diese Anlage speziell für die Spaltung dieser organischen Schadstoffe eingesetzt wird.

In normalen Haus-/Industrie-Müllverbrennungsanlagen treten diese Schadstoffe jedoch nicht ständig, sondern

nur dann auf, wenn diese organischen Schadstoffe im zu verbrennenden Abfall anfallen. Die Konzentrationen im Rauchgas sind damit sehr unterschiedlich und können stark schwanken, z.B von einigen Pikogramm bis zu mehreren Hundert Pikogramm .
Eine generelle Auslegung, Bau und Betrieb aller Müll- und Abfallverbrennungsanlagen bei diesen hohen Temperaturen führt neben hohen Kosten für Investition und Betrieb vor allem auch zu anderen Nachteilen, wie beispielsweise höher NO_x-Konzentrationen im Rauchgas und zu erhöhter Korrosionsgefahr an den Verbrennungseinrichtungen, wie beispielsweise den Rosten sowie den Dampfkessel oder Wärmeaustauschern.

Diese Nachteile treten dann nicht auf, wenn es gelingt, diese organischen Schadstoffe aus den Rauchabgasen abzuscheiden und dann in geeigneter Form zu beseitigen.

Gegenstand der Erfindung ist ein Verfahren zur Abscheidung und Beseitigung von schwer zersetzlichen, organischen Schadstoffen, insbesondere polyhalogenierten aromatischen Verbindungen aus Rauchgasen durch Erhitzen des schadstoffhaltigen Rauchgases auf Temperaturen von $>$ 1000°C, dadurch gekennzeichnet, dass die Schadstoffe aus dem Rauchgas adsorptiv entfernt, die adsorptiv gebundenen Schadstoffe durch Erhitzen auf höhere Temperatur desorbiert und das Desorptionsgas durch Zuführung von Fremdwärme auf Temperaturen von über 1000°C, vorzugsweise 1000 bis 1400°C bei einer zur Spaltung der Schadstoffe ausreichenden Verweilzeit erhitzt werden.

Als Adsorptionsmittel sind besonders A-Kohle oder A-Koks geeignet. Dieser A-Koks, A-Kohle oder ein anderes geeignetes Adsorptionsmittel werden in an sich bekannter Weise durch Erhitzen auf höhere Temperaturen desorbiert.

Die Kohleschicht weist eine Dicke von z.B. 1,50 bis 2 m auf.

Da bei der Reinigung von Rauchgasen mittels eines A-Koks (A-Kohle-)Filterbettes auch andere Schadstoffe wie SO_2 und Schwermetalle simultan abgeschieden werden, ist es bisher bekannt, die Desorption dieser A-Kokse/ A-Kohle mit inerten Gasen im Temperaturbereich von etwa 350-750°C durchzuführen. Diese Temperatur reicht damit aber zur thermischen Spaltung der organischen Schadstoffe noch nicht aus.

Gemäß einer Ausführungsform der Erfindung wird das Desorptionsmittel hinter dem Desorber durch Zuführen von Fremdwärme, wie beispielsweise durch Zubrennen von Erdgas, Heizöl, sonstigen fossilen Brennstoffen oder auch durch Erwärmung mit elektrischer Energie in einer Spaltkammer auf Temperaturen von über 1000°C bis zu etwa 1400°C erhitzt. Die Verweilzeit der Gase in der Spaltkammer wird so bemessen, dass genügend Zeit zur vollständigen Spaltung der organischen Schadstoffmoleküle besteht. Sie liegt in der Größenordnung von mehreren Sekunden (z.B. 5 bis 10 Sekunden). Das heiße Gas wird nach der Spaltung wieder mittels eines Wärmeaustauschers abgekühlt, wobei die freiwerdende Wärme in wärmewirtschaftlich sinnvoller Weise, also beispielsweise zur Vorwärmung der Verbrennungsluft anderer Gase, aber auch zur wärmewirtschaftlichen Nutzung im Wasserdampfkreislauf einer solchen Müllverbrennungsanlage ausgenutzt.

Gemäß einer weiteren Ausführungsform der Erfindung kann die Spaltkammer für die thermische Zersetzung der Schadstoffe in Desorptionsgas entfallen. In diesem Falle wird die Desorption gleich mit einem heißen Desorptionsgas vorgenommen, das die zur thermischen Spaltung der Schadstoffe notwendige Wärmeenergie enthält. Diese Ausführungsweise ist möglich, da die A-Kohle des Filters hohe Tempe-

raturen im Bereich von 1000 bis 1300 °C ohne weiteres aushält. Das Desorptionsgas (üblicherweise entweder durch Verbrennung von Heizöl oder Erdgas mit unterstöchometrischen Sauerstoffmengen erhalten) wird dann bei den für die Zersetzung erforderlichen Temperaturen in der Größenordnung von 1200°C in den Desorber geleitet.

Der Vorteil dieses Verfahrens liegt somit darin, dass die in sehr niedrigen Konzentrationen im großen Rauchgasvolumen enthaltenen Schadstoffe zunächst aus diesem herausgefiltert werden und dann lediglich in der sehr viel geringeren Desorptionsmenge, die nun natürlich eine höhere Schadstoffkonzentration aufweist, auf die erforderlichen Spalttemperaturen zu erhitzen, wodurch ein wesentlich wärmewirtschaftlicherer Betrieb erreicht wird, da die Rauchgasmenge um ein vielfaches, teilweise bis zum Faktor 100-200, größer ist als die Desorptionsgasmenge.

Die Erfindung wird anhand der nachfolgenden Zeichnung beispielhaft erläutert:

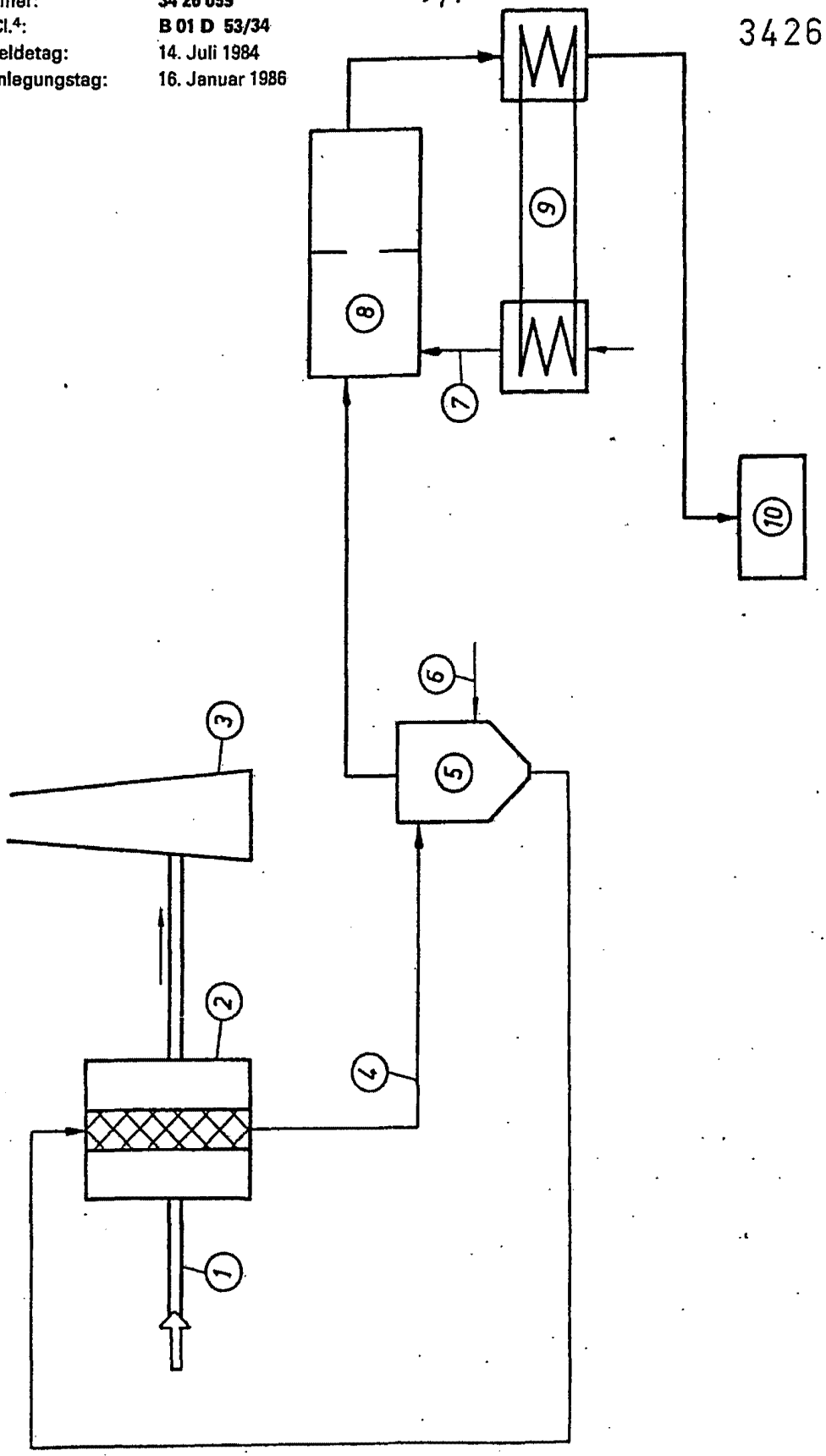
Das mit den organischen Schadstoffen beladene Rauchgas (1) tritt in den Adsorber (2) ein, der mit einem geeigneten Adsorptionsmittel wie Aktivkoks beschickt ist und wird dann über den Schornstein (3) abgeführt. Das mit den Schadstoffen beladene Adsorptionsmaterial wird über Leitung (4) in den Desorber (5) transportiert, dort bei erhöhten Temperaturen mittels eines Desorptionsgases der Schadstoff ausgetrieben und in eine Verbrennungskammer (8) transportiert. Diese wird mittels des durch Leitung (7) zugeführten heißen Gases auf die zur Zersetzung der Schadstoffe erforderlichen Temperaturen von

> 1000°C bis zu etwa 1400°C aufgeheizt. In dieser Spaltkammer erfolgt die thermische Zersetzung bzw. Verbrennung der Schadstoffe. Das heiße Gas verlässt die Spaltkammer und gibt in einem Wärmetauscher (9) wenigstens einen Teil seines Wärmeinhalts an das zur Aufheizung der Kammer (8) verwendete Gas ab, bevor es in die Reinigungsanlage (10) eintritt.

Bei der weiteren Ausführungsform gemäß der Erfindung entfällt die Spaltkammer (8). Bei (6) wird in den Absorber heißes Desorptionsgas eingeleitet, das dann wieder im Wärmeaustauscher (9) wenigstens einen Teil seines Wärmeinhalts abgibt, vorzugsweise zum Aufheizen des gleichzeitig zur Desorption und der thermischen Zersetzung verwendeten in den Desorber eintretenden Gases.

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Bibliographic Information

Removal of mercury from a gas. Yokota, Noriyuki; Tokuda, Shingo; Ito, Yoshiro; Takatomi, Hiroshi. (Osaka Soda Co., Ltd.). Jpn. Tokkyo Koho (1974), 3 pp. CODEN: JAXXAD JP 49043197 19741119 Showa. Patent written in Japanese. Application: JP 70-124108 19701229. CAN 82:144527 AN 1975:144527 CAPLUS (Copyright 2005 ACS on SciFinder (R))

Patent Family Information

Patent No.	Kind	Date	Application No.	Date
JP 49043197	B4	19741119	JP 1970-124108	19701229

Priority Application		
JP 1970-124108	A	19701229

Abstract

Hg can be removed from a gas by treating with an absorbent comprising a metal (Li, Na, K, Ca, Mg, Zn, Al, Fe, Ni, Co) iodide or a compd. of the general formula R4NI (where R = H or a C1-4 alkyl) and an inorg. reducing agent on a carrier such as zeolite or silica gel. The reducing agent may be a hydrazonium salt, phosphorous acid salt, thiosulfuric acid, sulfurous acid salt, or stannous compds. Hg is present in H in alkali salt electrolysis. In an example, when a gas contg. Hg 1000-40,000 ±g/m3 is passed over a packed layer of the absorbent at a space velocity of 200-4000 hr-1, the amt. of Hg in the exit gas is reduced to <10 μg/m3.

(51) Int.Cl.　(52)日本分類
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1

(54)ガス中の水銀除去方法

(21)特　願　昭45−124108
(22)出　願　昭45(1970)12月29日
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発明の詳細な説明

本発明はガス中に含まれる微量の水銀を除去する方法に関する。

例えば水銀法アルカリ塩電解で得られる水素ガス中には水銀を含み、これは微量でも有機化合物の接触還元等に水素を使用する際、触媒毒となるため、あらかじめ実質的に除去しておくことが要求される。このような場合、水銀の除去方法としては水素を液体アンモニアの真空蒸発により−40℃に冷却してある竪型の管型冷却器に送り冷却し、水銀を微粒子に凝縮して除く深冷凝縮法、或いは水銀蒸気を含むガスを3〜5kg/cm²の圧力の下に−30℃以下に冷却して除去する方法があるが、いずれも気体冷却のため膨大な冷凍設備を必要とする。

さらにモレキュラーシーブ又は活性炭により選択的に吸着させる方法、あるいは水銀を含むガスを活性炭または酸化アルミニウム上で硫化水銀と硫黄の混合物と接触せしめる方法があるが、前者は比較的能率の悪い欠点があり又後者は微量な水

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銀分が完全には吸着されない欠点がある。

又化学的方法として塩素水と水銀含有水素ガスを接触させて、水銀塩化物として除去する方法が知られているが操作時の調節が難かしく余分の塩素によりガスを再汚染する欠点がある。

又オゾン処理による除去方法も考案されているが後処理の静電分離、又は機械的ろ過に難点がある。さらにヨウ素を活性炭に吸着せしめた担体で除去方法があるが、ヨウ素が逸散する為に連続使用の点に難点があつた。

本発明者らは以上の問題点を解決するために検討をかさねた結果、水銀との反応性に富んだ遊離ヨウ素を含有しないヨウ素化合物および還元剤を利用してきわめて効果的にガス中の水銀を除去することに成功したものである。すなわち本発明はガス中の水銀を除去するに当り遊離ヨウ素を含有しないリチウム、ナトリウム、カリウム、カルシウム、マグネシウム、亜鉛、アルミニウム、鉄、ニッケル、コバルトより選ばれた金属ヨウ化物、あるいは一般式R_4NI（但しRはHまたはC_1〜C_4のアルキル基）で示される化合物を炭素系担体、ゼオライト、シリカゲルのいづれかに吸着させた吸着剤担体に無機還元剤を1種または2種以上共存せしめて水銀を含むガスを接触させることを特徴とするガス中の水銀除去方法である。

このようなヨウ素化合物としてはヨウ化リチウム、ヨウ化ナトリウム、ヨウ化カリウム、ヨウ化カルシウム、ヨウ化マグネシウム、ヨウ化亜鉛、ヨウ化アルミニウム、ヨウ化鉄、ヨウ化ニッケル、ヨウ化コバルト、ヨウ化テトラエチルアンモニウムなどが挙げられる。また共存させる無機還元剤としてはヒドラジニウム塩、ヒドロキシルアンモニウム塩、亜リン酸及びその塩、チオ硫酸、次亜硫酸、亜硫酸及びその塩、第1錫化合物などが挙げられる。

また本発明に用いられる吸着剤担体の粒度は約6〜100メッシュが適当である。

PAC ET AL. EXHIBIT 1021
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本発明方法を実施するためにはあらかじめ該ヨウ素化合物を水に溶解させて、吸着剤担体の充填層に流下させることにより充分担体表面にヨウ素化合物を吸着せしめるか、あるいは該ヨウ素化合物を溶解させたアルコール溶液に吸着剤担体に加えて充分接触撹拌後、アルコールを逸散せしめて担体表面にヨウ素化合物を吸着せしめる。さらに無機還元剤を共存させるために、その水溶液を同様にして担体表面に吸着させた後水銀を含むガスを通ずればよい。本発明方法は水素以外のガス、たとえば空気、窒素、塩酸ガスなどにも適用しうるものである。またガスの種類によつて耐用性が劣化を来したり、あるいはガス中の水銀の形態は通常水銀蒸気であるがガスの種類によつてそのごく一部が酸化水銀のごとき水銀化合物になつていることもあり、本発明法のごとく還元剤を共存せしめることにより効果的に水銀を除去しうるものである。

なおヨウ素化合物の吸着量はヨウ素分として吸着剤担体の重量の2～25重量%程度、無機還元剤の吸着量は担体重量の0.1～5重量%程度が適当である。

このようにして水銀含量約1000～40000 μg/m³（μgはmgの1000分の1）のガスを空間速度200～40001/Hrで充填層に流通せしめると、排ガス中の水銀は10 μg/m³以下に減少する。

ガス中におけるヨウ素化合物と水銀との反応機構は明らかではないが、最終的には吸着もしくは担持せしめたヨウ素化合物が水銀と反応してこれを捕促するものと思われる。

又還元剤を共存させることによる反応機構は明らかではないが最終的には担体に存在するヨウ素化合物が水銀と反応してこれを捕捉すると同時に共存せしめた還元剤により耐用性がよくなりさらに酸化水銀の如き水銀化合物も還元されてより効果的に水銀を除去しうるものと思われる。

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なお還元剤としては種々知られているが本発明方法に用いられる還元剤はこれらのうちで特に還元力にとみ、又耐用性を助長することが大で、実用化に適しているものである。

参考例　1

6～20メッシュの活性炭40gを内径20%のガラス管に充填し水銀含量12000 μg/m³の水素ガスを空間速度1500 l/Hrで流通せしめたところ排出ガス中の水銀濃度は1時間後で150 μg/m³、20時間後で3200 μg/m³ 90時間後で11700 μg/m³であつた。

参考例　2

20～30メッシュのゼオライト30gを内径20%のガラス管に充填し水銀含量9700 μg/m³の水素ガスを空間速度1000 l/Hrで流通せしめたところ排出ガス中の水銀濃度は1時間後で9600 μg/m³であつた。

実施例　1

10～40メッシュの活性炭40gを内径20%のガラス管に充填しあらかじめヨウ化ナトリウム10gを溶解しているエタノール150 mlを流下せしめて担体に充分吸着せしめたのち風乾し、溶媒を充分除去する。さらに硫酸第一錫2gを含む水溶液50 mlを流下せしめて硫酸第一錫を共存せしめた後、水銀含量250 μg/m³の塩酸ガスを空間速度1500 l/Hrで流通せしめたところ排出ガス中の水銀濃度は10時間後で2 μg/m³、90時間後で3 μg/m³、250時間後で5 μg/m³、500時間後で9 μg/m³であつた。

実施例　2～4

実施例1と同様の方法でヨウ素化合物、担体および還元剤の種類をかえた実験結果を下表に示す。

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実施例 No.	ヨウ素化合物	溶媒	担体 種類	担体 重量 g	担体 ヨウ素化合物吸着量 重量%	還元剤 種類	還元剤 共存量 重量%	対象ガス 種類	対象ガス 流量空間速度 1／Hr	ガス中の水銀濃度（μg／Nl） 入口	出口 10時間後	出口 250時間後	出口 500時間後
2.	ヨウ化亜鉛	水	活性炭	40	約 4.5	塩化第一錫	約2.0	H_2	1500	14600	2	4	9
3.	ヨウ化アルミニウム	水	活性炭	40	約10.0	硫酸ヒドロキシルアミン＋亜硫酸一錫	約2.0	H_2	1500	15000	3	4	10
4.	ヨウ化テトラエチルアンモニウム	水	ゼオライト	50	約 5.5	硫酸ヒドラジン	約1.5	H_2	600	9700	4	5	10

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㊀特許請求の範囲

1　ガス中の水銀を除去するにあたり遊離ヨウ素を含有しないリチウム、ナトリウム、カリウム、カルシウム、マグネシウム、亜鉛、アルミニウム、鉄、ニッケル、コバルトより選ばれた金属ヨウ化物、あるいは一般式 R_4NI（但しRはHまたは C_1～C_4 のアルキル基）で示される化合物を炭素系担体、ゼオライト、シリカゲルのいづれかに吸着させた吸着剤担体に無機還元剤を1種または2種以上共存せしめて、水銀を含むガスを接触させることを特徴とするガス中の水銀除去方法。

㊁引用文献

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米国特許　3194629

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Patent Family Information

Patent No.	Kind	Date	Application No.	Date
JP 50006438	B4	19750313	JP 1970-124107	19701229

Priority Application		
JP 1970-124107	A	19701229

Abstract

An I-contg. compd. and/or I mixt. is adsorbed on an anion exchange resin. The resulting compd. is used to remove Hg from a gas by contact. Thus, a 500 ml aq. soln. contg. 43 g NaI was introduced into a 20 mm-diam. glass column packed with 50 g 15-50 mesh anion exchange resin having the functional group NMe3+ Cl-. The amt. of I adsorbed on the resin was 17 wt.%. H contg. 7500 mg Hg/m3 was passed through the column at 800 l./hr and the Hg concns. after 10, 90, and 250 hr were 2, 4, and 10 mg Hg/m3.

⑤1 Int.Cl².
B 01 J 1/08
B 01 D 53/00
C 25 B 1/36

⑤2日本分類
13(9) F 112
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15 F 212.123

⑲日本国特許庁

特許公報

⑪特許出願公告
昭50－6438
⑭公告 昭和50年(1975) 3月13日
発明の数 1
(全 3 頁)

1

⑤4ガス中の水銀除去方法

②特願 昭45－124107
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発明の詳細な説明

本発明はガス中に含まれる微量の水銀を除去する方法に関する。

例えば水銀法アルカリ塩電解で得られる水素ガス中には水銀を含み、これは微量でも有機化合物の接触還元等に水素を使用する際、触媒毒となるため、あらかじめ実質的に除去しておくことが要求される。

このような場合、水銀の除去方法としては水素を液体アンモニアの真空蒸発により－40℃に冷却してある竪型の管型冷却器に送り冷却し、水銀を微粒子に凝縮して除く深冷凝縮法、あるいは水銀蒸気を含むガスを3～5kg/cm²の圧力の下に－30℃以下に冷却して除去する方法があるが、いずれも気体冷却のため膨大な冷凍設備を必要とする。さらにモレキュラーシーブ又は活性炭により選択的に吸着させる方法、あるいは水銀を含むガスを活性炭または酸化アルミニウム上で硫化水銀と硫黄の混合物と接触させる方法があるが前者は比較的能率の悪い欠点があり、又後者は微量な水銀分が完全には吸着されない欠点がある。又化学

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的方法として塩素水と水銀含有水素ガスを接触させて、水銀塩化物として除去する方法が知られているが操作時の調節が難かしく余分の塩素によりガスを再汚染する欠点がある。又オゾン処理による除去方法も考案されているが後処理の静電分離又は機械的ろ過に難点がある。

本発明は以上の難点を解決するものであつて水銀との反応性に富むヨウ素化合物単独あるいはこれとヨウ素を利用し、加うるにそれらの特異な吸着性を示す陰イオン交換樹脂を併用して、容易にかつ有効にガス中の水銀を除去する方法を提供するものである。

すなわち本発明は、ヨウ素化合物、又はこれらとヨウ素の混合物を吸着せしめた陰イオン交換樹脂に水銀を含むガスを接触せしめることを特徴とするガス中の水銀除去方法である。

このようなヨウ素化合物としては、ヨウ化アルミニウム、ヨウ化亜鉛、ヨウ化カリウム、ヨウ化アンモニウム、ヨウ化カルシウム、ヨウ化コバルト、ヨウ化ストロンチウム、ヨウ化鉄(II)、ヨウ化ナトリウム、ヨウ化ニッケル、ヨウ化マグネシウム、ヨウ化リチウム、ヨウ化テトラエチルアンモニウム、ヨウ化メチレン、α－ヨードナフタリン、O－ヨードフエノール、ヨードベンゼンなどが上げられる。

又本発明に用いられる陰イオン交換樹脂としては、その母体に、$-N(CH_3)_3^+X^-$, $-N(CH_3)_2(C_2H_4OH)^+X^-$, $-N(R)_2$ $-NHR$, $-NH_2$ と$-N(CH_3)_2$, (XはCl－, OH－などの陰イオンを表わし、RはCH₃, C₂H₅などのアルキル基を表わす)の如き交換基を有するものが適当である。

本発明に用いる陰イオン交換樹脂は水溶媒系、非水溶媒系のいずれにおいても吸着能を有するものが用いられる。

本発明方法を実施するためには、あらかじめ上記ヨウ素化合物、又はこれらとヨウ素の混合物を

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水又は有機溶媒に溶解させて、陰イオン交換樹脂の充填層に流下させることにより充分樹脂にヨウ素化合物、又はこれらとヨウ素の混合物を吸着させて後水銀を含むガスを通ずればよい。本来陰イオン交換樹脂には水溶媒系においてヨウ素イオンとして吸着されるものであるが、エタノールの如き有機溶媒には前記ヨウ素化合物のうち例えばヨウ化ナトリウム、ヨウ化メチレンなどはよく溶解し、陰イオン交換樹脂に吸着される、このような場合を含めて、本発明方法におけるヨウ素化合物とはヨウ素イオンになりえて陰イオン交換樹脂にイオン吸着されるものである。

本発明方法は水素以外のガス、たとえば空気、窒素、炭酸ガスなどにも適用しうる。

なおヨウ素分の陰イオン交換樹脂に対する吸着量は樹脂重量の5～95%が適当である。

ここで云うヨウ素分とは、例えばヨウ化カリウムのみを含む溶液、あるいはヨウ素とヨウ化カリウムとの混合溶液中で陰イオン交換樹脂にそれらを吸着せしめた場合、吸着された全ヨウ素を意味するものである。又実施例において重量当りに対し吸着されたヨウ素分が大きい値を示している場合があるが、これは単にヨウ素イオンの吸着量が大きいのみでなく、例えばヨウ素とヨウ化カリウムの混合溶液中では、下記に示す反応式の如きポリヨウ素イオンが生成し、よく吸着されるものである。

$$nI + I^{+} \rightarrow I_{n}^{-} \quad (n: 3, 5\text{など})$$

このようにして、水銀約1,000～40,000 μg／m³（μgは㎎の1,000分の1）を含むガスを空間速度200～4,000 l／Hr で充填層に流通せしめると排出ガス中の水銀濃度は10 μg／m³以下に減少する。

ヨウ素化合物、又はこれらとヨウ素の混合物を吸着した陰イオン交換樹脂とガス中における水銀との反応機構は明らかではないが、最終的には陰イオン交換樹脂上に吸着されたヨウ素分が水銀と反応してこれを補促するものと思われる。

本発明に使用する、ヨウ素イオンを吸着した陰イオン交換樹脂はきわめてその製法が簡単であり、かつヨウ素分としてきわめて多く吸着するために水銀に対する吸着能もすぐれ、長時間の連続使用に耐えうるものである。

以下示す比較例および実施例において水銀濃度

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の測定方法は次の如くである。すなわち充填層の通過前のガス中の水銀濃度（100～10,000 μg／m³）の分析は、北川式ガス検知管（ヨウ化第一銅を吸着せしめたシリカゲル粉を入れたガラス管に被検ガスを流し、そのシリカゲル粉の変色域の長さにより水銀濃度を測定する）により行つた。また充填層通過後のガス中の微量水銀濃度（1～10 μg／m³）の分析は、電磁一週マンガン酸カリ混合水溶液中に被検ガスを導き、水銀分を吸収せしめ、その吸収液に還元剤を加えて空気でバブリングを行い、水銀を金属蒸気として気化せしめ253.7 mμの紫外線での吸光光度を測定した。

比較例　1

粒度15～50メッシュの－N（CH_3）$_3^{+}$ Cl^{-}基を有する陰イオン交換樹脂（商品名DIAION・SA11A・三菱化成社製）50 gを内径20 m／mのガラス管に充填し、水銀12,000 μg／m³の水素ガスを空間速度460 l／Hr で流通せしめたところ排出ガス中の水銀濃度を1時間後に測定したところ12,000 μg／m³であつた。

実施例　1

粒度15～50メッシュの－N（CH_3）$_3^{+}$ Cl^{-}基を有する陰イオン交換樹脂（商品名DIAION・SA11A・三菱化成社製）50 gを内径20 m／mのガラス管に充填し、ヨウ化ナトリウム43 gを溶解した水溶液500 m l を流下せしめて陰イオン交換樹脂に充分吸着せしめたところ、樹脂重量当りのヨウ素分の吸着量は約17%であつた。このヨウ化ナトリウム吸着陰イオン交換樹脂に水銀含量7,500 μg／m³の水素ガスを空間速度800 l／Hr で流通せしめたところ排出ガス中の水銀濃度は10時間後で2 μg／m³，90時間後で4 μg／m³，250時間後で10 μg／m³であつた。

実施例　2

粒度15～50メッシュの－N（CH_3）$_2$（C_2H_4OH）$^{+}$ Cl^{-}基を有する陰イオン交換樹脂（商品名DIAION・SA21A三菱化成社製）50 gを内径20 m／mのガラス管に充填し、ヨウ化カリウム90 gとヨウ素60 gを溶解した水溶液1,200 m l を流下せしめて陰イオン交換樹脂に充分吸着せしめたところ樹脂重量当りのヨウ素分の吸着量は約90%であつた。

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このヨウ素分を吸着した陰イオン交換樹脂に水銀含量5,500μg／m³の水素空間速度1,500 1／dryで流通せしめたところ排出ガス中の水銀濃度は10時間後で3μg／m³，90時間後で5μg／m³，250時間後で9μg／m³であつた。

実施例　3

粒度15～40メッシュの－N（CH_3）$_2$（C_2H_4OH）$^+Cl^-$基を有する陰イオン交換樹脂（商品名DIAION・SA21A三菱化成社製）50gを内径20m／mのガラス管に充填し、ヨウ化コバルト50gとヨウ化テトラエチルアンモニウム10gを溶解した水溶液500mlを流下せしめて陰イオン交換樹脂に充分吸着せしめたところ樹脂重量当りのヨウ素分の吸着量は約15%であつた。このヨウ素分を吸着した陰イオン交換樹脂に水銀含量6,000μg／m³の水素を空間速度700 1／Hrで流通せしめたところ排出ガス中の水銀濃度は10時間後で4μg／m³，90時間後で5μg／m³，250時間後で9μg／m³であつた。

実施例　4

粒度15～50メッシュの－N（CH_3）$_2$基

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を有する陰イオン交換樹脂（商品名Dowex-3ダウケミカル社製）50gを内径20m／mのガラス管に充填し、ヨウ化ナトリウム60gとヨウ素40gを溶解したエタノール1,000mlを流下せしめて陰イオン交換樹脂に充分吸着せしめたところ樹脂重量当りのヨウ素分の吸着量は約60%であつた。このヨウ素分を吸着した陰イオン交換樹脂に水銀含量400μg／m³の塩素ガスを空間速度350 1／Hrで流通せしめたところ排出ガス中の水銀濃度は10時間後で4μg／m³，90時間後で7μg／m³，250時間後で10μg／m³であつた。

㊀特許請求の範囲

1　ヨウ素化合物、又はこれらとヨウ素の混合物を吸着せしめた陰イオン交換樹脂に水銀を含むガスを接触せしめることを特徴とするガス中の水銀除去方法。

㊁引用文献

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	2380-00200
First Inventor	Edwin S. Olson, et al.
Title	Sorbents for the Oxidation and Removal of Mercury
Express Mail Label No.	EL 967180618 US

ADDRESS TO: Commissioner for Patents
P. O. Box 1450
Arlington VA 22313-1450

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing*
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☒ Specification [Total Pages 36 Both the claims and abstract must start on a new page (for information on the preferred arrangement see MPEP 608.01(a))
4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 7
5. Oath and Declaration [Total Sheets]
   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☒ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, items a. - c. are required)*
   i. ☐ Computer Readable Form (CRF)
   iii. ☐ Transfer Request (37 CFR 1.821(e))
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____
10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney *(when there is an assignee)*
11. ☐ English Translation Document *(if applicable)*
12. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☒ Copies of foreign patent documents, publications, & other information
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. ☐ Nonpublication Request under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-Part (CIP) of prior application No.:

Prior application information: *Examiner* Art Unit:

19. CORRESPONDENCE ADDRESS

☒ *Customer Number of Bar Code Label* **23505** or ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

Name (Print/Type)	Timothy S. Westby	Registration No. (Attorney/Agent)	52,352
Signature		Date	August 22, 2005

The collection of information is required by 37 CFR 1.53(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 1.14. 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.

PTO/SB/17 (12-04V2))
Approved for use through 07/31/2006. 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.

Effective on 12/08/04.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($)2,900.00

Complete if Known	
Application Number	Unassigned
Filing Date	Concurrently Herewith
First Named Inventor	Edwin S. Olson, et at.
Examiner Name	Unassigned
Art Unit	Unassigned
Attorney Docket No.	2380-00200

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify):_____

☒ Deposit Account Deposit Account Number: **03-2769** Deposit Account Name: **Conley Rose, P.C.**

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☒ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☒ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☒ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	300	150	500	250	200	100	$1000.00
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
54	- 20 or HP =	34	x	$50.00	=	$1700.00

HP = highest number of total claims paid for, if greater than 20

Indep. Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
4	- 3 or HP =	1	x	$200.00	=	$200.00

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims

Fee ($)	**Fee Paid ($)**

3. APPLICATION SIZE FEE

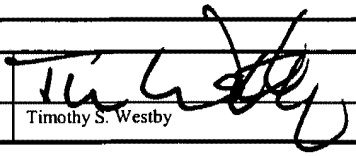
If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**		**Fee ($)**		**Fee Paid ($)**
43	- 100 =	0	/ 50 =	0	(round up to a whole number) x	0	=	

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge):_____	

SUBMITTED BY

Signature		Registration No. (Attorney/Agent)	52,352	Telephone	(713) 238-8000
Name (Print/Type)	Timothy S. Westby			Date	August 22, 2005

This collection of information is required by 37 CFR 1.136. 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, 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..**