AO 120 (Rev. 08/10)

TO:	Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court **District of Delaware** on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	7/17/2019	District of Delaware

PLAINTIFF	DEFENDANT
Midwest Energy Emissions Corp. and MES Inc.	Vistra Energy Corp., et al.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 10,343,114 B2	7/9/2019	Midwest Energy Emissions Corp.
2	US 8,168,147 B2	5/1/2012	Midwest Energy Emissions Corp.
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

Trials@uspto.gov
571-272-7822

Paper 11
Entered December 14, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AEP GENERATION RESOURCES INC., AEP TEXAS INC. and SOUTHWESTERN ENERGY POWER CO.,
Petitioner,

v.

MIDWEST ENERGY EMISSIONS CORP.,
Patent Owner.

IPR2020-01294 and IPR2020-01295 (Patent 10,343,114 B2)
IPR2020-01296 and IPR2020-01297 (Patent 8,168,147 B2)[1]

Before KRISTINA M. KALAN, ZHENYU YANG, CHRISTOPHER M. KAISER, and AVELYN M. ROSS, *Administrative Patent Judges*.[2]

PER CURIAM

DECISION

Granting Joint Motion to Withdraw Petition and
Dismissal Prior to Institution of Trial
37 C.F.R. § 42.71(a)

[1] This Order applies to each of the above-listed proceedings. We exercise our discretion to issue one Order to be filed in each proceeding. The parties are not authorized to use this style heading for any subsequent papers.

[2] This listing of Administrative Patent Judges does not reflect an expanded panel under SOP 1 § III.M. This order addresses multiple proceedings that collectively involve more than three Administrative Patent Judges.

On July 15, 2020, AEP Generation Resources Inc., AEP Texas Inc., and Southwestern Energy Power Co. (collectively "Petitioner") filed two petitions requesting an *inter partes* review of certain claims of U.S. Patent No. 10,343,114 (*see* IPR2020-01294, Paper 1; IPR2020-01295, Paper 1) and two petitions requesting an *inter* partes review of certain claims of U.S. Patent No. 8,168,147 (*see* IPR2020-01296, Paper 1; IPR2020-01297, Paper, 1). On December 8, 2020, with Board authorization, the parties filed a Joint Motion to Withdraw the Petition in each *inter partes* review. *See* IPR2020-01294, Paper 10; IPR2020-01295, Paper 11; IPR2020-01296, Paper 11; IPR2020-01297, Paper 10 (collectively "Motions" or "Motions to Withdraw"). The Motions to Withdraw filed in each *inter partes* review are substantively identical. *See id.*

In the Motions to Withdraw, the parties represented that they "have reached an agreement to settle IPRs and litigation between them" and that the District Court has dismissed the related litigation between the parties. Motions 1. Accordingly, "the parties jointly move to withdraw the petition . . . without adverse judgment and without a decision on institution." *Id.* at 2.

As the parties explain, "[t]he Board may take up petitions or motions for decisions in any order, may grant, deny, or dismiss any petition or motion, and may enter any appropriate order." *Id.* at 1 (quoting 37 C.F.R. § 42.71(a)). This proceeding is at an early stage and we have not yet decided whether to institute trial. Under the circumstances presented here, we determine it is appropriate to dismiss the Petition and terminate the proceeding to promote efficiency and minimize unnecessary costs. Therefore, the parties' Joint Motions to Withdraw are *granted.*

This Order does not constitute a final written decision pursuant to 35 U.S.C. § 318(a).

Accordingly, it is,

ORDERED that the Parties' Joint Motion to Withdraw the Petition in each case is *granted*;

FURTHER ORDERED that the Petition in each case is dismissed, and IPR2020-01294, IPR2020-1295, IPR2020-01296, and IPR2020-1297 are terminated;

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571-272-7822

Paper 19
Date: December 2, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NRG ENERGY, INC. and
TALEN ENERGY CORPORATION
Petitioner,

v.

MIDWEST ENERGY EMISSIONS CORP.,
Patent Owner.

IPR2020-00926
Patent 8,168,147 B2

Before ZHENYU YANG, CHRISTOPHER M. KAISER, and AVELYN M. ROSS, *Administrative Patent Judges.*

ROSS, *Administrative Patent Judge.*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4

I. INTRODUCTION

NRG Energy, Inc., Talen Energy Corporation, and Vistra Corp. (formerly known as Vistra Energy Corp.), filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 1, 2, 4–6, and 9–24 of U.S. Patent No. 8,168,147 B2 (Ex. 1001, "the '147 patent"). Pet. 1. Subsequently, Vistra Corp. and Midwest Energy Emissions Corp. ("Patent Owner") filed a Joint Motion to Terminate Vistra Corp. as a petitioner pursuant to settlement. Paper 8. That motion was granted. Paper 11. Therefore, NRG Energy, Inc. and Talen Energy Corporation (collectively "Petitioner") remain as petitioners. *Id.* at 4. Patent Owner filed a Preliminary Response. Paper 13 ("Prelim. Resp."). With our authorization, Petitioner filed a Reply (Paper 15, "Pet. Reply") and Patent Owner filed a Sur-reply (Paper 16, "Sur-reply").

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (2019). The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least [one] of the claims challenged in the petition."

For the reasons set forth below, upon considering the Petition, Preliminary Response, Reply, Sur-reply, and evidence of record, we determine the information presented in the Petition establishes a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. Accordingly, we institute an *inter partes* review.

A. Real Parties-in-Interest

Petitioner identifies the real parties-in-interest as NRG Energy, Inc., Talen Energy Corporation, and Vistra Corp. Pet. 1. Additionally, Petitioner identifies Brandon Shores LLC; Talen Generation LLC; H.A. Wagner LLC; IPH, LLC; Illinois Power Resources Generating, LLC; Dynegy Midwest Generation LLC; Dynegy Miami Fort, LLC; NRG Texas Power LLC; Midwest Generation EME, LLC; and Midwest Generation, LLC, as real parties-in-interest who are parties to the pending lawsuit identified below. *Id.* Talen and NRG also identify numerous *potential* real parties-in-interest—namely vendors and suppliers. *Id.* at 2–6.

B. Related Matters

Petitioner identifies a pending lawsuit between the parties, styled *Midwest Energy Emissions Corp. and MES Inc. v. Vistra Energy Corp.*, No. 1:19-cv-01334-RGA (D. Del.), as a related proceeding in which the Patent Owner asserts the '147 patent. Pet. 6–7; *see also* Paper 6, 1 (Patent Owner's Mandatory Notices).

Petitioner filed a second petition challenging the '147 patent applying different prior art and a different priority date. IPR2020-00928, Paper 3.[1] Additionally, Petitioner filed concurrent petitions challenging U.S. Patent No. 10,343,114 B2 ("the '114 patent"), also asserted by Patent Owner in the district court proceeding. *See* IPR2020-00832, Paper 3; *see* IPR2020-00834, Paper 3. We instituted trial on IPR2020-00832 and IPR2020-00834 on

[1] In accordance with our Trial Practice Guide, Petitioner provides an explanation of material differences and ranking for the multiple petitions directed to each challenged patent. Paper 3 (Petitioner's Explanation Regarding the Necessity of Multiple Petitions, "Explanation").

October 26, 2020. *See* IPR2020-00832, Paper 17; *see also* IPR2020-00834, Paper 18.

C. The '147 Patent

1. Specification

The '147 patent, titled "Sorbents for the Oxidation and Removal of Mercury," issued on May 1, 2012. Ex. 1001, codes (45), (54). The '147 patent is directed to methods for capturing mercury using reactive bromine-promoted carbon sorbents. *Id.* at 6:19–24.

The '147 patent explains that combusting coal generates flue gas containing mercury and other trace elements. *Id.* at 1:29–40. "The release of the mercury (and other pollutants) to the environment must be controlled by use of sorbents," e.g., activated carbon particles. *Id.* at 1:37–40, 57–62. According to the '147 patent, "[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." *Id.* at 2:10–14.

The '147 patent discloses that 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." *Id.* at 6:19–24. To prepare bromine-carbon sorbents, the '147 patent describes methods for chemically combining molecular bromine with activated carbon. *Id.* at 11:45–49. Specifically, the '147 patent describes an "in-flight" method of producing a bromine-promoted carbon sorbent by:

> 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.

Id. at 12:44–53.

The '147 patent depicts a schematic flow diagram for a mercury control system including bromine-promoted carbon sorbents in Figure 3, reproduced below:

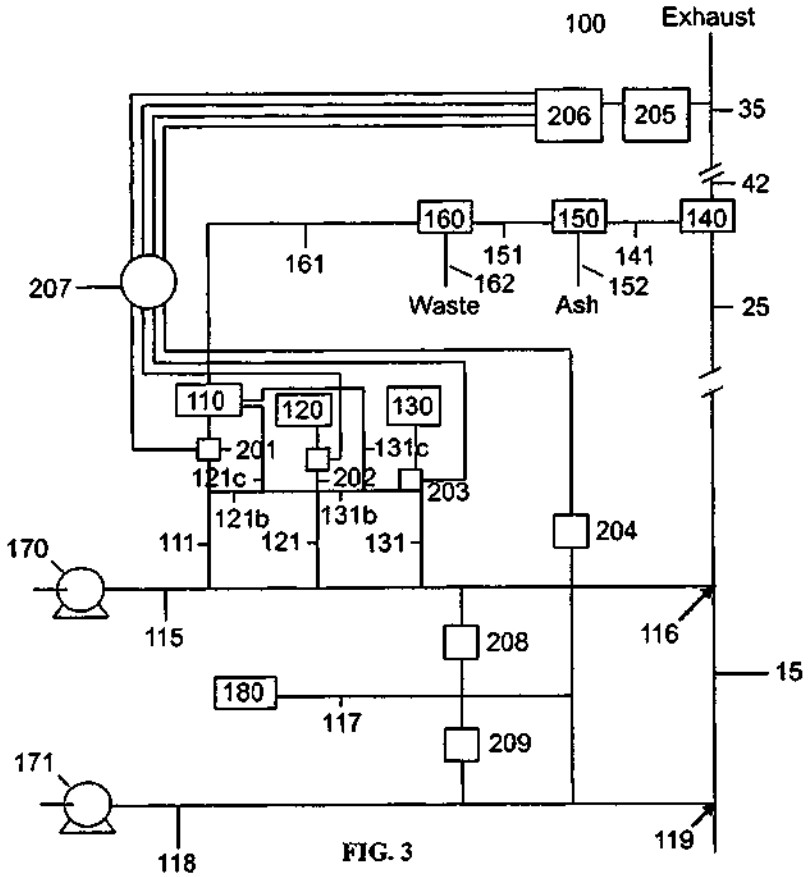


FIG. 3

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 . . . including in-flight preparation of

promoted carbon sorbent." *Id.* at 5:47–51. Figure 3 depicts base activated carbon reservoir 110, halogen/halide promoter reservoir 120, optional secondary component reservoir 130, and corresponding flow control devices 201–203. *Id.* at 8:21–30. Transport line 115 carries material discharged from reservoirs 110, 120, and 130 in a transport gas, which injects the materials into contaminated flue gas stream 15 via injection point 116. *Id.* at 8:33–42. Particulate separator 140 collects and separates solid materials, including sorbent stream 151, which may be passed to sorbent regenerator 160 to yield regenerated sorbent stream 161. *Id.* at 8:61–9:10.

Figure 3 illustrates several preferred methods for preparing bromine-promoted carbon sorbents. *Id.* at 9:43–64. For example, the '147 patent first describes an in-flight preparation by discharging the halogen/halide "via line 121 directly into transport line 115, within which it contacts and reacts with the base activated carbon prior to injection point 116." *Id.* at 9:51–56. In a second embodiment, "the halogen/halide may be combined via line 121*b* with base activated carbon prior to entering transport line 115." *Id.* at 9:56–57. As a third alternate method, Figure 3 of the '147 patent describes introducing halogen/halide via line 121*c* into activated carbon reservoir 110 and reacting the compounds in reservoir 110. *Id.* at 9:58–64.

2. Illustrative Claims

Although Patent Owner disclaimed claim 1, claims depending from claim 1 and therefore including the limitations of claim 1, are challenged. Specifically, claim 17, from which the claims 18–20 depend, depends directly from claim 1. *See generally* Ex. 1001, claims. Claims 1 and 17 are reproduced below.

1. A method for separating mercury from a mercury containing gas comprising:

(a) promoting at least a portion of a particulate sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

Ex. 1001, 23:34–52.

17. A method according to claim 1, further comprising

injecting the particulate sorbent material at a sorbent material injection rate and

injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent,

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 the sorbent material.

Id. at 24:34–41.

D. Statutory Disclaimer

Patent Owner states "[b]efore this petition was filed, ["Midwest Energy Emissions Corp.] statutorily disclaimed the non-'in-flight' claims of the '147 patent (1–16 and 21–25)." Prelim. Resp. 1 (citing Ex. 1019, 494).

A "patent owner may file a statutory disclaimer under 35 U.S.C. [§] 253(a) in compliance with § 1.321(a) of this chapter, disclaiming one or more claims in the patent. No *inter partes* review will be instituted based on disclaimed claims." 37 C.F.R. § 42.107(e) (2019). A disclaimer under 35 U.S.C. § 253(a) is "considered as part of the original patent" as of the date on which it is "recorded" in the Office. 35 U.S.C. § 253(a). For a disclaimer to be "recorded" in the Office, the document filed by the patent owner must:

(1) Be signed by the patentee, or an attorney or agent of record;

(2) Identify the patent and complete claim or claims, or term being disclaimed. A disclaimer which is not a disclaimer of a complete claim or claims, or term will be refused recordation;

(3) State the present extent of patentee's ownership interest in the patent; and

(4) Be accompanied by the fee set forth in [37 C.F.R.] § 1.20(d). 37 C.F.R. § 1.321(a); *see also Vectra Fitness, Inc. v. TNWK Corp.*, 162 F.3d 1379, 1382 (Fed. Cir. 1998) (holding that a § 253 disclaimer is immediately "recorded" on the date that the Office receives a disclaimer meeting the requirements of 37 C.F.R. § 1.321(a), and that no further action is required in the Office).

Patent Owner filed a statutory disclaimer of claims 1–16 and 21–25. Ex. 1019, 494. Based on our review of Exhibit 1019 and Office public records, we conclude that the disclaimer of claims 1–16 and 21–25 of

the '147 patent under 35 U.S.C. § 253(a) was recorded in the Office as of December 11, 2019. *Id.* at 493–495. Because claims 1–16 and 21–25 have been disclaimed under 35 U.S.C. § 253(a) in compliance with 37 C.F.R. § 1.321(a), no *inter partes* review shall be instituted as to those claims. 37 C.F.R. § 42.107(e); *Intuitive Surgical, Inc. v. Ethicon LLC*, IPR2018-01248, Paper 7 at 2 n.1, 9–10 (PTAB Feb. 7, 2019) (discussing interplay of a disclaimed claim, Federal Circuit precedent, and our governing statutes and rules); *Daikin Indus. Ltd. v. The Chemours Co.*, IPR2018-00993, Paper 12 at 5–7 (PTAB Nov. 13, 2018) (noting that adverse judgment following partial disclaimer was not appropriate at least because the nondisclaimed claims "ha[d] yet to be 'decided.'"); *cf. General Electric Co. v. United Techs. Corp.*, IPR2017-00491, Paper 9 (PTAB July 6, 2017) (precedential) (declining to institute *inter partes* review when all challenged claims were disclaimed under 35 U.S.C. § 253(a)).

E. Prior Art and Asserted Grounds of Unpatentability

Petitioner asserts that claims 1, 2, 4–6, 11, 12, 15, 16, 21–24 would have been unpatentable on the following grounds:

Claim(s) Challenged	Statutory Basis	Reference(s)/Basis
1, 2, 4–6, 9–17, 20–24	§ 103	Nelson,[2] Olson-Paper[3]
11, 12, 17–20	§ 103	Nelson, Olson-Paper, Lissianski[4]

[2] Nelson, Jr., US 6,953,494 B2, issued October 11, 2005 (Ex. 1012, "Nelson").
[3] E.S. Olson et al., *Chemical mechanisms in mercury emission control technologies*, 107 J. Phys. IV France 979–982 (2003) (Ex. 1079, "Olson-Paper").
[4] Lissianski et al., US 7,514,052 B2, issued April 7, 2009 (Ex. 1036, "Lissianski").

Claim(s) Challenged	Statutory Basis	Reference(s)/Basis
1; 2, 4–6, 11, 12, 15, 16, 21–24	§ 103	Downs-Halogenation,[5] Olson-Paper
17–20	§ 103	Downs-Halogenation, Olson-Paper, Lissianski

As discussed above, only the challenges to claims 17–20 are pending in this *inter partes* proceeding as the remaining claims were disclaimed prior to filing of the Petition.

Petitioner also relies on declaration testimony of Stephen Niksa, Ph.D. (Ex. 1003, "the Niksa Declaration").

Patent Owner disputes that Petitioner's asserted grounds render any of the challenged claims unpatentable and that the asserted references are not prior art. *See generally* Prelim. Resp. Patent Owner relies on declaration testimony of the named inventors and additional evidence to support its contention of an earlier invention date. *See* Ex. 2024.

II. ANALYSIS

A. Legal Standards

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics,*

[5] Downs et al., US 2007/0180990 A1, published August 9, 2007 (Ex. 1015, "Downs-Halogenation").

Inc., 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

A claim is unpatentable under 35 U.S.C. § 103(a) 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." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.[6] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

To show obviousness, it is not enough to merely show that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). "This is so because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR*, 550 U.S. at 418–419.

On the other hand, an obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR*, 550 U.S. at 418; *accord In re Translogic Tech., Inc.*, 504 F.3d 1249, 1259 (Fed. Cir. 2007). However,

[6] The parties have not asserted or otherwise directed our attention to any objective evidence of non-obviousness.

Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Instead, Petitioner must articulate a reason why a person of ordinary skill in the art would have combined or modified the prior art references. *In re NuVasive, Inc.*, 842 F.3d 1376, 1382 (Fed. Cir. 2016); *see also Metalcraft of Mayville, Inc. v. The Toro Co.*, 848 F.3d 1358, 1366 (Fed. Cir. 2017) ("In determining whether there would have been a motivation to combine prior art references to arrive at the claimed invention, it is insufficient to simply conclude the combination would have been obvious without identifying any reason why a person of skill in the art would have made the combination."); *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention.") (citing *InTouch Techs., Inc. v. VGO Commc'ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014)).

At this preliminary stage, we determine whether the information presented shows a reasonable likelihood that Petitioner would prevail in establishing that at least one of the challenged claims would have been obvious over the proposed prior art.

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

B. Level of Ordinary Skill in the Art

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of invention. *Graham*, 383 U.S. at 17. Petitioner contends that

> [a] person of ordinary skill in the art ("POSITA") would have at least a bachelor's degree in chemical engineering, mechanical engineering, or a related field of study with at least two years of experience with implementing pollution control in power generation plants for natural gas, coal, and/or industrial waste incineration.

Pet. 13 (citing Ex. 1003 ¶¶ 63–66).

Patent Owner does not identify the level of skill necessary for a person having ordinary skill in the art. *See generally* Prelim. Resp. And, neither party indicates that the outcome of any arguments made in this case would change depending on the level of ordinary skill in the art. For purposes of this Decision, and based on the record currently presented, we adopt Petitioner's definition of the level of ordinary skill in the art. Further, we find that the prior art of record reflects the level of skill in the art at the time of the invention. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). We will make any final determination pertaining to the level of ordinary skill in the art, however, on the full trial record.

C. Claim Construction

In an *inter partes* review filed on or after November 13, 2018, we construe claims "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b) (2019); *see Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

Petitioner does not propose any claim construction and asserts all claim terms should be accorded their plain and ordinary meaning. Pet. 20 (citing Ex. 1003 ¶ 211).

Patent Owner requests that we construe the term "in-flight." Prelim. Resp. 14. Patent Owner argues that "in-flight" describes "reacting bromine and activated carbon on-site in the gas transport system at a power plant" and not "pre-treating sorbents before using them at a power plant." *Id.*; *see also id.* at 19 ("an 'in-flight' reaction . . . require[s] a reaction on-site within the gas transport system at a power plant, not pre-treatment of sorbents.").

Patent Owner argues that the claims themselves, the specification, and the prosecution history of the '147 patent each support its proposed construction. *Id.* at 15–19. Patent Owner argues that disclaimed "[i]ndependent claim 1 broadly covers both pre-treatment and 'in-flight' treatment. Claim 17's use of the phrase 'in-flight' indicates that the phrase is intended to narrow the claim scope, not to be mere surplusage." *Id.* at 18. According to Patent Owner, claim 17 requires an in-flight reaction in a gas stream. *Id.*

Patent Owner further argues the '147 patent specification describes alternate methods for reacting bromine with activated carbon including "(1) pre-treatment of activated carbon sorbent with bromine promoter in a separate treatment vessel (Ex. 1001 at 14:40-64); and (2) 'in-flight' treatment of activated carbon sorbent with bromine promoter within the gas transport system at a coal-fired power plant (Ex. 1001 at 12:45-57)." *Id.* at 15. Patent Owner argues that Figure 3 illustrates "in-flight" treatment where bromine and carbon are provided into a transport gas connected to the combustion chamber flue gas line and thus react "in-flight." *Id.* at 15–16.

Patent Owner further contends that U.S. Provisional Application No. 60/605,640 ("the '640 provisional") supports its construction of "in-flight" and describes "in-flight" treatment in Figure 2, reproduced below. Ex. 1020, 16.

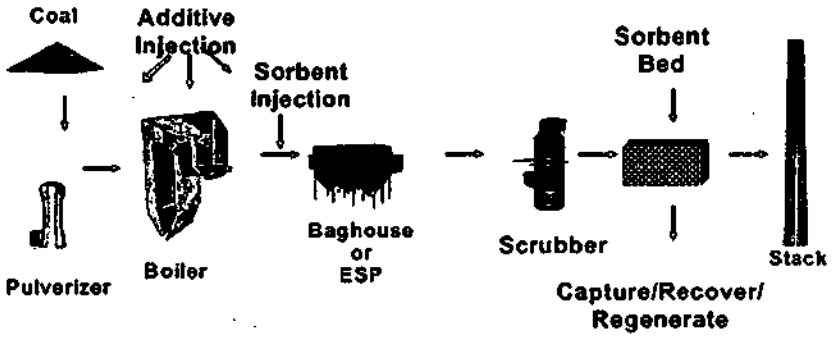


FIG. 2

Figure 2 is a block diagram of a sorbent injection process in a coal fueled facility. *Id.* at 15. Patent Owner argues that "[t]he provisional contrasts the disclosed in-flight treatment [described in Figure 2] with the pre-treatment process described in Nelson: '**[t]he Nelson method** lacks many of the features described in this application that impart exceptional activity to the sorbent in a convenient way, for example, . . . **the use of in-flight bromine treatment.**'"[7] Prelim. Resp. 17 (citing Ex. 1020, 12–13).[8]

Patent Owner additionally asserts that the prosecution history of the '114 patent provides support for its construction of "in-flight." *Id.* (citing Ex. 2028, 1696). Patent Owner explains that the '114 patent applicant successfully overcame a rejection over Nelson by contrasting its "in-flight"

[7] The provisional application cites the published application of Nelson, i.e., US 2004/0003716 A1, published January 8, 2004.
[8] Certain exhibits (*see e.g.*, Ex. 1019, 1020, and 2024) contain multiple documents within a single exhibit. For consistency, we cite to the exhibit page number as opposed to the individual document page number.

treatment with that of Nelson's pre-treatment method by stating that "Nelson did not recommend or teach adding chemicals to the flue gas or in-flight mixing of Br2 and HBr with sorbents. Quite the contrary, he recommended that the bromine be contacted with the sorbent outside the presence of boiler gases . . . ." *Id.* (citing Ex. 2028, 1814); *see also id.* at 17–18 (citing Ex. 2028, 1927–1928 (the Examiner explaining that "in-flight promotion . . . is more effective for mercury removal," "the Nelson reference seems to teach away from inflight promotion," and "one having ordinary skill in the art would not have looked to in-flight promotion" methods).

Petitioner replies that "[t]he plain language is not limited to a 'power plant,' and could include other '[m]ercury removal applications' such as 'waste incineration.'" Pet. Reply 10 (citing Ex. 1001, 1:50–55). Petitioner also contends that the claim language is not "limited to onsite in a transport system, as opposed to promoting sorbent offsite by suspending it on 'glass wool' or in a 'fluidized bed' reactor.'" *Id.* (citing Ex. 1001, 9:61–64, 15:63–16:50; Pet. 53). However, Petitioner asserts that "Grounds 1–4 apply even under Patent Owner's erroneous construction." *Id.*

After considering the parties' initial arguments and additional arguments on claim construction, we determine that a modified version of Patent Owner's proposed construction of "in-flight" is consistent with the claim language, the specification, and prosecution history of the '147 patent. We agree with Petitioner, however, that the claims are not limited to a "power plant" and may include other applications taught by the '147 patent. Pet. Reply 10; Ex. 1001, 1:50–55. Patent Owner fails to direct our attention any disclosure in the '147 patent or understanding in the art that would limit "in-flight" to use in a "power plant." *See generally* Sur-reply 9–10.

Accordingly, we determine that the term "in-flight" should be construed to mean "reacting bromine and activated carbon on-site in the gas transport system and within the transport line."

Claim terms generally should be given their ordinary and customary meaning, except "1) when a patentee sets out a definition and acts as his own lexicographer, or 2) when the patentee disavows the full scope of a claim term either in the specification or during prosecution." *Thorner v. Sony Computer Entm't Am. LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012). "To act as its own lexicographer, a patentee must 'clearly set forth a definition of the disputed claim term' other than its plain and ordinary meaning." *Id.* (quoting *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002)). Patent Owner asserts that "the inventors coined the term 'in-flight' to distinguish pre-treated sorbents." Prelim. Resp. 16. Though Petitioner asserts all claims should be given their plain and ordinary meaning, Petitioner does not explain what the ordinarily skilled artisan would understand the term "in-flight" to mean. Pet. 20; Pet. Reply 10 (arguing that Patent Owner is relying on an "exemplary process" as opposed to acting as his own lexicographer).

Based on our review of the record evidence, we are persuaded that '147 patentee acted as his own lexicographer. The '147 patent describes "in-flight" sorbent preparation as being accomplished by:

> 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.

Ex. 1001, 12:45–57 (emphasis added). The '147 patentee repeatedly explains that an "in-flight" promoted sorbent is prepared "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." Ex. 1001, 4:19–23 (emphasis added); *see also id.* at 4:30–35 (same), 4:55–59 (same); 12:62–65 ("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)"). Further, the '147 patent contrasts other preparation methods with its preferred "in-flight" method and states that

> [t]he 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.

Id. at 9:51–56. The '147 patent further explains that "'[i]n flight preparation of the halogen/halide promoted sorbent *on location* produces certain advantages," including, *inter alia*, the elimination of equipment and operation costs at the treatment facility, the method uses existing hardware, maintaining sorbent freshness, eliminating transport and handling concerns, and "allow[ing for] rapid *on-site* tailoring of additive-sorbent ratios. *Id.* at 12:59–13:19 (identifying the benefits "in-flight" methods performed at the "end-use site" "over current conventional concepts for treating sorbents off-site.").

Accordingly, we determine the term "in-flight" should be construed to mean "reacting bromine and activated carbon on-site in the gas transport system and within the transport line." We note that this construction excludes the introduction of pre-treated sorbents in the transport line.

D. Discretion to Deny Institution

1. 35 U.S.C. § 325(d)

Patent Owner argues that we should exercise our discretion to deny all of the asserted grounds under 35 U.S.C. § 325(d) because they present substantially the same prior art and arguments the Office previously considered during prosecution. *See* Prelim. Resp. 4–9.

Section 325(d) provides that in determining whether to institute an *inter partes* review, "the Director may take into account whether, and reject the petition or request because, the same or substantially the same prior art or arguments previously were presented to the Office." The Board uses a two-part framework in determining whether to exercise its discretion under § 325(d), specifically:

> (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of the first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.

Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GmbH, IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020) (precedential).

In applying the two-part framework, we consider several non-exclusive factors, including: (a) the similarities and material differences between the asserted art and the prior art involved during examination; (b) the cumulative nature of the asserted art and the prior art evaluated during

examination; (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection; (d) the extent of the overlap between the arguments made during examination and the manner in which Petitioner relies on the prior art or Patent Owner distinguishes the prior art; (e) whether Petitioner has pointed out sufficiently how the Examiner erred in its evaluation of the asserted prior art; and (f) the extent to which additional evidence and facts presented in the Petition warrant reconsideration of the prior art or arguments. *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (precedential as to § III.C.5, first paragraph). *Becton, Dickinson* factors (a), (b), and (d) relate to part (1) of the *Advanced Bionics* framework and factors (c), (e), and (f) relate to part (2). Therefore, if after review of factors (a), (b), and (d), we determine that the same or substantially the same art or arguments previously were presented to the Office, then we consider factors (c), (e), and (f) to determine whether petitioner demonstrates that the Office erred in a manner material to the patentability of the challenged claims. *Advanced Bionics*, Paper 6 at 10.

a) Advanced Bionics Framework Part (1)

For part (1) of the *Advanced Bionics* framework (and factors (a), (b), and (d) of *Becton, Dickinson*), Patent Owner argues that the Examiner considered Nelson in "initially reject[ing]" but ultimately allowing a claim similar to claim 17 during the prosecution of the '114 patent. Prelim. Resp. 4 (citing Ex. 2028, 1645). Patent Owner contends that the Examiner's arguments in the '114 patent are "nearly identical to Petitioner['s] current proposal of combining Nelson with Lissianski-Patent." *Id.* at 5. And, that "the same examiner that examined the '147 [patent] claims also determined

that similar claims were distinguishable over Nelson, and Nelson combined with a reference similar to Lissianski-Patent." *Id.* at 8.

Nelson was before the Office during the prosecution of the '114 patent but *not the prosecution of the '147 patent*; the '147 patent issued six years prior to the filing of the '114 patent. Moreover, as Petitioner explains, the '114 patent claims and the '147 "patent claims differ significantly." Pet. Reply 1 ("The '114 Patent claims were amended to recite bromine containing promoter 'added to the coal upstream of the combustion chamber' whereas claims 18–19 of the '147 Patent require the promoter to be added downstream of the combustion chamber (e.g., in mercury-containing gas.").

Further, it does not appear that the same or substantially the same arguments predicated on Nelson were before the Office. Specifically, the Examiner during the '114 patent prosecution determined that the combination of Felsvang, describing each limitation of then pending claim 2 except for the use of bromine, and Nelson, disclosing a bromine promoter, would not have been obvious because objective evidence of nonobviousness established that bromine was more effective than chlorine. Ex. 2028, 1927–1928. The Examiner further determined that Nelson did not suggest an in-flight promotion with bromine. *Id.* In contrast, Petitioner here contends that Lissianski provides the combination of bromine introduced into a gas stream and an in-flight reaction—unlike Felsvang—and relies on Nelson to describe injection of a sorbent material including graphene sheets having carbene species edge sites. Pet. 69–77.

Thus, Part (1) of the *Advanced Bionics* framework is not met as to the Petitioner's combination including Lissianski and Nelson as the prior art

combination considered by the Examiner during the '114 patent prosecution was different and applied in a different manner. Moreover, neither Downs-Halogenation nor Olson-Paper are alleged to have been before the Office. *See generally* Pet. 10–12; Prelim. Resp. 4–8.

It appears, however, that an earlier publication of Nelson (Ex. 1013, "Nelson-Publication") was before the Office during the prosecution of the '147 patent. Pet. 11. Therefore, we review Part (2) of the framework with respect to the Nelson Publication.

b) Advanced Bionics Framework Part (2)

For part (2) of the *Advanced Bionics* framework (and factors (c), (e), (f) of *Becton, Dickinson*), Petitioner argues that, following the Examiner's rejection based on Nelson-Publication, "applicants amended the sole independent claim to require: 'activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted-brominated sorbent for oxidation of the mercury.'" Pet. 11 (citing Ex. 1019, 322, 466–72). Petitioner contends that Olson-Paper, which was not before the Examiner and is used in combination with Nelson-Publication in each ground in the Petition, "discloses the specific sorbent in all primary references (activated carbon). Olson-Paper even discloses that the ***specific brand*** of sorbent in Nelson—Norit Darco FGD—contains 'carbene structures ... at the edges of the carbon graphene layers.'" *Id.* at 12. Petitioner also contends, "the Examiner should not have allowed the claims because 'a newly-discovered property of the prior art cannot support a patent' merely because 'the patentee explicitly claims that property.'" *Id.*

at 11 (citing *Abbott Labs. v. Baxter Pharm. Prod., Inc.*, 471 F.3d 1363, 1368 (Fed. Cir. 2006)).

Patent Owner argues that "Petitioners fail to identify any error in the examiner's conduct described above," and therefore have failed to demonstrate that institution is warranted with respect to Nelson or Nelson in combination with Lissianski. Prelim. Resp. at 8–9.

We find that Petitioner has sufficiently shown that the Examiner erred in a manner material to the patentability of the claims by failing to recognize that the sorbent used in Nelson-Publication contains the claimed graphene sheets having carbine species at the edge sites. Ex. 1079, 979; *see also* Ex. 1013 ¶¶ 76, 80, 83, 91, Fig 12. The Examiner's finding that Nelson-Publication failed to teach "activated carbon contain[ing] graphe[n]e sheets having carbine species edge sites" was a basis for the Examiner's reason for allowance. Ex. 1019, 471 (Notice of Allowability); *see Advanced Bionics*, Paper 6, 8 n.9 ("An example of a material error may be misapprehending or overlooking specific teachings of the relevant prior art where those teachings impact patentability of the challenged claims.").

For these reasons, and considering the *Advanced Bionics* framework as applied to the various references before us, we decline to exercise our discretion under § 325(d) to deny institution.

Although we have preliminarily analyzed Nelson, and determined (below) that challenged Ground 1 based on Nelson and Olson—without Lissianski—does not provide a basis for obviousness against the challenged claims, this preliminary determination does not conflict with our Part (2) determination that the Examiner erred in not considering Nelson-Publication in a manner potentially material to the patentability of the challenged claims.

2. 35 U.S.C. § 314(a)

Under § 314(a), we have discretion to deny institution of an *inter partes* review. *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016); *SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1356 (2018); *Harmonic Inc.*, 815 F.3d at 1367 ("[T]he PTO is permitted, but never compelled, to institute an IPR proceeding."); *see also* 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director."). In deciding whether to institute an *inter partes* review, we consider the guidance provided in the Consolidated Trial Practice Guide, which states

> Based on the Board's prior experience, one petition should be sufficient to challenge the claims of a patent in most situations. Two or more petitions filed against the same patent at or about the same time . . . may place a substantial and unnecessary burden on the Board and the patent owner and could raise fairness, timing, and efficiency concerns.

Patent Trial and Appeal Board Consolidated Trial Practice Guide ("Consolidated TPG") 64 (Nov. 2019), https://www.uspto.gov/sites/default/files/documents/ tpgnov.pdf, 59.

Here, Petitioner filed two petitions on the same day, one challenging claims 17–20 and the other challenging claims 18 and 19 of the '147 patent. In this Petition, Petitioner presents four obviousness grounds, two based on Nelson as the main reference and two based on Downs-Halogenation as the main reference. Pet. 10. In IPR2020-00928, Petitioner presents two obviousness challenges, the first based on Lissianski-Presentation and

Olson-646 and the second based on Sjostrom[9] and Olson-646.[10] IPR2020-00928, Paper 3, 10.

Petitioner "request[s] that the Board institute on both petitions" but explains that two petitions are warranted because the two petitions assert different priority dates and assert different references, citing the Consolidated Trial Practice Guide's statement that "more than one petition may be necessary . . . when there is a dispute about priority date requiring arguments under multiple prior art references." Paper 3 (Petitioner's Explanation Regarding the Necessity of Multiple Petitions, "Explanation") (citing Consolidated TPG 59). According to Petitioner,

> Petitioners expect Patent Owner to argue that all the claims of the '147 Patent can trace priority back to a provisional application filed August 30, 2004, while Petitioners dispute this. Petitioners assert that two of the claims—Claims 18 and 19—have no support in the Provisional or intervening applications, and thus the earliest priority date for these two claims is the filing date of what became the '147 Patent, April 9, 2009.

Id. at 1. The Explanation ranks this Petition above the Petition in IPR2020-00928. *Id.* at 2.

Petitioner further argues that the issues presented to the Board by the two Petitions are limited, because the Petition in this proceeding uses two primary references and two secondary references, whereas the Petition in IPR2020-00928 uses two primary references and only one secondary reference. *Id.* at 3. Petitioner also argues that they joined efforts to provide

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[9] S. Sjostrom, *Full Scale Evaluations of Mercury Control Technologies with PRB Coals*, Electric Utilities Environmental Conference (January 2005) (Exhibit 1010, "Sjostrom").

[10] Olson et al., US 2006/0048646 A1, published March 9, 2006 (Exhibit 1014, "Olson-646").

efficiency instead of each party individually filing separate petitions. *Id.* at 4–5.

We find Petitioner's arguments are persuasive. The existence of different priority date arguments and different prior art references in the two petitions invokes the Consolidated Trial Practice Guide statement that "more than one petition may be necessary . . . when there is a dispute about priority date requiring arguments under multiple prior art references." Consolidated TPG 59. Notwithstanding Petitioner's and Patent Owner's post-Petition arguments regarding the similarity of the priority date arguments, the fact remains that the Petitions themselves present different priority date arguments and rely on different prior art references. The Petitions are the documents to which the Patent Owner will be responding in the *inter partes* review proceeding. Moreover, Petitioner ranks this Petition first and, for the reasons discussed below, *inter partes* review will be instituted in this proceeding. We also institute *inter partes* review in IPR2020-00928 for the reasons discussed in that proceeding.

3. 35 U.S.C. § 312(a)(2)

Patent Owner argues that "35 U.S.C. § 312(a)(2) provides that a petition may only be considered if 'the petition identifies all real parties in interest.'" Prelim. Resp. 9. Patent Owner contends that Petitioner lists "dozens of 'potential real parties in interest,' without explanation as to their relationship to petitioners," that this "is not an identification of *all real parties in interest*," and that, if instituted, this proceeding would be under a cloud of uncertainty because the ambiguity in Petitioner's list "will likely lead to confusion and disputes as to which parties are real parties in interest and which are bound by the estoppel provisions of 35 U.S.C. § 315." *Id.*

at 9–10. For instance, Patent Owner asserts that Petitioner identifies various vendors and suppliers as "potential real parties in interest" but states that "[n]one of these companies or any unnamed entity is funding, controlling, or directing, or otherwise has an opportunity to control or direct this Petition or proceeding" and this implies that these entities are not actually real parties in interest. *Id.* at 10. In addition, Patent Owner argues that some entities are identified both as "potential real parties in interest" and "real parties in interest," which creates ambiguity and conflict in the listing of entities. *Id.* at 10–11. For these reasons, Patent Owner contends that "Petitioners have not met their burden of identifying all real parties in interest" and "the Board should deny institution for failure to comply with § 312(a)(2)." *Id.* at 11.

We are not aware of, and Patent Owner does not direct us, to any rule, statute, or case law that prohibits Petitioner from identifying multiple real parties-in-interest or multiple potential real parties-in-interest. Petitioner's identification of about a dozen real parties-in-interest does not appear problematic or overly burdensome. Pet. 1–2. Petitioner's identification of numerous potential real parties-in-interest, albeit unusual, also does not appear problematic. *Id.* at 2–6. To the extent Petitioner has identified an entity as both a real party-in-interest and as a potential real party-in-interest, we interpret that to mean that party is identified as a real party-in-interest. Petitioner's reasons for identifying numerous potential real parties-in-interest reasons appear plausible: Petitioner identifies these parties "out of an abundance of caution" because "they are vendors and suppliers" in the related litigation but have not "agreed to be listed as a real party-in-interest" in this Petition. Pet. 1–6. This provides the Board and Patent Owner notice that other potential entities may be indirectly involved, but also provides

reasons for not committing those parties to the real party-in-interest category. Ordinarily, problems regarding identification of real parties-in-interest arise when a petitioner fails to identify a real party-in-interest. *See, e.g., Ventex Co., Ltd. v. Columbia Sportswear N. Am., Inc.*, IPR2017-00651, Paper 152 (PTAB Jan. 24, 2019) (precedential) (terminating proceeding where Petition failed to name time-barred RPI and privy). Here, the alleged problem is over-identification of potential real parties-in-interest. Without express violation of a known rule, statute, or case law, this does not appear to be a problem warranting a denial on institution of *inter partes* review.

E. *Availability of Prior Art*

Petitioner contends that Nelson, Downs-Halogenation, and Lissianski, each qualify as prior art under 35 U.S.C. §§ 102(b) and (e) (pre-AIA), and Olson-Paper qualifies as prior art under §§ 102(a) and (b), because each reference predates the filing date of the '640 provisional, i.e., August 30, 2004. Pet. 9.[11]

Patent Owner contends that "Petitioners have failed to qualify these references as prior art because the inventors conceived the claimed invention prior to May 6, 2003 and diligently reduced to practice before March 22, 2004." Prelim. Resp. 20. Patent Owner presents evidence in the form of declaration testimony from the named inventors and a "research ideas" file to support its argument that the inventors "conceived of using bromine as the pre-combustion additive" by August 2002. *Id.* at 23–25, 26 (citing

[11] Petitioner also contends "[e]ach reference is also prior art under §102 (b) (pre-AIA) with respect to claims 18–19 [because e]ach was patented and/or described in a printed publication or otherwise available to the public, including more than one year before the effective filing date of claims 18–19 of the '147 Patent (April 2009)." Pet. 9.

Ex. 2024[12] (Pavlish Decl.) 4–8, 13–30; Ex. 2007; Ex. 2008; Ex. 2010). Patent Owner presents further evidence in the form of "meeting presentations, testing logbooks, and post-testing reports" to support its argument that the inventors reduced the invention to practice "through pilot scale testing conducted in September 2003, December 2003, and February 2004." *Id.* at 23, 32 (citing Ex. 2024; Exs. 2011–2014; Ex. 1016). Patent Owner argues that the relevant period for establishing diligence "is from May 5, 2003 to September 2003" and that "[t]his is an entirely reasonable amount of time for the inventors to have designed, developed, and performed the necessary testing to optimize their new approach to mercury capture." *Id.* at 39–40.

Petitioner disputes Patent Owner's assertion of an earlier actual reduction to practice. Pet. Reply. 2–10. Petitioner argues that "Patent Owner fails to demonstrate conception or provide 'independent evidence corroborating the inventor's testimony.'" *Id.* at 3. Petitioner criticizes Patent Owner's evidence as "a hodgepodge of 'research ideas' from anonymous authors that Dr. Pavlish 'had compiled' from the CATM research center" that "leave[] it to the Board to decipher conception evidence from Exhibit 2024, which does not identify ***any*** authors, much less the named inventors." *Id.* at 3–4. Petitioner asserts that "[n]owhere does the [Patent Owner Preliminary Response] include a claim chart, or any other

[12] Exhibit 2024 comprises three separate declarations—the declaration testimony of John Pavlish ("the Pavlish Decl."), Edwin S. Olson ("the Olson Decl."), and Michael J. Holmes ("the Holmes Decl."). *See* Ex. 2024, 1, 32, 34. The Olson and Holmes declarations "confirm" the accuracy of the testimony provided in the Pavlish declaration. *Id.* at 33, 35. Exhibit 24 additionally includes a claim chart detailing Patent Owner's evidence of reduction to practice. *Id.* at 36.

evidence, showing conception of ***each*** element of claims 1 and 17–20 of the '147 patent" nor has Patent Owner explained how the remaining evidence, including the Department of Energy ("DOE") reports "disclose every feature of the subject matter sought to be patented." *Id.* at 4–5 (citing *Unified Patents, LLC v. Lighthouse Consulting Grp. LLC*, IPR2020-00194, 2020 WL 3065760, at *12 (P.T.A.B. June 9, 2020); *Burroughs Wellcome Co. v. Barr Labs*, 40 F.3d 1223, 1228 (Fed. Cir. 1994) (requiring "every feature of [the] claimed invention"). Petitioner argues that Patent Owner has "fail[ed] to chart numerous claim limitations" including the "carbene species edge sites" or "a bromine-containing promoter that is 'gas, vapor, or non-aqueous.'" *Id.* at 7. Petitioner presents detailed arguments against Patent Owner's conception evidence (*id.* at 3–5), reduction to practice evidence (*id.* at 5–8), and diligence evidence (*id.* at 9–10). Petitioner argues that trial should be instituted so it may depose Patent Owner's declarants and "explore the deficiencies in Patent Owner's evidence." *Id.* at 3.

Patent Owner replies that Petitioner misunderstands the "rule of reason" for a conception date. Sur-reply 2. Patent Owner also replies that Petitioner failed to show that the inventors' asserted reduction to practice date lacks credibility. *Id.* at 4–6. Patent Owner contends that Petitioner has not shown that any non-obvious limitations are missing from the evidence establishing reduction to practice. *Id.* at 7. Finally, Patent Owner argues that Petitioner failed to show that the inventors lacked diligence. *Id.* at 8–9.

To remove a patent as a prior art reference, the record must establish either (1) a conception and reduction to practice before the filing date of the patent or (2) a conception before the filing date of the patent combined with

diligence and reduction to practice after that date. *See Taurus IP, LLC v. DaimlerChrysler Corp.*, 726 F.3d 1306, 1323 (Fed. Cir. 2013).

"Conception exists when a definite and permanent idea of an operative invention, including every feature of the subject matter sought to be patented, is known." *Sewall v. Walters*, 21 F.3d 411, 415 (Fed. Cir. 1994). Furthermore, the "conception analysis necessarily turns on the inventor's ability to describe his invention with particularity. Until he can do so, he cannot prove possession of the complete mental picture of the invention." *Burroughs*, 40 F.3d at 1228. Objective evidence that corroborates an inventor's testimony regarding the conception of the invention is required "because of the danger in post-hoc rationales by an inventor claiming priority." *Invitrogen Corp. v. Clontech Labs., Inc.*, 429 F.3d 1052, 1065 (Fed. Cir. 2005). The sufficiency of corroboration is determined according to a "rule of reason." *Price v. Symsek*, 988 F.2d 1187, 1195 (Fed. Cir. 1993). Under the rule of reason, "all pertinent evidence is examined in order to determine whether the inventor's story is credible." *Fleming .v Escort Inc.*, 774 F.3d 1371, 1377 (Fed. Cir. 2014) (quoting *Sandt Tech., Ltd. v. Resco Metal & Plastics Corp.*, 264 F.3d 1344, 1350 (Fed. Cir. 2001)).

To establish an actual reduction to practice, as opposed to the constructive reduction to practice that occurs when a patent application is filed, a party must establish that: (1) the inventor constructed an embodiment or performed a process that satisfies every element of the claim at issue; and (2) the inventor determined that the invention would work for its intended purpose. *E.I. du Pont De Nemours & Co. v. Unifrax I LLC*, 921 F.3d 1060, 1075 (Fed. Cir. 2019). The same requirement for evidence that corroborates

inventor testimony on conception under the rule of reason also applies to the reduction to practice determination. *Id.* at 1076. To demonstrate diligence, a patent owner "must show there was *reasonably continuous* diligence" throughout the critical period. *Perfect Surgical Techniques, Inc. v. Olympus Am., Inc.*, 841 F.3d 1004, 1009 (Fed. Cir. 2016).

Petitioner bears the burden of persuasion that the challenged claims are unpatentable, which includes the burden of establishing that any reference upon which it relies constitutes prior art under 35 U.S.C. § 102. *See* 35 U.S.C. § 316(e); *Mahurkar v. C.R. Bard, Inc.*, 79 F.3d 1572, 1576 (Fed. Cir. 1996) (holding that the challenger "bore the burden of persuasion . . . on all issues relating to the status of [the asserted reference] as prior art"). However, because Petitioner initially offered up the prior art references into evidence, which on their face qualify as prior art, Patent Owner bears the subsequent procedural burden of producing evidence antedating the prior art references. *See Dynamic Drinkware*, 800 F.3d at 1378–80; *Magnum Oil*, 829 F.3d at 1375. Although the burden of production can be a shifting burden, we note that the burden of persuasion is on Petitioner to ultimately prove "unpatentability by a preponderance of the evidence," and that this burden never shifts to Patent Owner. *Dynamic Drinkware*, 800 F.3d at 1378.

Petitioner has come forward with evidence to support its assertion that the prior art references are in fact prior art to the '147 patent. *See* Explanation 2–3. Patent Owner has come forward with evidence and argument that the proffered prior art references are not prior art, due to the asserted prior conception, reduction to practice, and diligence on the part of the inventors. *See* Prelim. Resp. 19–40; Sur-reply 2–9. However, on this

record and at this preliminary stage, we are not persuaded that the evidence and arguments before us are sufficient to show the asserted conception date, reduction to practice date(s), or diligence. Most importantly, Patent Owner does not explain in sufficient detail how the proffered testimony and documents disclose *every feature* of the subject matter challenged. It is also unclear, without further explanation, what the documents purporting to show conception and reduction to practice actually demonstrate, and how they are related specifically to the limitations of the challenged claims.

Accordingly, based on the preliminary record, we determine that, for purposes of this Decision, Nelson, Olson-Paper[13], Lissianski, and Downs-Halogenation constitute prior art under 35 U.S.C. § 102, and, as such, it is proper to rely on them in the grounds presented under 35 U.S.C. § 103. The parties may further address this issue in post-institution briefing.

F. Priority Date for the '147 Patent

Petitioner explains that "[t]he current petition assumes *arguendo* that the Challenged Claims of the '147 Patent have priority to August 30, 2004." Pet. 7. Petitioner explains that the instant petition differs from the second petition, i.e., IPR 2020-00928, in that the second petition asserts a different priority date of April 2009 for claims 18 and 19 of the '147 patent. *Id.* at 7–9. Therefore, each reference in the instant petition is prior art under 35 U.S.C. § 102(e) and "is also prior art under § 102(b) (pre-AIA) with respect to claims 18–19. Each was patented and/or described in a printed publication or otherwise available to the public, including more than one

[13] Patent Owner does not appear to assert that Olson-Paper fails to qualify as prior art. *See generally* Prelim. Resp. 19–39; *see also* Pet. Reply 2 (noting that "Patent Owner does not dispute the prior-art status of Olson-Paper").

year before the effective filing date of claims 18–19 of the '147 Patent (April 2009)." *Id.* at 9.

Patent Owner asserts that "Petitioners attempt to justify filing multiple petitions against this patent by arguing that they will only challenge the priority date of the '147 claims in IPR2020-00928. However, Petitioners made the same representation in related proceedings (IPR2020-00834) and have reversed course." Prelim. Resp. 43–44. Therefore, Patent Owner "copies" its arguments from IPR2020-00928 and presents them here. Specifically, Patent Owner alleges that claims 18 and 19 of the '147 patent are entitled to the earliest priority date, that is, the priority date of the '640 provisional application, August 30, 2004. *Id.* at 49–50.

Petitioner, in reply, likewise copies its arguments from IPR2020-00928 and asserts that claims 18 and 19 are not entitled to the priority date of the '640 provisional application because priority has been broken, the incorporated material has not been specified, and that "'essential material' cannot be incorporated [by reference] from a provisional application." Pet. Reply. 11–12. Petitioner also contends that even if the '640 provisional application can be considered, its written description fails to provide the requisite support for claims 18 and 19. *Id.* at 12–14. Similarly, Petitioner urges that intervening applications, i.e., the '163 and '595 applications fail to teach injecting the sorbent material separate from the bromine promoter and injecting the bromine promoter into a mercury containing gas stream. *Id.* at 14–15.

Patent Owner asserts that Petitioner's position is based on a continued misinterpretation of the '640 provisional application and in particular example 9. Sur-reply 11. Patent Owner further maintains that claims 18 and

19 are supported by the intervening '163 and '595 applications. *Id.* at 13–15.

This Petition does not raise the same priority date issues presented in IPR2020-00928, because the prior art here predates the presumed priority date based on the '640 provisional application filing date of August 30, 2004. Explanation 2; Pet. 9. But, Patent Owner in this case raises priority arguments by referring to the arguments raised in the IPR2020-00928 and IPR2020-00832 Petitions and invites us to consider the arguments raised and evidence presented in IPR2020-00928. Prelim. Resp. 43–60. In the IPR2020-00928 Institution Decision, we analyze this priority date issue in depth based on the parties' arguments and evidence and determine that, at this stage of the proceedings, the priority date for claims 18 and 19 is no earlier than April 6, 2009, i.e., the filing date for the '147 patent. We are aware of the potential problems that could arise if we ignore or fail to address a priority date issue in this case, when the same potentially dispositive issue has been raised and analyzed in IPR2020-00928 concerning the same patent and the same priority date evidence. Petitioner elected to take two different priority date approaches in the Petitions in IPR2020-00926 and IPR2020-00928, for the purposes of qualifying each petition for separate institution. Explanation, 1–2. This drafting choice results in two Petitions that ostensibly present different sets of evidence, but that may end up turning on the same priority date issue raised in IPR2020-00928. The conception, reduction to practice, and diligence issues raised here, however, distinguish this case sufficiently that our reasoning for granting institution in both petitions, as further explained below, is unchanged.

G. Alleged Obviousness over Nelson and Olson-Paper (claims 17 and 20)

Petitioner contends claims 17 and 20 are rendered obvious over the combination of Nelson and Olson-Paper. Pet. 20–57. Petitioner also relies on the testimony of Dr. Niksa to support its arguments. *Id.*

1. Nelson (Ex. 1012)

Nelson relates to preparing a mercury sorbent "by treating a carbonaceous substrate with an effective amount of a bromine-containing gas for a sufficient time to increase the ability of the carbonaceous substrate to adsorb mercury and mercury-containing compounds." Ex. 1012, 4:58–63. Nelson discloses "that the simple act of exposing a carbonaceous material, preferably powdered activated carbon (PAC), to gaseous bromine, $Br_2(g)$, or to gaseous hydrogen bromide, HBr(g), significantly increases the carbonaceous material's ability to remove mercury species when injected into high-temperature coal-fired flue-gas compositions." *Id.* at 6:10–15. Nelson discloses that

> [t]he carbon material and the bromine gas need simply be contacted with each other for the advantageous mercury-reactive surface compounds to quickly form. . . . Using a gas-phase carbon reactant considerably simplifies the production of the sorbent and leads to the low costs which are a requirement for a sorbent to be used as a once-through duct injectant. . . . It is also preferable that the mixing of bromine gas and carbon be done at an elevated temperature. This keeps the bromine gas in the gaseous form, but also minimizes the amount of any bromine physically-adsorbed into the pores of the carbon.

Id. at 6:42–64.

Nelson's manufacturing process for a mercury sorbent is depicted below in Figure 1.

Figure 1.

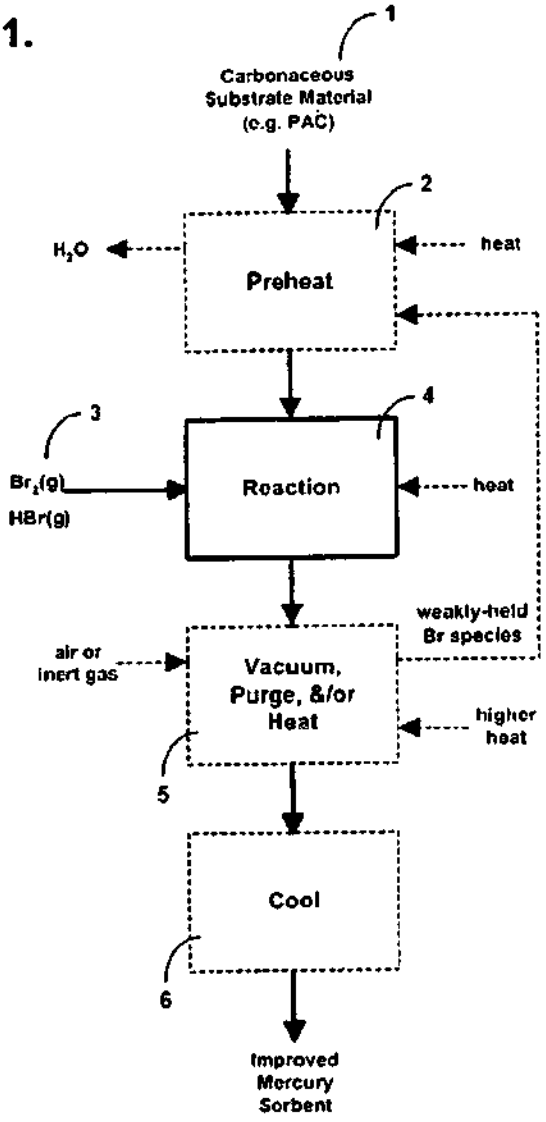


Figure 1 is "block diagram of the process for manufacturing the improved mercury sorbent compositions." *Id.* at 5:29–30. Figure 1 depicts "activated carbon entering the treatment process at 1." *Id.* at 7:29–31. The activated carbon is preheated at 2 and enters a reaction chamber where gaseous bromine 3 is introduced at 4. *Id.* at 7:37–8:14. Nelson discloses that "the size of the carbonaceous particles during bromination . . . can be fine enough [to] be mixed with and carried by the mercury-containing flue-gas stream, or

it can be large and granular, to be comminuted after bromination, but prior to being injected into the mercury-containing gas stream." *Id.* at 7:16–23. Nelson describes preferred powdered activated carbons ("PACs") as including Norit's Darco FGD®. *Id.* at 11:10–20.

Nelson discloses that "[i]n some applications it may be beneficial to utilize a diluting carrier gas to better distribute the $Br_2(g)$ or HBr(g) among the carbonaceous substrate particles." *Id.* at 7:64–66. According to Nelson,

> [t]he key step in the sorbent manufacturing process is exposing the dried carbonaceous materials to the bromine containing gas, 4. . . . [P]referably this is done with the carbonaceous materials at a temperature at or above about 150° C., or above the temperature of the mercury-containing flue-gas stream into which the sorbents will be injected.

Id. at 8:8–21. Nelson also discloses that

> [w]hile over 30 wt % of $Br_2(g)$ can be adsorbed into some powdered activated carbons, for example, significant increases in mercury reactivity will be observed with only about 1 wt % $Br_2(g)$ in the PAC. Greater degrees of bromination do correlate with greater maximum mercury capacities for a particular carbonaceous substrate. . . . If a PAC substrate is used, brominating to 1 wt % provides a highly-capable mercury sorbent, although a 5 wt % material performs better and may be preferable.

Id. at 8:35–56.

Figure 2 depicts injecting the mercury sorbent into hot combustion flue gas as reproduced below. *Id.* at 9:30–35.

Figure 2.

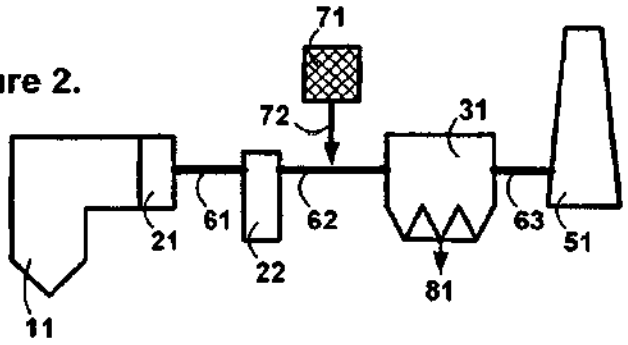


Figure 2 is a schematic diagram of an exhaust gas system "describing example methods for using the improved sorbent compositions to remove and isolate mercury species from hot combustion flue gases." *Id.* at 5:30–34. Nelson discloses that "the mercury sorbent of this invention, stored in a container such as a bin 71, is fed to and through an injection line 72 to the ductwork 62 and injected through a multitude of lances to be widely dispersed in the hot combustion flue gas." *Id.* at 9:31–35.

2. Olson-Paper (Ex. 1079)

Olson-Paper relates chemisorption mechanisms in mercury emission control technologies. Ex. 1079, 19. Olson-Paper discloses mechanisms of mercury-flue gas-sorbent interactions from activated carbon sorbents, including Norit FGD. *Id.* at 21. Olson-Paper depicts a mechanistic model for Hg^0 oxidation and binding in Figure 2, reproduced below.

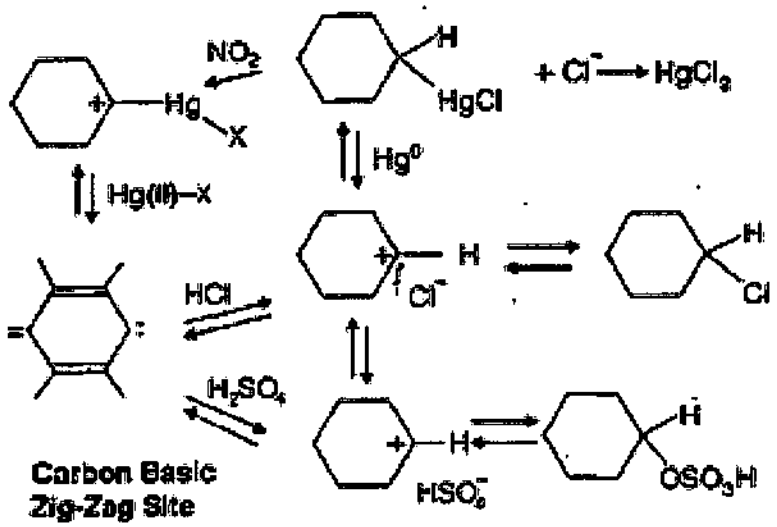


Figure 2 depicts a reaction site model for activated carbon. *Id.* at 22. The model "uses the concept of zig-zag carbene structures recently proposed for electronic states at the edges of the carbon graphene layers. In the edge carbene model of Hg capture, the zig-zag carbon atom positioned between aromatic rings is hypothesized to be a Lewis base site." *Id.*

3. Analysis of claim 17

Although claim 1 is disclaimed, claim 17 depends from and includes the limitations of claim 1. Ex. 1001, 24:34–41. Accordingly, we review Petitioner's contentions as to claim 1, followed by the additional limitations of claim 17.

Petitioner contends that Nelson discloses a method for separating mercury from a mercury containing gas by promoting an activated carbon particulate sorbent material by chemically reacting activated carbon with gaseous or liquid bromine to form a promoted brominated sorbent. *See* Pet. 30–34 (citing Ex. 1012, 2:36–37, 4:58–63, 5:63–6:37, 7:4–36, 7:45–51). Petitioner explains that Nelson describes the particulate sorbent as Norit

Darco FGD® powdered-activated carbon. *Id.* at 31 (citing Ex. 1012, 11:11–20; Ex. 1003 ¶¶ 297–300).

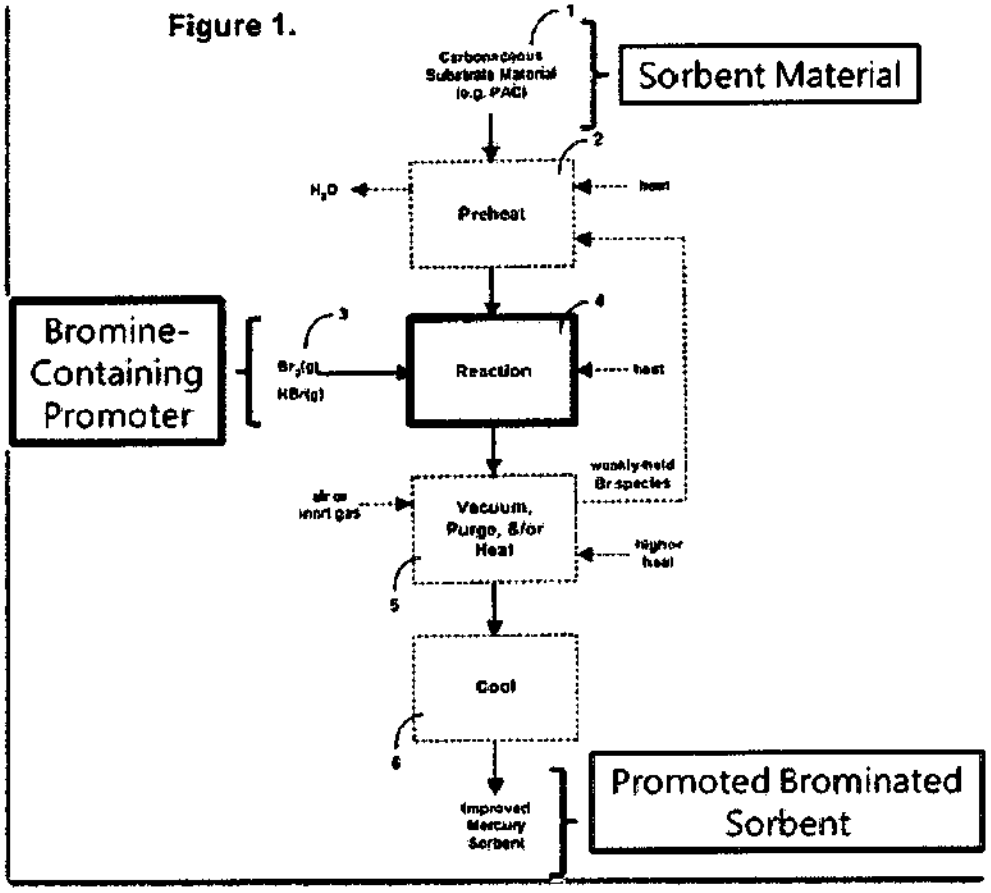
Petitioner contends that Olson-Paper discloses the limitation "wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury." *Id.* at 34. Specifically, Petitioner contends that Olson-Paper "describes that activated carbon—particularly the Norit Darco FGD® of Nelson—contains graphene sheets having "a zig-zag *carbene site* on the *carbon edge*." *Id.* (citing Ex. 1079, 979, 982). Petitioner further contends that Olson-Paper discloses that "[t]he basic carbene cannot react directly with [elemental mercury] Hg^0, but reacts with HCl *to form stable carbenium ion intermediates*, which are then active for binding Hg^0, accepting electrons from the atom (Figure 2). Thus *HCl or other acids promote the oxidation step*." *Id.* at 36 (quoting Ex. 1079, 982). Petitioner contends that although Olson-Paper "identifies hydrochloric acid (HCl) and chloride anions (Cl^-), a POSITA would have applied the same mechanism for a bromine-containing promoter (e.g., HBr)," as taught by Nelson. *Id.* at 37–38.

Petitioner contends that both Nelson and Olson-Paper disclose chemically reacting elemental mercury with the promoted brominated sorbent to form a mercury/sorbent composition, i.e., claim 1, step (b). *Id.* at 39–40 (citing Ex. 1012, 6:26–34, Figure 12; Ex. 1079, 982; Ex. 1003 ¶¶ 321–323).

Petitioner contends that Nelson "discloses separating mercury/sorbent particulates from the mercury containing gas 'along with the fly ash,' using a

'particulate collector' such as an 'electrostatic precipitator (ESP) or fabric filter,'" i.e., claim 1, step (c). *Id.* at 41–42 (citing Ex. 1012, 6:1–4, 6:30–41, 9:17–10:67; Ex. 1003 ¶¶ 324–328).

With respect to claim 17, Petitioner contends Nelson discloses: (1) "injecting the particulate sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream," and (2) "whereby in-flight reaction produces the promoted brominated sorbent." *Id.* at 52–53. Petitioner submits annotated Figure 1 of Nelson to support its argument, as reproduced below.



Petitioner's annotated version of Nelson's Figure 1 illustrates "the sorbent (red) and bromine-containing promoter (blue) are injected separately into a

gas stream, in which in-flight reaction (blue) produces promoted-brominated sorbent (purple)." *Id.* at 52. Petitioner contends that a person of ordinary skill in the art "would have understood that for sorbent and promoter to be injected, they must necessarily have been injected at an injection rate," as further illustrated in Nelson's Figure 14. *Id.* Petitioner contends that Nelson's "[b]romine-containing promoter and sorbent react inflight in a gas-phase, such as in a 'fluidized-bed unit' or a 'transport reactor.'" *Id.* at 53 (citing Ex. 1012, 8:57–67; Ex. 1003 ¶¶ 359–364). Finally, Petitioner contends that "nothing in claim 17 (or claim 1) of the '147 patent limits the in-flight reaction to one that occurs at the combustion site." *Id.* (citing Ex. 1003 ¶¶ 357–358).

Petitioner contends that Nelson discloses that "the promoter is reacted in the gas phase or as a vapor" because Nelson describes reacting gaseous Br_2(g) and HBr(g) with sorbent in a gas phase. *Id.* at 32–33, 53 (citing Ex. 1012, 2:36–37, 6:26–34, 7:45–51; Ex. 1003 ¶¶ 301–303, 308–309, 365).

Finally, Petitioner contends that Nelson discloses the limitation that "the promoter is added at from about 1 to about 30 grams per 100 grams of the sorbent material," whether the claim is interpreted as a ratio of promoter added to the sorbent or promoter added to the gas stream. *Id.* at 54–55. Specifically, Petitioner contends that "Nelson expressly describes adding promoter *to the sorbent* from about 1–30 grams of sorbent." *Id.* at 54 (citing Ex. 1012, 8:35–42, 11:10–20, 12:9–20, 13:23–26, 14:55–63, 15:35–46; Ex. 1003 ¶ 367). Petitioner contends that although Nelson does not expressly disclose the ratio of promoter added to gas stream, "it would have been obvious, given the highly reactive nature of HBr and Br_2 towards activated carbon, that the gas-phase ratio would have been similar to the

ratio on the sorbent in Nelson." *Id.* at 55 (citing Ex. 1012, 8:9–35; Ex. 1003 ¶¶ 368–369).

Petitioner contends that a person of ordinary skill in the art would have combined Nelson and Olson-Paper "to describe the surface chemistry of the sorbent, [Norit's Darco FGD], in Nelson." *Id.* at 28 (citing Ex. 1003 ¶¶ 290–291). Petitioner contends that a person of ordinary skill in the art would have understood the applicability of Olson's chloride-containing chemical reactions with activated-carbon sorbent to Nelson's bromide-containing chemical reactions with the same sorbent. *Id.* (citing Ex. 1003 ¶¶ 292–294).

Patent Owner, at this time, does not challenge most of Petitioner's allegations regarding the teachings of Nelson and Olson. *See generally* Prelim. Resp. Instead, Patent Owner focuses its argument on Petitioner's purported failure to show an "in-flight reaction [that] produces the promoted brominated sorbent," as claimed. *Id.* at 40–41. At this stage of the proceeding, Petitioner's arguments and evidence are sufficient to suggest each limitation of claim 17 of the '471 patent, except that which Patent Owner disputes. Below we address whether Nelson teaches the requisite "in-flight reaction."

Patent Owner contends that claim 17, correctly interpreted, requires injecting "bromine into a gas stream moving through a power plant's gas transport system, as opposed to gas located in a stationary treatment vessel." *Id.* at 18. Patent Owner disputes Petitioner's argument that "claims 17 and 20 may be met by pre-treating sorbent off-site, as opposed to treating sorbent 'in-flight' within the gas transport system of the power plant." *Id.* at 40.

On this record, Petitioner fails to establish that Nelson suggests an "in-flight" reaction as claimed. As properly construed, and discussed above (*see supra* Section II.C.), claim 17 requires preparing the bromine promoted sorbent by an "in-flight" reaction, that is, "reacting bromine and activated carbon on-site in the gas transport system and within the transport line." Petitioner directs our attention to annotated Figure 1 of Nelson which, according to Petitioner, shows "the sorbent (red) and bromine-containing promoter (blue) . . . injected separately into a gas stream, in which in-flight reaction (blue) produces promoted-brominated sorbent (purple)." Pet 52. Petitioner contends that Nelson describes reacting the bromine promoter and sorbent "in-flight" using a fluidized-bed like the '147 patent. And, Petitioner asserts that "nothing in claim 17 (or claim 1) of the '147 patent limits the in-flight reaction to one that occurs at the combustion site." *Id.* at 53. Each of Petitioner's arguments fails to consider claim 17 in light of the '147 patent specification and reads portions of the specification in isolation. For example, while true that claim 17 requires "injecting separately the bromine containing promoter into a *gas stream*," the inquiry does not end there as Petitioner suggests. Ex. 1001, 24:34–38 (emphasis added). The claim continues "whereby [an] *in-flight* reaction produces the promoted brominated sorbent." *Id.* (emphasis added). An "in-flight" reaction, according to the specification, is not simply injecting the bromine promoter into a gas stream but rather reacting the promoter and activated carbon *on-site in the gas transport system* and *within the transport line.* Figure 1 of Nelson, referenced by Petitioner, depicts injecting both the sorbent material and the bromine containing promoter separately and carrying out the bromination of the activated carbon sorbent in a reactor

vessel. Ex. 1012, 8:9–9:16. The bromine-promoted sorbent is collected in storage bin 71 and fed into mercury containing gas through injection line 72. *Id.* at 9:21–10:67, Figs. 2–6. Therefore, the sorbent in Nelson is premixed and not subject to an "in-flight" reaction within the gas transport system. Petitioner's reliance on the fluidized-bed embodiment of the '147 patent does not persuade us otherwise as that embodiment is described in contrast to "in-flight" methods and details preparing the promoted carbon sorbent in a reservoir separate from the transport line. Ex. 1001, 9:51–64.

Accordingly, we determine that Petitioner fails to demonstrate sufficiently that the combination of Nelson and Olson-Paper teaches or suggests an "in-flight" reaction. Because each challenged claim requires an "in-flight" reaction, we determine that Petitioner fails to show a reasonable likelihood of prevailing on its assertion that claims 17–20 of the '147 patent would have been obvious over Nelson and Olson-Paper.

H. Alleged Obvious over Nelson, Olson-Paper, and Lissianski

Petitioner contends claims 17–20 are rendered obvious over the combination of Nelson, Olson-Paper, and Lissianski. Pet. 59–81. Petitioner also relies on the testimony of Dr. Niksa to support its arguments. *Id.*

1. Lissianski (Ex. 1036)

Lissianski relates to a method for removing mercury emissions from coal combustion flue gas by injecting NH_4Br into the flue gas; oxidizing elemental mercury with a halogen from the injected additive; absorbing the oxidized mercury with an adsorbent in the flue gas; and collecting the adsorbent in a combustion waste treatment system. Ex. 1036, 2:3–13. Lissianski discloses that "[t]he hot flue gas causes the additive to thermally decompose to form HCl, HBr or HI which results in more significant

mercury oxidation. The increase in mercury oxidation allows for improved efficiency of mercury removal by activated carbon (AC) injection." *Id.* at 3:45–49. Lissianski discloses that "[t]he halogen additive can be co-injected with air, recycled flue gas, nitrogen or another carrier gas to increase the penetration of the additive aqueous solution across the flue gas path and to improve mixing of the additive aqueous solution and flue gas." *Id.* at 4:20–23.

Lissianski illustrates the method for removing mercury emissions in a coal plant with a halogen containing additive in Figure 3, reproduced below.

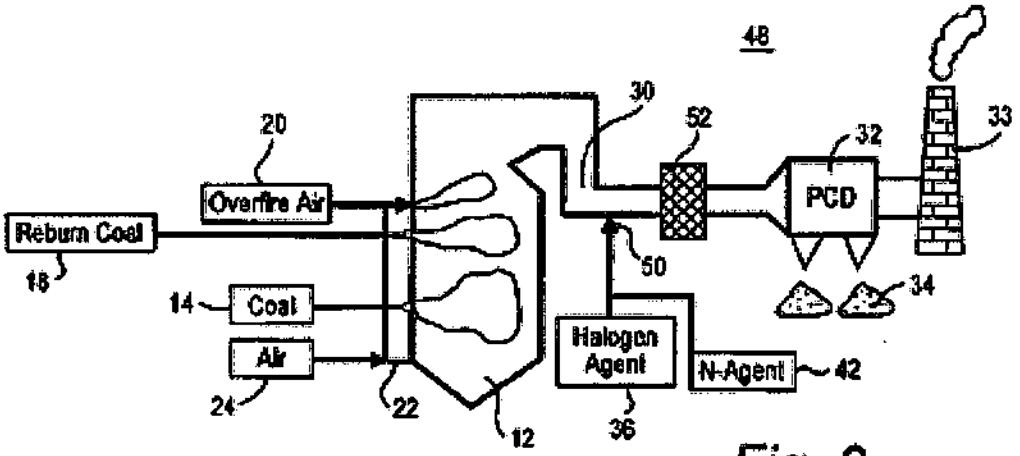


Fig. 3

Figure 3 "is a schematic diagram of coal fired power plant . . . where the additive injector is in a conductive pass of the plant and the conductive pass also includes a Selective Catalytic Reduction ('SCR') unit." *Id.* at 2:61–64. Figure 3 illustrates halogen containing additive 36 injected via nozzles 50 into conductive pass 30 of the boiler and upstream of SCR unit 52 and particulate control device ("PCD") 32. *Id.* at 4:1–5, 4:43–59.

Lissianski discloses that "[m]odeling predicts that injection of chlorine or bromine in the amount of 3 ppm results in mercury oxidation at

higher temperatures. Modeling also predicts that bromine is a more effective oxidizing agent than is chlorine." *Id.* at 6:53–65, Figure 9.

2. Analysis of Claim 17

Petitioner contends that Nelson and Olson-Paper disclose the steps and limitations of claim 1, from which claim 17 depends as outlined above (*supra* Section II.F.3). *See* Pet. 59. Petitioner argues that Lissianski "discloses supplying NH_4Br directly into mercury-containing gas, which thermally decomposes to form HBr and provides the mercury-containing gas (green) with a gas-phase 'Br' concentration of 0.3 or 3 ppm," as illustrated in annotated Figure 3 below. *Id.* at 73 (citing Ex. 1035, 6:63–7:6; Ex. 1003 ¶¶ 408–409).

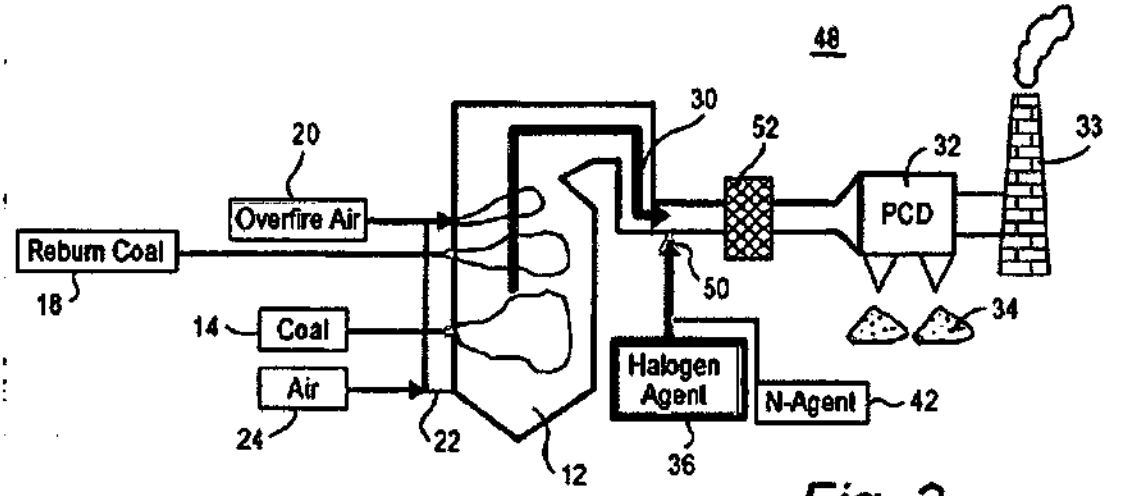
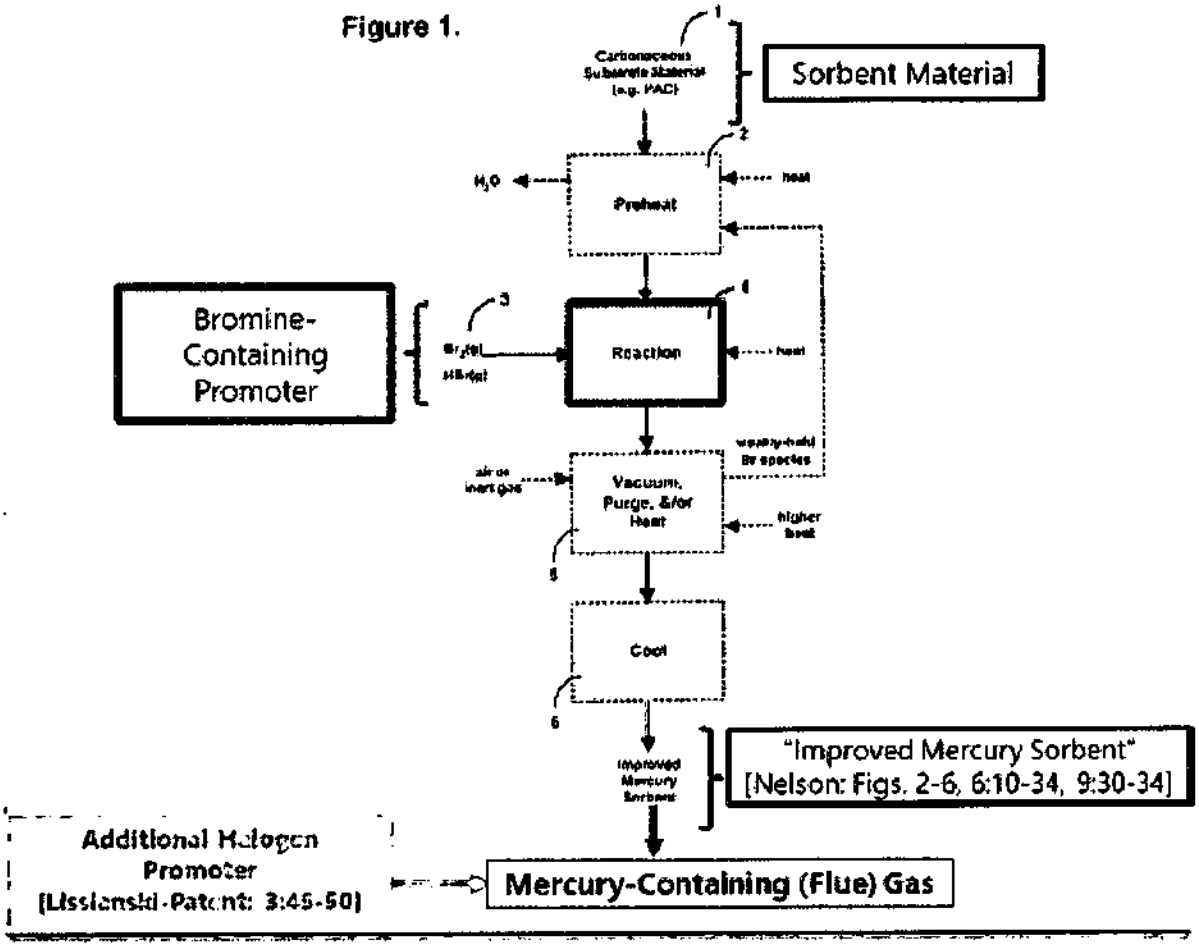


Fig. 3

Petitioner contends a person of ordinary skill in the art would have combined Lissianski's promoter with Nelson's sorbent as illustrated in modified Nelson Figure 1 below. *Id.* at 73–74 (citing Ex. 1003 ¶ 410).



Petitioner's modified Figure 1 shows Nelson's improved mercury sorbent (purple) and the additional halogen promoter of Lissianski (yellow) separately fed into a mercury-containing flue gas (green). Petitioner contends that "[a]n 'in-flight' reaction occurs in mercury-containing gas between the HBr(g) of [Lissianski] and the pre-brominated (partially promoted) sorbent of Nelson." *Id.* at 75. Petitioner contends that "most of the Br-species supplied by [Lissianski] would have been available to react with the pre-brominated sorbent of Nelson (purple), as opposed to being consumed in oxidizing mercury." *Id.* (citing Ex. 1036, 6:33–40, 6:62–67; Ex. 1003 ¶ 412).

Petitioner contends a person of ordinary skill in the art would have been motivated "to combine Nelson and [Olson-Paper] with [Lissianski] to: (i) supply the pre-brominated sorbent of Nelson into mercury-containing flue gas; and (ii) supply the halogen agent of [Lissianski], upstream of the sorbent, into the same mercury-containing flue gas." *Id.* at 61 (citing Ex. 103 ¶¶ 382–391). Petitioner contends that "[c]ombining the pre-brominated sorbent of Nelson (purple) in mercury-containing gas (green) with additional halogen (gold) of [Lissianski] beneficially provides multi-pollutant control, enhancing removal of both NOx and mercury." *Id.* at 65 (citing Ex. 1003, ¶¶ 387–392).

Patent Owner does not dispute Petitioner's allegations regarding the teachings of Nelson, Olson-Paper, and Lissianski. *See generally* Prelim. Resp. Instead, Patent Owner contends that a person of ordinary skill in the art would not have combined Lissianski with Nelson. Prelim. Resp. 41. At this stage of the proceeding, Petitioner's arguments and evidence are sufficient to show that each limitation of claim 17 of the '471 patent is taught or suggested by the combination of Nelson, Olson-Paper, and Lissianski. Below we consider whether Petitioner has demonstrated sufficiently that a person of ordinary skill in the art would have had a reason to combine the teachings of Lissianski and Nelson.

Patent Owner contends that neither of Petitioner's reasons to combine the references, *viz.*, (1) improving mercury capture and (2) NOx reduction, would have motivated a person of ordinary skill in the art. *Id.* First, Patent Owner argues that Nelson teaches bromine species are corrosive and thus a person of ordinary skill in the art would not have added in-flight bromine to a mercury capture process. *See id.* at 6–7 (citing Ex. 2028, 1827–28), 41.

Second, Patent Owner argues that "[i]f a POSITA using Nelson were motivated to further improve NOx reduction, that could be accomplished in the conventional way by injecting NH_3. Petitioners offer no reason other than hindsight for a POSITA to inject NH_4Br instead." *Id.* at 43.

On this record, we are persuaded Petitioner adequately sets forth a reason to combine the teachings of Lissianski and Nelson. Patent Owner's argument that Nelson teaches bromine species are corrosive and therefore, a person skilled in the art would not have had reason to make the proffered combination is unpersuasive. Both Nelson and Lissianski teach using bromine species to improve mercury removal processes. Ex. 1012, 6:4–19; Ex. 1036, 2:1–13, 4:35–45. Though Nelson describes mercury as corrosive, Nelson suggests lining equipment with corrosion-resistant material. Ex. 1012, 52–56. "The fact that the motivating benefit comes at the expense of another benefit, however, should not nullify its use as a basis to modify the disclosure of one reference with the teachings of another. Instead, the benefits, both lost and gained should be weighed against one another." *Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 n.8 (Fed. Cir. 2000).

We are similarly unpersuaded by Patent Owner's hindsight argument. It is improper to base a conclusion of obviousness upon facts gleaned only through hindsight. "The invention must be viewed not after the blueprint has been drawn by the inventor, but as it would have been perceived in the state of the art that existed at the time the invention was made." *Sensonics, Inc. v. Aerosonic Corp.*, 81 F.3d 1566, 1570 (Fed. Cir. 1996) (citing *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1138 (Fed. Cir. 1985)). Therefore, "to establish a *prima facie* case of obviousness based on a

combination of elements disclosed in the prior art, the [Petitioner] must articulate the basis on which it concludes that it would have been obvious to make the claimed invention." *Id.* Impermissible hindsight is inferred when the specific understanding or principle within the knowledge of one of ordinary skill in the art that would motivate one (with no knowledge of the claimed invention) to make the proposed combination has not been explained. *In re Rouffet*, 149 F.3d 1350, 1358 (Fed. Cir. 1998).

In weighing the evidence before us, Petitioner has provided sufficient reasoning with rational underpinnings to explain why one of ordinary skill in the art would have modified the teachings of the applied references. *See KSR*, 550 U.S. at 418. The modification proposed by Petitioner is supported, in part, on its contention that the skilled artisan would have had reason to combine Lissianski and Nelson in order to reduce NOx. Pet. 61–66 (citing Ex. 1003 ¶¶ 382–401). According to Petitioner, Nelson and Lissianski each describe using a selective catalytic reduction ("SCR") unit to reduce NOx emissions and improve particulate removal. Ex. 1012, 10:34–37; Ex. 1036, 4:44–59; Ex. 1003 ¶ 393–395. According to Lissianski, "[t]he injected additive [i.e., NH_4Cl, NH_4Br, or NH_4I] also reduces NOx emissions in a selective catalytic reduction (SCR) and/or (SNCR) process." Ex. 1036, 3:42–52. Accordingly, we find no evidence of hindsight reconstruction.

After considering the parties' arguments and evidence of record, we determine Petitioner has established a reasonable likelihood of prevailing on its obviousness challenge of claim 17 based on the combined teachings of Nelson, Olson-Paper, and Lissianski. Patent Owner does not separately address the additional limitations of claims 18–20. We have reviewed the information Petitioner provides, including the relevant portions of the Niksa

Declaration and Petitioner's arguments and determine that that Petitioner has established a reasonable likelihood of prevailing on its challenge with respect to these claims.

I. Alleged Obviousness over Downs, Olson-Paper, and Lissianski

Petitioner contends claims 17–20 are rendered obvious over the combination of Downs-Halogenation, Olson-Paper, and Lissianski. Pet. 105–121. Petitioner also relies on the testimony of Dr. Niksa to support its arguments. *Id.*

1. Downs-Halogenation (Ex. 1015)

Downs-Halogenation relates to a dynamic halogenation process for treating powdered activated carbon sorbents for removing mercury from flue gases. Ex. 1015 ¶ 19; *see also*, Ex. 1016 ¶ 22. Specifically, Downs-Halogenation discloses using bromine-containing compounds to enhance the capture of elemental mercury by carbonaceous sorbents. Ex. 1015 ¶ 10; *see also*, Ex. 1016 ¶ 12.[14]

Figure 2 illustrates a method for treating conventional powdered activate carbon sorbents with a halogen as reproduced below.

[14] Because Petitioner relies on the filing date of the Downs-Halogenation provisional (i.e., Provisional application no. 60/555,281, filed March 22, 2004 (Ex. 1016, "Downs provisional")) for establishing a prior art date under 35 U.S.C. § 102(e), Petitioner provides parallel citations to both Downs-Halogenation and the Downs provisional for written-description support.

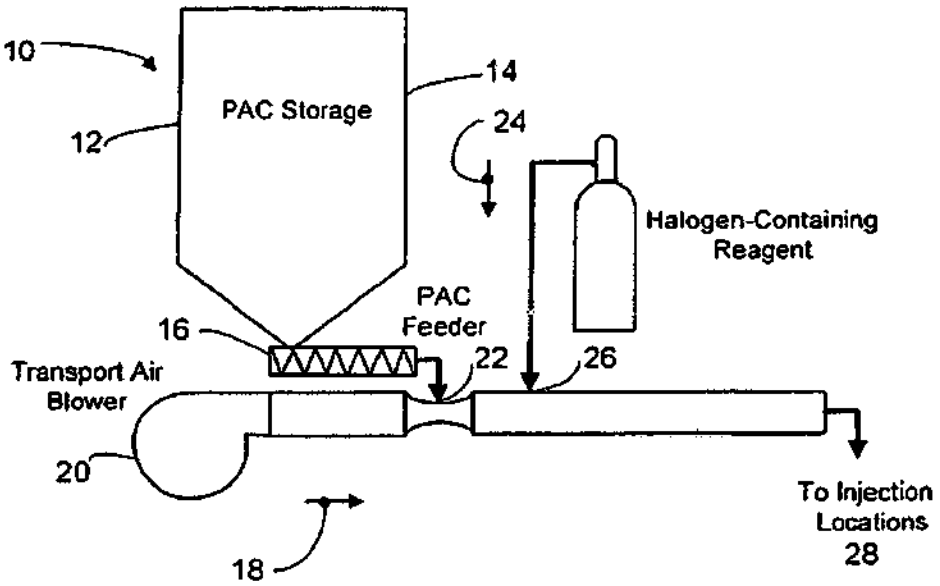


FIG. 2

Figure 2 is a schematic illustration of the Dynamic Halogenation process for treating sorbents for the removal of mercury from flue gases." Ex. 1015 ¶ 14. Figure 2 depicts sorbent storage tank 12 metered into sorbent transport air stream 18 and sorbent transport air blower 20 which supplies air for conveying sorbent 14 to injection locations 28. Ex. 1015 ¶ 19; *see also* Ex. 1016 ¶ 22. Downs-Halogenation discloses that gaseous halogen-containing reagent 24 is injected into the flowing transport air/sorbent stream. *Id.* Downs-Halogenation discloses that "[t]he adsorption of [] halogen-containing reagent 24 onto [] sorbent particles 14 occurs during the transport of this gas-solid mixture to [] point of injection 28" into the flue gas. Ex. 1015 ¶ 19; *see also* Ex. 1016 ¶¶ 22, 27.

Downs-Halogenation discloses that "halogen containing reagent 24, and a commercially-produced PAC were used as [] carbonaceous sorbent 14." Ex. 1015 ¶ 19; *see also* Ex. 1016 ¶ 26. Downs-Halogenation discloses that:

> 1) PAC injection, alone, at a similar injection rate provided no discernable mercury removal; 2) the use of hydrogen bromide was more effective than the use of hydrogen chloride; and 3) the rates of addition of both the hydrogen bromide and PAC were many times lower than the rates for other halogen addition processes and conventional PAC injection processes.

Ex. 1015 ¶ 23; *see also* Ex. 1016 ¶ 26.

2. Analysis of Claim 17

Although claim 1 is disclaimed, claim 17 depends from and includes the limitations of claim 1. Accordingly, we review Petitioner's contentions as to claim 1, followed by the limitations added by claim 17.

Petitioner contends that Downs-Halogenation discloses a method for separating mercury from a mercury containing gas by promoting activated carbon by chemically reacting powdered activated carbon with gaseous bromine (HBr or Br_2) to form a promoted brominated sorbent. *See* Pet. 87–90 (citing Ex. 1015 ¶¶ 4, 10, 19, 21. 23–24, 26–27; Ex. 1016 ¶¶ 4–5, 12, 22, 24, 26–27, 29–30; Ex. 1003 ¶¶ 443, 448–449).

Petitioner contends that Olson-Paper discloses the limitation that "wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury." *Id.* at 90–93. Specifically, Petitioner contends that Olson-Paper discloses that powdered activated carbon contains graphene sheets having "a zig-zag *carbene site* on the *carbon edge*." *Id.* at 91 (citing Ex. 1079, 979, 982). Petitioner further contends that Olson-Paper discloses that the basic carbene "reacts with HCl *to form stable carbenium ion intermediates,* which are then active for binding Hg^0, accepting electrons from the atom (Figure 2)." *Id.* at 92 (quoting Ex. 1079, 982). Petitioner

contends that although Olson-Paper "identifies HCl and chloride anions (Cl^-), a POSITA would have applied the same mechanism for a bromine-containing promoter (e.g., HBr)," as taught by Downs-Halogenation. *Id.* at 93.

Petitioner contends that both Downs-Halogenation and Olson-Paper disclose the step of chemically reacting elemental mercury with the promoted brominated sorbent to form a mercury/sorbent composition, i.e., claim 1, step (b). *Id.* at 94 (citing Ex. 1015 ¶¶ 4, 6, 19–20; Ex. 1016 ¶¶ 5, 7, 22–26; Ex. 1079, 982; Ex. 1003 ¶¶ 462–463).

Petitioner contends Downs-Halogenation "discloses separating mercury/sorbent particulates from the mercury containing gas 'along with the fly ash,' using a 'particulate collector' such as an 'electrostatic precipitator (ESP) or fabric filter,'" i.e., claim 1, step (c). *Id.* at 95–96 (citing Ex. 1015 ¶¶ 3–4, 22, 29; Ex. 1016 ¶¶ 4–5, 25, 32; Ex. 1003 ¶¶ 465–467).

With respect to claim 17, Petitioner submits annotated Figure 2, illustrating the combined teachings of Downs-Halogenation and Lissianski. *Id.* at 110–113.

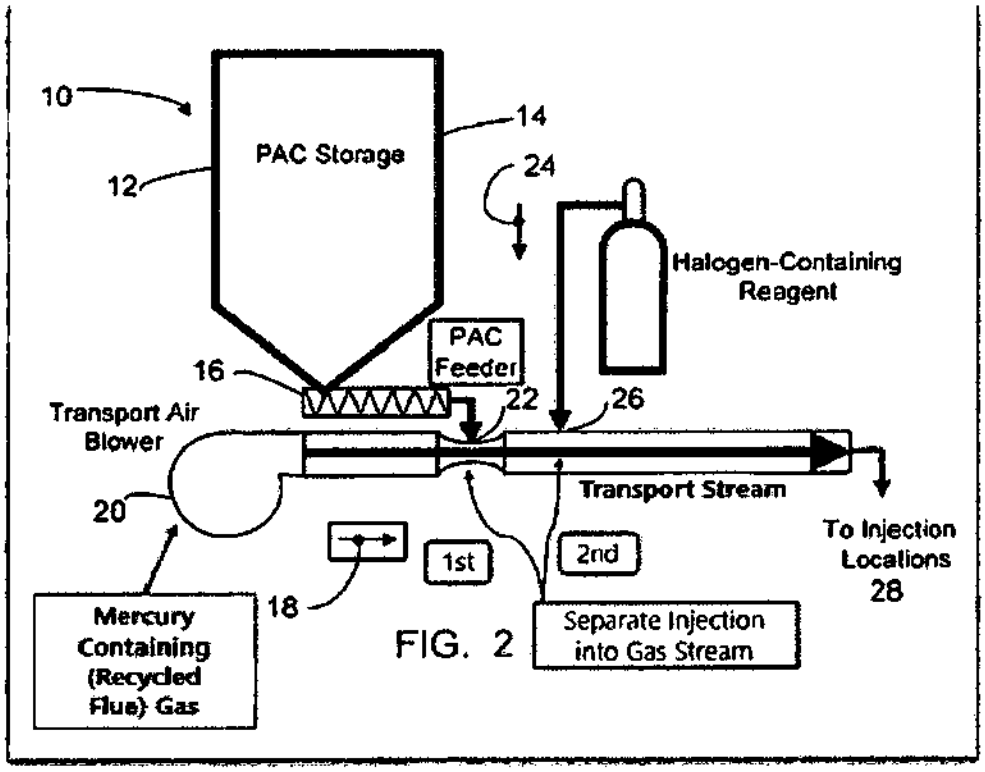


FIG. 2

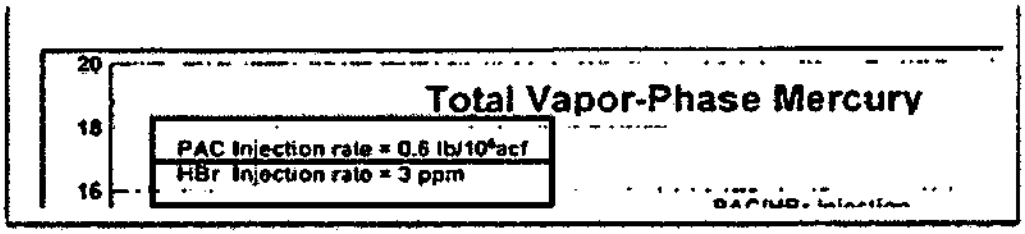
Petitioner contends Downs-Halogenation "describes separately injecting bromine-containing promoter (HBr, blue) and activated-carbon sorbent (red), with in-flight reaction occurring in a transport line (purple) to produce promoted-brominated sorbent." *Id.* at 105–106; *see also id.* at 111–112 (citing Ex. 1003 ¶¶ 504–506). Petitioner contends that a person of ordinary skill in the art would have been motivated to use Lissianski's "stream of recycled (mercury-containing) flue gas (below, green) as the medium in which activated-carbon sorbent and halogen-containing reagent undergo in-flight reaction in [Downs-Halogenation], and for carrying the promoted-brominated sorbent to injection location(s) 28 in the main flue gas duct." *Id.* at 107. Petitioner contends that "[t]he above in-flight reaction would occur regardless of whether the transport gas is air (as in [Downs-Halogenation]),

or the transport gas is a recycled flue gas (as in [Lissianski]). *Id.* at 112–113 (citing Ex. 1036, 4:20–23; Ex. 1003 ¶¶ 507–509).

As to the limitation of claim 17 that "the promoter is reacted in the gas phase or as a vapor," Petitioner contends that Downs-Halogenation "discloses gaseous HBr(g) and/or Br2(g) reacting with sorbent in the gas phase." *Id.* at 113 (citing Ex. 1003 ¶ 510).

Finally, Petitioner contends that the combination of Downs-Halogenation and Lissianski teaches adding the promoter "from about 1 to about 30 grams per 100 grams of the sorbent material." *Id.* at 113–116. As discussed above, Petitioner presents two potential interpretations the ratio of added promoter, either: (1) ratio of promoter added to the gas stream or (2) ratio of promoter added to the sorbent. *Id.* at 113.

Petitioner first addresses the ratio of added promoter to gas stream. *Id.* Petitioner contends Downs "describes a sorbent-injection rate of 0.6 lb/MMacf (pounds-per-million actual cubic feet of flue gas), and a bromine-promoter injection rate of 3 ppm (parts-per-million in flue gas)," as shown in annotated Figure 3, reproduced below. *Id.* (citing Ex. 1015, Figure 3; Ex. 1016, Figure 3; Ex. 1003 ¶¶ 88–90).



Downs-Halogenation Figure 3 lists PAC injection rate and HBr Injection rate based on total vapor-phase mercury. Ex. 1015 ¶ 15. Petitioner contends that Lissianski discloses concentrations of 3 ppm and 0.3 ppm bromine-promoter in flue gas provide "almost the same effect," and therefore

"expressly motivates" a lower promoter rate. *Id.* at 114–115 (citing Ex. 1036, 6:62–67; Ex. 1003 ¶ 512). Petitioner contends that "[t]he promoter rate of Lissianski-Patent (0.3 ppm) corresponds to 19.55 g/MMacf, and the sorbent rate of Downs-Halogenation (0.6 lb/MMacf) corresponds to 272 g/MMacf. Accordingly, there is a gas-phase ratio of 7.19 grams of bromine-containing promoter per 100 grams of sorbent, which is within the range of claim 17." *Id.* at 115 (citing Ex. 1003 ¶¶ 84, 88–90, 513–516).

Second, Petitioner addresses the ratio of added promoter to sorbent. *Id.* at 115–116. Petitioner contends "a gas-phase ratio of 7.19 grams bromine per 100 grams sorbent also leads to a disclosure that the 'promoter is added [to the sorbent] at from about 1 to about 30 grams per 100 grams of the sorbent material.'" *Id.* at 115 (citing Ex. 1003 ¶ 517). Petitioner further contends that "[i]t would have been well within the purview of a [person of ordinary skill in the art] to adjust promoter and sorbent-injection rates, as needed, to achieve desired mercury removal." *Id.* at 116 (citing Ex. 1003 ¶ 518).

Petitioner contends that a person of ordinary skill in the art "would have had a reasonable expectation of success in using recycled flue gas as the medium for in-flight reaction between sorbent and promoter and subsequent transport, because Downs-Halogenation teaches flexibility in gases used in the transport line (purple)." *Id.* at 108–109 (citing Ex. 1015 ¶ 19; Ex. 1016 ¶ 22; Ex. 1003 ¶ 498; Ex. 1036, 4:420–23). Furthermore, Petitioner contends that Downs-Halogenation, Lissianski, and Olson-Paper are all from the same field of endeavor and thus would have been combined by a person of ordinary skill in the art. *Id.* at 109 (citing Ex. 1003 ¶¶ 499–502).

Patent Owner, at this time does not challenge Petitioner's allegations regarding the teachings of Downs-Halogenation, combined with Olson-Paper and Lissianski. *See generally* Prelim. Resp. Instead, Patent Owner argues that Downs-Halogenation, as well as the other asserted references, is not prior art, based on its contention that the '147 patent is entitled to an earlier date of invention based on conception and reduction to practice as early as May 6, 2003. Prelim. Resp. 20. On this record, Petitioner's arguments and evidence are sufficient to show that each limitation of claim 17 of the '471 patent is taught or suggested by the combination of Downs-Halogenation, Olson-Paper, and Lissianski. Because we determined above (*supra* Section II.E.) that the '147 patent was not entitled to an earlier date of invention, we determine that Petitioner has established a reasonable likelihood of prevailing on its challenge to claim 17 as obvious over the combination of Downs and Olson-Paper. Patent Owner does not separately address the additional limitations of claims 18–20. We have reviewed the information Petitioner provides, including the relevant portions of the Niksa Declaration and Petitioner's arguments and determine that that Petitioner has established a reasonable likelihood of prevailing on its challenge with respect to these claims.

III. CONCLUSION

For the reasons set forth above, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing with respect to at least one challenged claim of the '147 patent. Thus, we institute an *inter partes* review on all challenged claims and on all grounds presented.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that an *inter partes* review is instituted on each of the grounds asserted in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial, which shall commence on the entry date of this decision.

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Paper 17
Date: December 2, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NRG ENERGY, INC. and
TALEN ENERGY CORPORATION
Petitioner,

v.

MIDWEST ENERGY EMISSIONS CORP.,
Patent Owner.

IPR2020-00928
Patent 8,168,147 B2

Before ZHENYU YANG, CHRISTOPHER M. KAISER, and AVELYN M. ROSS, *Administrative Patent Judges.*

ROSS, *Administrative Patent Judge.*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4

I. INTRODUCTION

NRG Energy, Inc., Talen Energy Corporation, and Vistra Corp. (formerly known as Vistra Energy Corp.), filed a Petition (Paper 3, "Pet.") requesting *inter partes* review of claims 18 and 19 of U.S. Patent No. 8,168,147 B2 (Ex. 1001, "the '147 patent"). Pet. 1. Subsequently, Vistra Corp and Midwest Energy Emissions Corp. ("Patent Owner") filed a Joint Motion to Terminate Vistra Corp. as a petitioner pursuant to a settlement. Paper 8. That motion was granted. Paper 11. Therefore, NRG Energy, Inc. and Talen Energy Corporation (collectively "Petitioner") remain as petitioners. *Id.* at 4. Patent Owner filed a Preliminary Response to the Petition (Paper 12, "Prelim. Resp."). Pursuant to our authorization, Petitioner filed a Reply (Paper 14, "Pet. Reply"), and Patent Owner filed a Sur-reply (Paper 15, "Sur-reply").

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (2019). The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least [one] of the claims challenged in the petition."

For the reasons set forth below, upon considering the Petition, Preliminary Response, and evidence of record, we determine the information presented in the Petition establishes a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. Accordingly, we institute *inter partes* review.

A. Real Parties-in-Interest

Petitioner identifies the real parties-in-interest as NRG Energy, Inc. ("NRG"), Talen Energy Corporation ("Talen"), and Vistra Corp. Pet. 1. Petitioner identifies the following real parties-in-interest who are parties to the pending lawsuit identified below: Brandon Shores LLC; Talen Generation LLC; H.A. Wagner LLC; IPH, LLC; Illinois Power Resources Generating, LLC; Dynegy Midwest Generation LLC; Dynegy Miami Fort, LLC; NRG Texas Power LLC; Midwest Generation EME, LLC; and Midwest Generation, LLC. *Id.* Petitioner also identifies numerous *potential* real parties-in-interest—namely vendors and suppliers. *Id.* at 2–6.

B. Related Matters

Petitioner identifies a pending lawsuit between the parties, styled *Midwest Energy Emissions Corp. and MES Inc. v. Vistra Energy Corp.*, No. 1:19-cv-01334-RGA (D. Del.), as a related proceeding in which the Patent Owner asserts the '147 patent. Pet. 6–7; *see also* Paper 6, 1 (Patent Owner's Mandatory Notices).

Petitioner filed a second petition challenging claims 1, 2, 4–6, and 9–24 of the '147 patent, applying different prior art and a different priority date. IPR2020-00926, Paper 2.[1] Additionally, Petitioner filed concurrent petitions challenging U.S. Patent No. 10,343,114 B2 ("the '114 patent"), which is also asserted by Patent Owner in the district court proceeding. *See* IPR2020-00832, Paper 3; *see also,* IPR2020-00834, Paper 3. We instituted

[1] In accordance with our Trial Practice Guide, Petitioner provides an explanation of material differences and ranking for the multiple petitions directed to each challenged patent. Paper 2, (Petitioner's Explanation Regarding the Necessity of Multiple Petitions, "Explanation").

trial on IPR2020-00832 and IPR2020-00834 on October 26, 2020. *See* IPR2020-00832, Paper 17; *see also* IPR2020-00834, Paper 18.

C. The '147 Patent

1. Specification

The '147 patent, titled "Sorbents for the Oxidation and Removal of Mercury," issued on May 1, 2012. Ex. 1001, codes (45), (54). The '147 patent is directed to methods for capturing mercury using reactive bromine-promoted carbon sorbents. *Id.* at 6:19–24.

The '147 patent explains that combusting coal generates flue gas containing mercury and other trace elements. *Id.* at 1:29–40. "The release of the mercury (and other pollutants) to the environment must be controlled by use of sorbents," e.g., activated carbon particles. *Id.* at 1:37–40, 57–62. According to the '147 patent, "[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." *Id.* at 2:10–14.

The '147 patent discloses that 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." *Id.* at 6:19–24. To prepare bromine-carbon sorbents, the '147 patent describes methods for chemically combining molecular bromine with activated carbon. *Id.* at 11:45–49. Specifically, the '147 patent describes an "in-flight" method of producing a bromine-promoted carbon sorbent by

> 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.

Id. at 12:44–53.

The '147 patent depicts a schematic flow diagram for a mercury control system including bromine-promoted carbon sorbents in Figure 3, reproduced below:

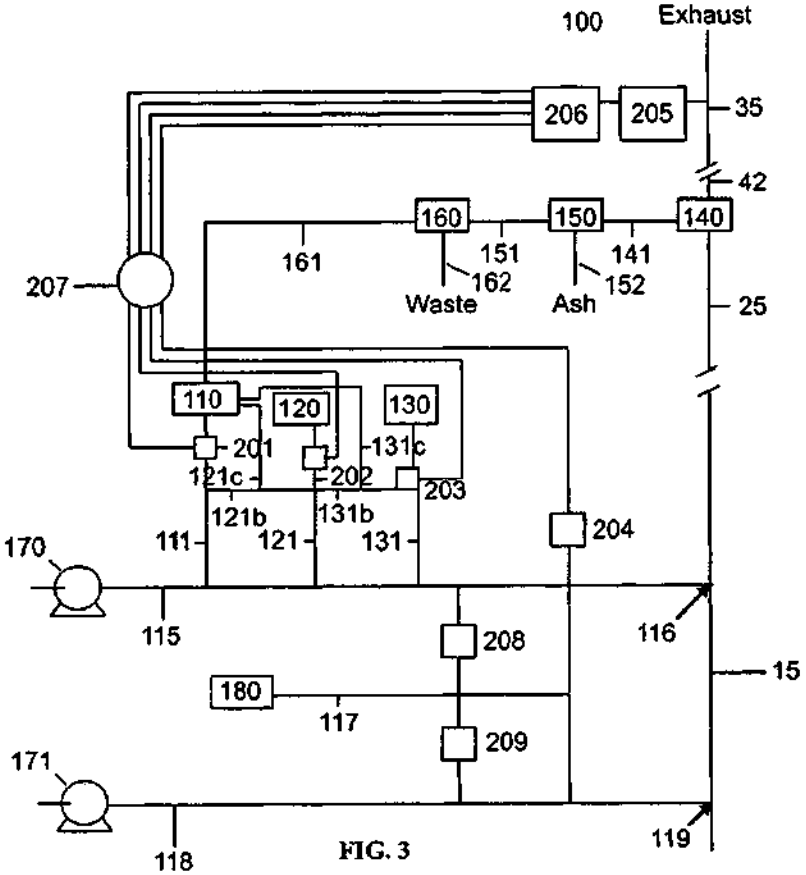


FIG. 3

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 . . . including in-flight preparation of

promoted carbon sorbent." *Id.* at 5:47–51. Figure 3 depicts base activated carbon reservoir 110, halogen/halide promoter reservoir 120, optional secondary component reservoir 130, and corresponding flow control devices 201–203. *Id.* at 8:21–30. Transport line 115 carries material discharged from reservoirs 110, 120, and 130 in a transport gas, which injects the materials into contaminated flue gas stream 15 via injection point 116. *Id.* at 8:33–42. Particulate separator 140 collects and separates solid materials, including sorbent stream 151, which may be passed to sorbent regenerator 160 to yield regenerated sorbent stream 161. *Id.* at 8:61–9:10.

Figure 3 illustrates several preferred methods for preparing bromine-promoted carbon sorbents. *Id.* at 9:43–64. For example, the '147 patent first describes an in-flight preparation by discharging the halogen/halide "via line 121 directly into transport line 115, within which it contacts and reacts with the base activated carbon prior to injection point 116." *Id.* at 9:51–56. In a second embodiment, "the halogen/halide may be combined via line 121*b* with base activated carbon prior to entering transport line 115." *Id.* at 9:56–57. As a third alternate method, Figure 3 of the '147 patent describes introducing halogen/halide via line 121*c* into activated carbon reservoir 110 and reacting the compounds in reservoir 110. *Id.* at 9:58–64.

2. Illustrative Claims

Petitioner challenges dependent claims 18 and 19, which depend from claims 1 and 17. Claims 1, 17, 18 and 19 are reproduced below.

> 1. A method for separating mercury from a mercury containing gas comprising:
>
> (a) promoting at least a portion of a particulate sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing

promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

Ex. 1001, 23:34–52.

17. A method according to claim 1, further comprising

injecting the particulate sorbent material at a sorbent material injection rate and

injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent,

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 the sorbent material.

Id. at 24:34–41.

18. A method according to claim 17, wherein the gas stream is a mercury containing gas.

Id. at 24:42–43.

19. A method according to claim 18, wherein the gas stream is a transport gas.

Id. at 24:44–45.

D. Prior Art and Asserted Grounds

Petitioner asserts that claims 18 and 19 would have been unpatentable on the following grounds:

Claim(s) Challenged	Statutory Basis	Reference(s)/Basis
18, 19	§ 103	Lissianski-Presentation,[2] Olson[3]
18, 19	§ 103	Sjostrom,[4] Olson

Petitioner also relies on declaration testimony of Stephen Niksa, Ph.D. (Ex. 1003, "the Niksa Declaration").

II. ANALYSIS

A. Legal Standards

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

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[2] V. Lissianski, *Integrated Approach to Multi-Pollutant Control*, 9th Electric Utilities Environmental Conference (January 2006) (Exhibit 1011, "Lissianski-Presentation").

[3] Olson et al., US 2006/0048646 A1, published March 9, 2006 (Exhibit 1014, "Olson").

[4] S. Sjostrom, *Full Scale Evaluations of Mercury Control Technologies with PRB Coals*, Electric Utilities Environmental Conference (January 2005) (Exhibit 1010, "Sjostrom").

A claim is unpatentable under 35 U.S.C. § 103(a) 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." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.[5] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

To show obviousness, it is not enough to merely show that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). "This is so because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *KSR*, 550 U.S. at 418–419.

On the other hand, an obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR*, 550 U.S. at 418; *accord In re Translogic Tech., Inc.*, 504 F.3d 1249, 1259 (Fed. Cir. 2007). However, Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d

[5] The parties have not asserted or otherwise directed our attention to any objective evidence of non-obviousness.

1364, 1380 (Fed. Cir. 2016). Instead, Petitioner must articulate a reason why a person of ordinary skill in the art would have combined or modified the prior art references. *In re NuVasive, Inc.*, 842 F.3d 1376, 1382 (Fed. Cir. 2016); *see also Metalcraft of Mayville, Inc. v. The Toro Co.*, 848 F.3d 1358, 1366 (Fed. Cir. 2017) ("In determining whether there would have been a motivation to combine prior art references to arrive at the claimed invention, it is insufficient to simply conclude the combination would have been obvious without identifying any reason why a person of skill in the art would have made the combination."); *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention.") (citing *InTouch Techs., Inc. v. VGO Commc'ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014)).

At this preliminary stage, we determine whether the information presented shows a reasonable likelihood that Petitioner would prevail in establishing that at least one of the challenged claims would have been obvious over the proposed prior art.

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

B. Level of Ordinary Skill in the Art

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of invention. *Graham*, 383 U.S. at 17. Petitioner contends that

> [a] person of ordinary skill in the art ("POSITA") would have at least a bachelor's degree in chemical engineering, mechanical engineering, or a related field of study with at least two years of

> experience with implementing pollution control in power generation plants for natural gas, coal, and/or industrial waste incineration.

Pet. 11 (citing Ex. 1003 ¶¶ 63–66).

Patent Owner does not identify the level of skill necessary for a person having ordinary skill in the art. *See generally* Prelim. Resp. And, neither party indicates that the outcome of any arguments made in this case would change depending on the level of ordinary skill in the art. For purposes of this Decision, and based on the record currently presented, we adopt Petitioner's definition of the level of ordinary skill in the art. Further, we find that the prior art of record reflects the level of skill in the art at the time of the invention. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). We will make any final determination pertaining to the level of ordinary skill in the art, however, on the full trial record.

C. Claim Construction

In an *inter partes* review filed on or after November 13, 2018, we construe claims "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b) (2019); *see Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

Petitioner does not propose any claim construction and asserts all claim terms should be accorded their plain and ordinary meaning. Pet. 19 (citing Ex. 1003 ¶ 211).

Patent Owner contends that Petitioner interprets "claim 17 in a manner that is contrary to the plain claim language. In particular, Petitioners insert the following limitation into the claim language: "injecting separately the bromine containing promoter[, **and no other material,**] into a gas stream." Prelim. Resp. 3; *see also* Sur-reply (stating that Petitioner argues "the plain meaning of the claim requires that any promoter be injected entirely on its own"). Patent Owner contends that the claimed methods include the use of additional materials beyond those specifically recited. Prelim. Resp. 3–4. Specifically, Patent Owner contends "a particulate sorbent material comprising activated carbon" may include other materials, such as pyrolysis char, and "a bromine containing promoter" may include other materials, such as an organic solvent or chloride. *See id.* (citing Ex. 1001, 2:55–60; 7:45–50).

Petitioner replies that it "did not insert 'and no other material' into the claims" and instead applies the plain language as written. Pet. Reply 2. Petitioner states that "'the gas stream' in claims 18–19 refers to 'a gas stream' of parent claim 17, and thus, claims 18–19 require 'injecting the particulate sorbent material . . . and ***injecting separately*** the bromine containing promoter ***into***' a ***mercury containing gas stream***." *Id.*

After reviewing the parties' arguments, we are not persuaded that Petitioner is attempting to insert additional language into the claim such that the relevant term would read "injecting separately the bromine containing promoter[, and no other material,] into a gas stream," as alleged by Patent Owner. And, neither party proposes an express construction for our consideration. We determine that it is not necessary, at this stage of

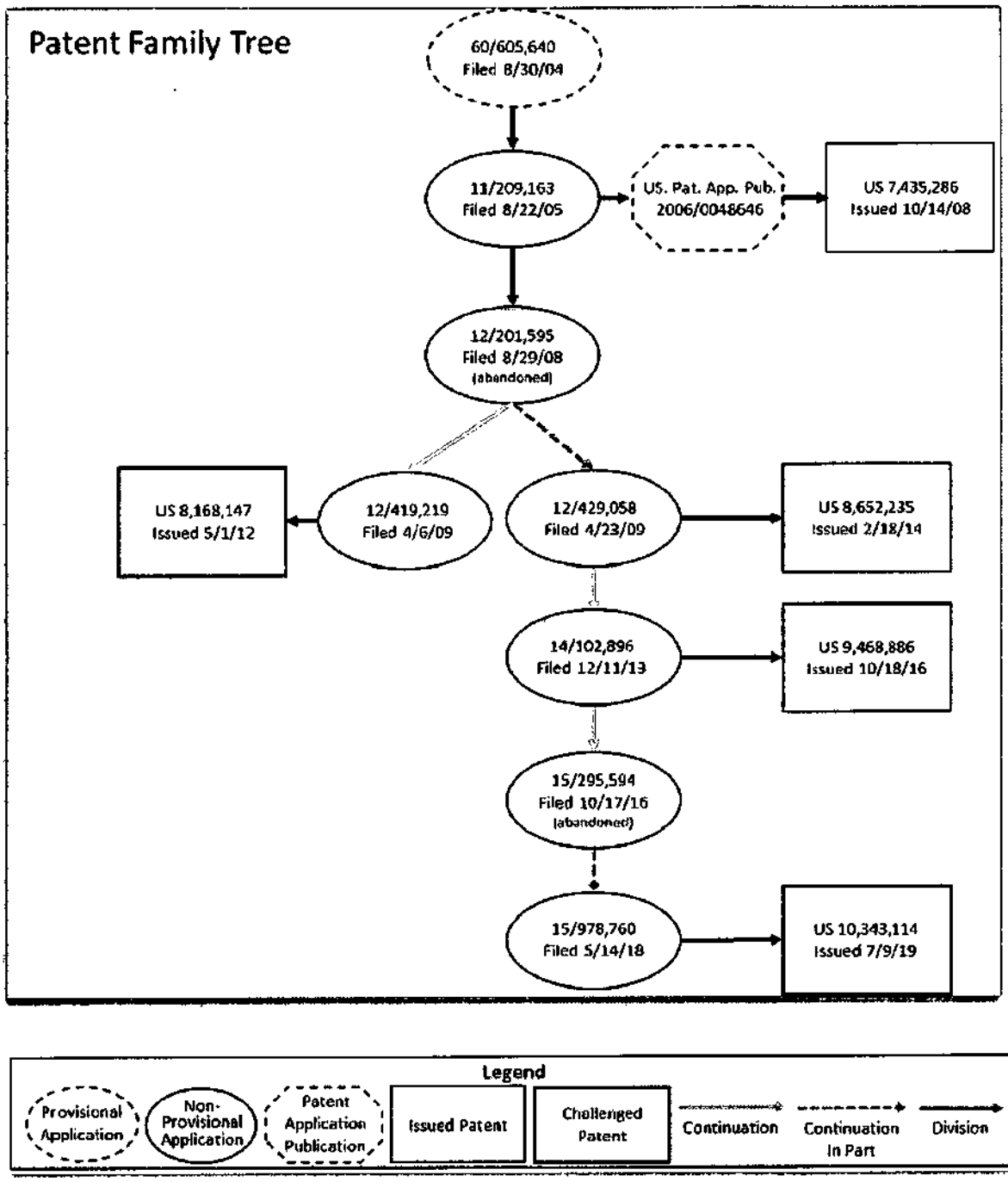
the proceeding, to provide an express construction for this term. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

We will revisit the issue based on the full record developed over the course of trial, if needed.

D. Priority for claims 18 and 19 of the '147 patent

As discussed above, the '147 patent issued from U.S. Application No. 12/419,219 ("the '219 application"), filed on April 6, 2009, which claims earliest priority through a series of non-provisional applications to U.S. Provisional Application No. 60/605,640 ("the '640 provisional"), filed August 30, 2004.

Petitioner provides the following summary of the '147 patent priority chain and family:



Ex. 1017. This summary depicts the earliest filed application at the top and shows the latest filed application at the bottom. As illustrated above, the '147 patent has the following priority chain:

- Provisional Application 60/605,640, filed August 30, 2004, ("the '640 provisional application");
- Non-provisional Application 11/209,163 ("the '163 application"), filed August 22, 2005, claiming priority to the '640 provisional application;
- Non-provisional Application 12/201,595 ("the '595 application"), filed August 29, 2008, claiming priority to the '163 application as a divisional application;
- Non-provisional Application 12/419,219 ("the '219 application"), filed on April 6, 2009, claiming priority to the '595 application as a continuation application;

Id.; Ex. 1001, code (21), (22), (60).

However, Petitioner contends that claims 18 and 19 are not supported by the '640 provisional application or the intervening non-provisional applications. Pet. 19–20. Therefore, according to Petitioner, the correct priority date for claims 18 and 19 is April 6, 2009, the filing date of the '219 application along with the preliminary amendment introducing the claims into the application. *Id.* at 20.

Patent Owner asserts that the '640 provisional application as well as the intervening '163 and '595 applications provide the requisite written description support for claims 18 and 19.[6] *See generally* Prelim. Resp. 9–19; Sur-reply 1–4. Because the '640 provisional application was filed before Lissianski-Presentation and Sjostrom were publicly accessible (January 2006 and January 2005, respectively) and before Olson-646 was published (March

[6] Patent Owner explains that "[f]or purposes of this dispute, the '595 and '163 applications contain substantively identical disclosures. For ease of reading, patent owner refers to the '163 application below." Prelim. Resp. 15. In our discussion below, we similarly refer to Exhibit 2021, i.e., the '163 application, as we discern little or no difference between the '595 and '163 applications.

2006), if claims 18 and 19 the '147 patent are entitled to the priority date of the '640 provisional application, Lissianski-Presentation, Sjostrom, and Olson-646 would not qualify as prior art. Reply 1.

We address the disclosure of the provisional and non-provisional applications, along with the parties' priority arguments below.

1. Provisional application

Petitioner argues that Patent Owner cannot rely on the '640 provisional application because the '640 provisional application fails to provide sufficient disclosure to support claims 18 and 19 and because the intervening applications "do not include the relied-upon disclosure of the Provisional, thus breaking priority." Pet. 22 (citing Ex. 1003 ¶¶ 185–186; *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1571 (Fed. Cir. 1997)). According to Petitioner, even if the disclosure in '640 provisional application were sufficient, "the intervening applications only include[] a generic statement of incorporation by reference, without identifying with particularity what specific material is being incorporated." *Id.* at 22–23. For example, the '147 patent includes the following cross-reference to related applications:

> This application is a continuation of U.S. patent application Ser. No. 12/201,595 filed on Aug. 29, 2008, which is a division of U.S. patent application Ser. No. 11/209,163, filed on Aug. 22, 2005 (now U.S. Pat. No. 7,435,286), which claims priority to the extent appropriate from provisional application 60/605,640, filed on Aug. 30, 2004. Application Ser. Nos. 12/201,595; 11/209,163; and 60/605,640 are incorporated herein by reference.

Ex. 1001, 1:7–14. Petitioner contends that claiming "priority ***to the extent appropriate from***" the'640 provisional application "indicates that applicants did not intend to claim priority to and incorporate the entire Provisional

Application, but only parts of it, again without identifying the specific material to incorporate." Pet. 23. Petitioner asserts that "applicants' incorporation by reference language fails as a matter of law," and therefore, "none of the disclosure in the Provisional is properly incorporated to the applications in the priority-chain and thus cannot provide written description support for the '147 Patent claims." *Id.*

Petitioner further argues that "material incorporated by reference from the Provisional, but not disclosed in the ['147 patent] specification, cannot be considered as providing written-description support in a priority analysis because such material would be deemed 'essential material.'" *Id.* at 24. Petitioner explains that "essential material"—which includes "material that is necessary to: provide a written description of the claimed invention"—"may be incorporated by reference, but ***only*** by way of incorporation by reference to a ***U.S. patent or U.S. patent application publication***." *Id.* (quoting 37 C.F.R. § 1.57(d) (2020)). And, Petitioner asserts that because a provisional application is not published, it "is neither a 'U.S. patent' nor a 'U.S. patent application publication.'" *Id.* (citing 35 U.S.C. § 122(b)(2)(A)(iii); 35 U.S.C. § 111).

As to the substantive disclosure of the '640 provisional application, Petitioner contends that the '640 provisional application "fails to disclose Claims 18–19 because it only discloses injecting a halogen and activated carbon sorbent ***together*** into a mercury-containing gas, ***not separately*** as recited in claims 18–19." *Id.* at 25 (citing Ex. 1020, 11).[7] Petitioner contends that "[t]he halogen and activated carbon sorbent are being

[7] Petitioner cites to the pages of the provisional application, not the pages of Exhibit 1020.

combined in a transport line with a *non*-mercury-containing gas, and then injected together (not separately), into a mercury-containing gas." *Id.* (citing Ex. 1003 ¶ 203).

Petitioner discusses Figure 2 of the '640 provisional, reproduced below, in detail. *Id.* at 25–26.

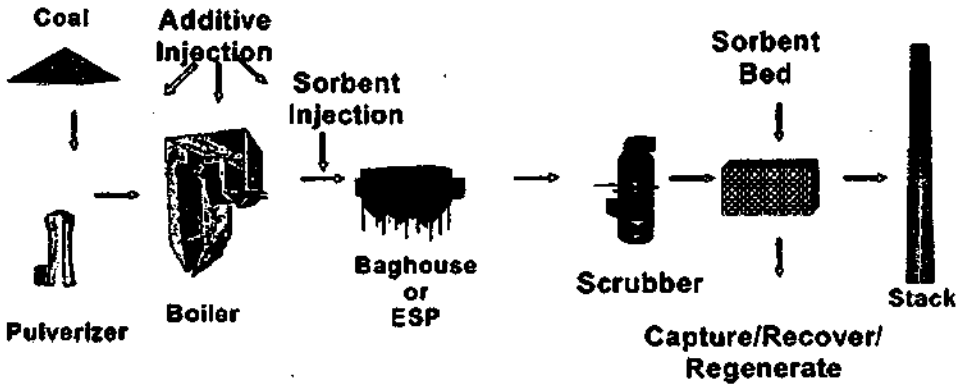


FIG. 2

Figure 2 is a block diagram illustrating a mercury control method in a coal fueled facility. Ex. 1020, 15. In relevant part, Figure 2 depicts pulverized coal introduced to a boiler and fed through a baghouse or an electrostatic precipitator ("ESP") for mercury removal. *Id.* A sorbent is injected in the transport line after the boiler and before the baghouse or ESP. *Id.* Figure 2 also shows an additive injection that may occur with the coal, in the boiler, or at the sorbent injection site. *Id.*

Petitioner first contends that Figure 2 was not included in the '147 patent. Pet. 26. Second, Petitioner contends that the "additive" of the "additive injection" is limited to "compounds of Group I or II elements," and does not include Group VII elements, e.g., bromine. *Id.* (citing Ex. 1020, 4 (Example 9)). Third, Petitioner contends that the additive injection is used to augment previously promoted activated carbon and "does not provide an

in-flight reaction promoting the sorbent with a bromine-containing promoter within the mercury containing (flue) gas stream." *Id.* at 27 (citing Ex. 1003 ¶¶ 204–205).

Patent Owner contends that the '640 provisional provides support for separately adding bromine and activated carbon sorbent to mercury-containing flue gas, thereby supporting claims 18 and 19. Prelim. Resp. 10–13. For example, with reference to the "additive" in Figure 2, Patent Owner explains the '640 provisional discloses "the sorbent is injected into the flue gas after the boiler. The additive can be injected where desired (e.g., before, after, or within the boiler)." *Id.* at 12 (citing Ex. 1020, 15–16, Fig. 2). Patent Owner contends that Figure 2 shows "the bromine-containing additive is mixed with powdered (pulverized) coal (which inherently contains mercury) and[ ]air and injected into the combustion chamber (which also contains mercury from the combusted coal). Later, activated carbon sorbent is injected into the mercury-containing flue gas to cause the promotion reaction." *Id.* As to Petitioner's arguments limiting the Figure 2 "additive injection" to Group I or II elements, Patent Owner contends that Example 9 discloses additional additives to the bromines additives of Examples 1–8. *Id.* at 14 (citing Ex. 1020, 5). Patent Owner contends that "even if the inventors had intended example 9 to redefine the word 'additive'—they did not—it would not exclude the use of bromine containing additives." *Id.* at 14–15.

Patent Owner contends that in another example, the '640 provisional application describes "combining the treatment system with the carbon injection system at the end-use site. . . . [T]he halogen is introduced to the carbon-air mixture in the transport line (or other part of the sorbent storage

and injection system)."). This gas stream is a 'transport gas' as required by claim 19." *Id.* at 13 (citing Ex. 1020, 14). Patent Owner further contends that the provisional application describes "recycling and reusing the sorbent." *Id.* (citing Ex. 1020, 5–8 (Examples 6 and 10), 13, 14). Patent Owner contends that "[b]ecause this recycled sorbent contains mercury from its use in the flue gas, this provides 'injecting separately the bromine containing promoter into a [mercury containing] gas stream whereby in-flight reaction produces the promoted brominated sorbent'" as required by claim 18. *Id.*

Petitioner in reply stresses that "[t]he '640 Provisional 'only discloses injecting a halogen and activated carbon sorbent ***together*** into a mercury-containing gas, ***not separately*** as recited in claims 18–19.'" Pet. Reply 2 (quoting Pet. 25). Petitioner further contends that claims 18 and 19 additionally require that the bromine promoter be injected separately "'***into***' a ***mercury containing gas stream***." *Id.* Because both separate injection of the bromine promoter and activated carbon and injection of the bromine promoter into a mercury containing gas stream are missing from the '640 provisional application, Petitioner asserts there is no written description support for claims 18 and 19 of the '147 patent. *Id.*

Petitioner contends that Patent Owner's position that Figure 2 of the '640 provisional application—which is missing from the '163 and '595 applications—suggests the separate addition of a bromine "additive" into a mercury containing gas stream is incorrect because "$CaBr_2$ and NaBr are salts that exist as a solid or in aqueous solution" and that "[t]he '640 Provisional teaches that the 'additive' is not the 'promoter,' because the 'additive' is used to 'augment the ***treated*** activated carbon' (i.e., sorbent that

had been previously promoted)—by capturing pollutants 'released to the gas phase as the sorbent becomes saturated or capacity limited.'" *Id.* at 3 (citing Ex. 1020 at 7). Petitioner also disputes Patent Owner's position that in recycling regenerated sorbent, a bromine containing promoter is injected separately into a mercury containing gas because some mercury is recycled with the sorbent. Prelim. Resp. 13. Petitioner contends that "the '640 Provisional does not disclosed recycled sorbent containing mercury" because the sorbent is regenerated "so that the sorbent 'captures mercury at the same level as before.'" Pet. Reply. 4 (citing Ex. 1020, 4). Further, according to Petitioner, even if mercury remains in in the sorbent, it would be present as a "solid-phase as part of a 'stable bond' to the sorbent, and not in a 'mercury containing gas.'" *Id.* (citing Ex. 1001, claim 18; Prelim. Resp. 11).

Having considered the parties' positions and evidence, we determine that Petitioner has demonstrated a reasonable likelihood that one or more of the applications in the priority chain for the '147 patent lacks written description from the '640 provisional application to support the challenged claims.

According to *Lockwood v. American Airlines, Inc.*

> [i]n order to gain the benefit of the filing date of an earlier application under 35 U.S.C. § 120, each application in the chain leading back to the earlier application must comply with the written description requirement of 35 U.S.C. § 112. *In re Hogan*, 559 F.2d 595, 609, 194 USPQ 527, 540 (CCPA 1977).

107 F.3d at 1571. Here, Figure 2 of the '640 provisional application and its corresponding written description are entirely missing from the intervening applications. *Compare* Ex. 1020, 12, Fig. 2, *with* Ex. 1021 ¶¶ 52–53, Fig. 2. Therefore, even if the '640 provisional application was found to provide

support for challenged claims 18 and 19 of the '147 patent, at least the '163 application and the '595 application do not include that written description from the '640 provisional application. Thus, there is a break in the priority chain.

And Patent Owner's remaining arguments are insufficient to establish that the '640 provisional application in question provides the requisite written description for claims 18 and 19. With respect to Figure 2, it is unclear whether the term "additive injection" in Figure 2 includes bromine or is limited to Group I or Group II elements, as Petitioner suggests, and further, whether an in-flight reaction occurs *in* the mercury-containing gas even assuming the "additive injection" includes bromine. For example, the '640 provisional application refers to "additives" as "Ca, Na, and others" as separate from the "additional substances," including bromine. *See e.g.*, Ex. 1020, Abstract, 3–4. The '640 provisional application further states that bromine may be reacted with the activated carbon in-flight and *within* "the duct through which the carbon is transported from a reservoir *to* the flue gas duct." *Id.* at 3 (emphasis added); *see also id.* 10–11 ("the sorbent can be readily treated with any combination of bromine and the second component in-flight using vapors of the these components contacting the very fine carbon particles dispersed in air or other gas stream that *conveys the particles to the flue gas duct.*" (emphasis added)). Thus, the only teaching of an in-flight reaction between bromine and activated carbon occurs in the duct work before being introduced into the mercury containing gas.

In addition to relying on Figure 2, Patent Owner also urges us to consider the regenerated and recycled sorbent as including a "mercury-containing gas." Prelim. Resp. 13. However, the '640 provisional does not

describe any mercury recycled with the regenerated sorbent unlike the later filed '163 application. *Compare* Ex. 1020, *with* Ex. 1021, 10 ("the mercury-containing sorbent particles are regenerated to remove some or substantially all of the mercury"). Rather, the '640 provisional application states that "[t]he sorbent can be regenerated by washing off contaminating components derived from flue gas that poison the spent sorbent." Ex. 1020, Abstract; *see also id.* at 11 ("the poisoning contaminants from the flue gas are removed and an inexpensive promoting agent added to restore mercury sorption activity"). The '640 provisional application continues to explain that "[a] comparison of the sorbent after subsequent regeneration with HBr indicates that it not only captures mercury at the same level as before (100% capture) but is enhanced such that its capacity is prolonged by several minutes." *Id.* at 14. Furthermore, the '640 provisional application contrasts its inventive aspects against other prior art inventions where "Hg is only partially removed from the sorbent at temperatures up to 500°C. The sorbents do not work effectively after regeneration using this technique." *Id.* at 15.

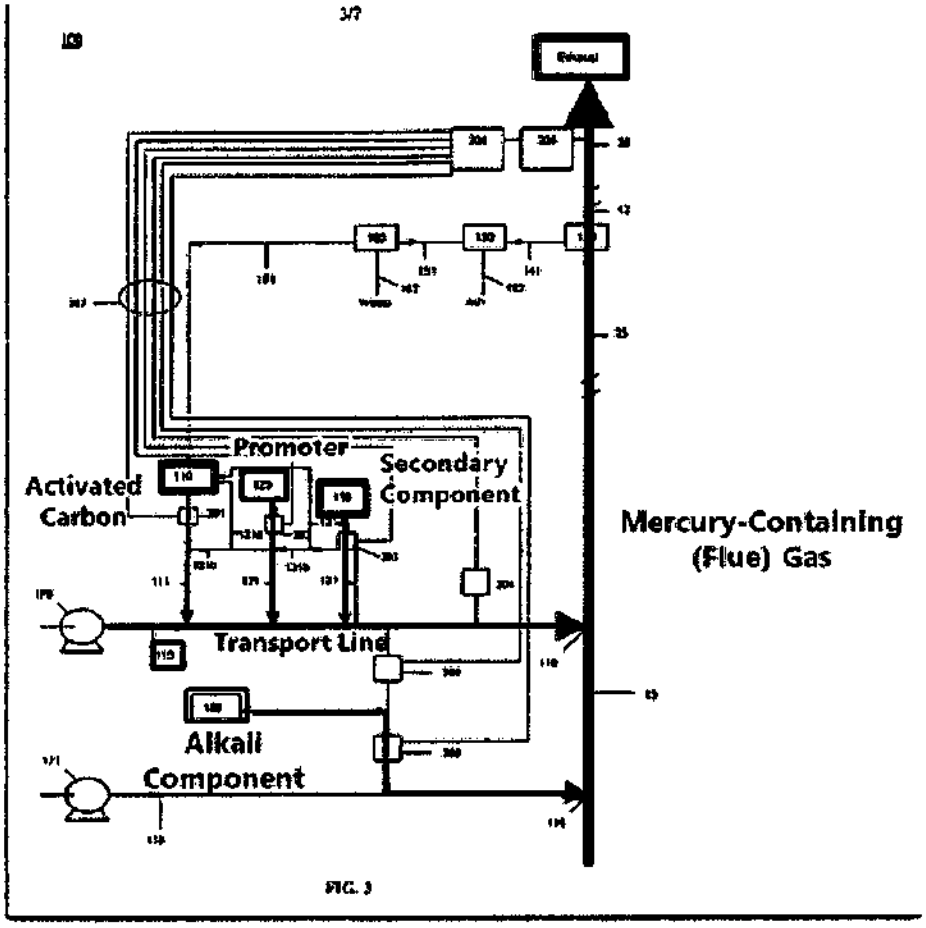
Lastly, Petitioner is correct that 37 C.F.R. § 1.57(c) (2005) permits incorporation by reference of essential material, which includes material necessary to provide a written description of the claimed invention, but it is critical to note that it limits such incorporations to U.S. patents and U.S. patent application publications. 37 C.F.R. § 1.57(c) (2005)). Patent Owner does not dispute this point. *See generally* Prelim. Resp.; Sur-reply; *cf. Ex parte Maziere,* 27 USPQ2d 1705, 1706–07 (BPAI 1993) (holding that if "essential material" is included in the application at issue, incorporation by reference in the parent application was sufficient to claim priority and to satisfy the written description requirement, but not discussing provisional

applications). Therefore, to the extent the provisional application provides support for the challenged claims, incorporation by reference of the provisional application by the '595 and '163 applications cannot cure the deficiencies discussed above.

2. Non-provisional applications

Petitioner contends that the intervening non-provisional applications, the '163 and '595 applications, do not disclose "injecting the sorbent and separately injecting the promoter into a mercury containing gas." Pet. 28 (citing Ex. 1003 ¶¶ 181–182). Petitioner contends that the non-provisional applications "describe 'in-flight' promotion only as treating the activated carbon with a bromine promoter ***before*** introduction into the mercury-containing flue gas." *Id.* at 28–29 (citing Ex. 1021 ¶ 75; Ex. 1022 ¶ 75).

Petitioner contends that annotated Figure 3 of the non-provisional applications illustrates that "in-flight promotion occurs before any injection into the mercury-containing gas," as reproduced below. *Id.* at 29–30.



According to Petitioner, annotated Figure 3 illustrates that "activated-carbon sorbent (red) and bromine-containing promoter (blue) are introduced into a transport line (purple), and thus react ***before*** being injected together into the mercury-containing gas (green)." *Id.* (citing Ex. 1021, 43; Ex. 1022, 42). Petitioner asserts that "there is no disclosure that the transport line contains any mercury-containing gas, as in Claim 19." *Id.* at 30.

Petitioner further argues that annotated Figure 1 of the non-provisional applications "reinforces that in-flight promotion occurs before any injection into the mercury-containing gas," as reproduced below. *Id.* at 31–32.

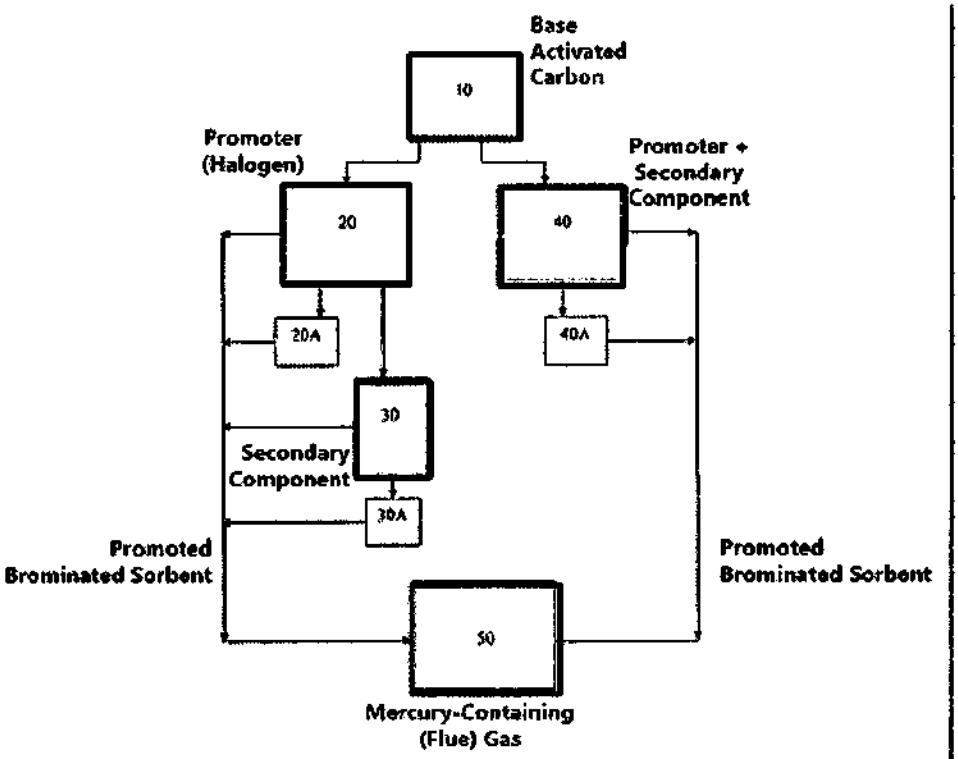


FIG. 1

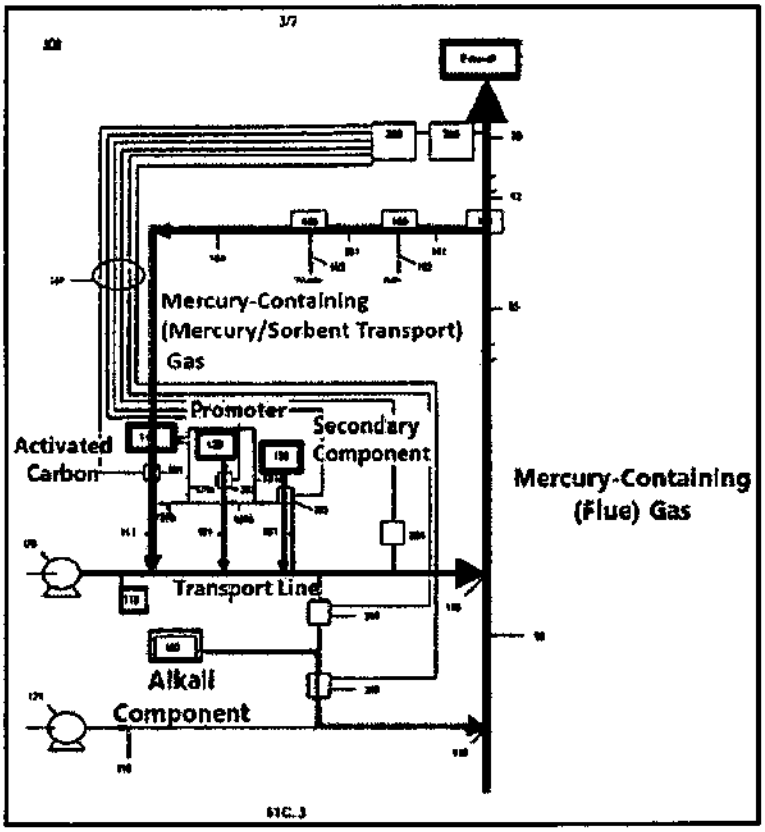
Petitioner contends that "[b]oth 'paths' for the base activated-carbon sorbent (red) illustrate the activated carbon reacting with the promoter (blue) to form a promoted brominated sorbent (purple) ***before*** being injected together into the mercury-containing gas (green), such that they are not injected separately." *Id.* at 31–32. Petitioner contends that Patent Owner cannot rely on replacement Figure 1 of the '147 patent, which includes a direct arrow between base activated carbon 10 and mercury-containing (flue) gas 50, because the replacement Figure 1 was not present in '163 and '595 applications. *Id.* at 32–34.

Patent Owner contends that the non-provisional applications supports claims 18 and 19 because: (1) the non-provisional applications are not

limited to a single point of injection and (2) the non-provisional applications describe a sorbent recycling system. Prelim. Resp. 15–19.

First, Patent Owner contends that the non-provisional applications disclose that "[f]or 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." *Id.* at 15 (quoting Ex. 1021 ¶ 56). Patent Owner contends that "[t]his multiple injection point embodiment satisfies the requirement of 'injecting separately the bromine containing promoter into a gas stream.'" *Id.* at 15–16.

Second, Patent Owner submits a second annotated Figure 3, reproduced below, illustrating a sorbent recycling system.



Patent Owner contends that the '163 application discloses after "mercury is removed from the gas stream by the sorbent particles, the sorbent particles

are separated from the ash particles . . . and the sorbent particles are reinjected into the gas stream." *Id.* at 17 (citing Ex. 1021 ¶ 26). Patent Owner contends that

> [w]hen such a recycling system is in use, a transport gas is used to "reinject" used sorbent back into the transport line for sorbent and promoter. As a result, the transport gas is necessarily a mercury-containing gas because it contains the mercury recycled with the used sorbent. As shown in figure 3, bromine promoter is then separately injected into this mercury-containing transport gas as required by claims 18 and 19.

Id. at 17–18. Patent Owner also addresses Petitioner's annotated Figure 1, arguing that both paths may be used simultaneously so that "the promoter 20 in the left path is injected into the mercury-containing gas 50 separately from the activated carbon sorbent in the right path," thereby combining promoter 20 including activated carbon, with separately added activated carbon. *See id.* at 18–19.

Petitioner replies that "[w]hile multiple injection points may be used, the activated carbon and promoter are still injected together at each individual injection point, and not separately." Pet. Reply 5 (citing Ex. 1021, 43; Ex. 1022, 42; Pet. 29–31). Petitioner contends that Figure 3 of the '163 application "shows 'regenerated sorbent stream 161' combining with 'transport line 115' prior to subsequent promoter addition and combined injection into mercury-containing flue gas." *Id.* (citing Ex. 1021, 14–15, 43). And, with reference to Figure 1 of the '163 application, Petitioner asserts that "the intervening applications refer to these as two ***alternative*** embodiments, and do not refer to both paths being used in parallel or in the same embodiment." *Id.* (citing Ex. 1021, 12–13; 1022, 8–9). Further, in each alternative embodiment, "the promoter is combined with the activated

carbon ***prior*** to injection into mercury-containing gas." *Id.* (citing Prelim. Resp. 18; Pet. 30–31).

Patent Owner responds that Figure 3 of the '163 application "depicts a loop of recycled, mercury-containing gas into which activated carbon and bromine-containing promotor are both injected." Sur-reply 4.

On this record, we determine that Petitioner has demonstrated a reasonable likelihood that one or more of the non-provisional applications in the priority chain for the '147 patent lack the written description necessary to support claims 18 and 19 of the '147 patent. We are not persuaded by Patent Owner's arguments to the contrary as we discuss below. Patent Owner's first argument is that Figure 3 depicts multiple injection points 116 and 119 and that the '163 application explains that "single injection points 116 and 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." Prelim. Resp. 15 (quoting Ex. 1021, ¶ 56). However, each of injection ports 116 and 119 depicts a transport gas to inject either the brominated sorbent or optional alkali components, respectively, *into the flue gas*. Ex. 1021, 14. There is no suggestion that bromine and the activated carbon are separately injected into mercury-containing flue gas line 15 through "multiple injection points." *Id.*

We are similarly unpersuaded by Patent Owner's argument regarding the recycle feed containing mercury gas because when activated carbon and regenerated sorbent are injected into transport line 115 through line 118 and the promoter is separately injected into transport line 115 through line 121 "the transport gas is necessarily a mercury-containing gas because it contains the mercury recycled with the used sorbent." Prelim. Resp. 18. At

this stage in the proceeding, it is unclear whether the skilled artisan at the time would have considered the small amount of mercury recycled after the sorbent is regenerated to be a "mercury-containing gas" as recited in claim 18. The '163 application makes clear that that the purpose of the '163 application is to remove mercury from the flue gas stream generated during the burning of coal and other fossil fuels. Ex. 1021, 5. The '163 application effects this purpose by using an electrostatic precipitator, a bag house, or both to remove mercury captured on the sorbent materials. *Id.* at 6, 10, 11, 15, 26, 27, 29. Though the '163 application explains that "the mercury-containing sorbent particles are regenerated to remove some or substantially all of the mercury," the mercury that may remain has formed a "stable bond" with the sorbent. Ex. 1021, 10, 13–14; *see also* Prelim. Resp. 11 ("When these components are mixed into mercury-containing gas, the mercury (Hg) is drawn toward the carbon and the bromine ion, creating a stable bond."). Furthermore, each instance of "mercury containing" gas in the '163 application refers to "mercury-containing flue gas" as opposed to a recycled sorbent containing some amount of mercury. *Id.* at 9, 12, 36. Therefore, without more, we understand the term "mercury-containing gas" to refer to the "mercury-containing flue gas" that is subject to treatment. We encourage the parties to address this issue in subsequent briefing and will revisit this issue based on the full record developed during trial.

Lastly, Patent Owner argues that Figure 1 of the '163 application depicts parallel, simultaneous feeds such that when each path combines with mercury-containing flue gas 50, a feed containing a halogen and a feed containing an activated carbon are separately injected into a mercury-containing gas. Prelim. Resp. 17–18. We are not persuaded by Patent

Owner's position and instead agree with Petitioner that Figure 1 depicts alternate embodiments. According to the '163 application, "Figure 1 schematically illustrates *methods* for preparation of promoted carbon sorbents in accordance with the present invention." Ex. 1021, 10 (emphasis added). The '163 application provides further details of these embodiments and explains that the left-hand path of Figure 1 describes "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." *Id.* at 12. According to the '163 disclosure, the right-hand path describes

> *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.

Id. (emphasis added)

Moreover, although we have only analyzed the '595 and '163 applications, we also look to the incorporation statements in the other applications in the chain leading to the '219 application. The '219 application provides that it "is a continuation of U.S. patent application 12/201,595 . . . which is a division of U.S. patent application 11/209,163 . . . which claims priority *to the extent appropriate* from provisional application 60/604,640." Ex. 1019, 54. The '219 application then states that "Application Serial Numbers 12/201,595; 11/209,163; and 60/604,640 are incorporated herein by reference." *Id.* "To incorporate material by reference, the host document must identify with *detailed particularity* what

specific material it incorporates and *clearly indicate where* that material is found in the various documents." *Zenon Envtl., Inc. v. U.S. Filter Corp.*, 506 F.3d 1370, 1378, 1379 (Fed. Cir. 2007) (quoting *Cook Biotech Inc. v. Acell, Inc.*, 460 F.3d 1365, 1376 (Fed. Cir. 2006)). It is unclear to us what "to the extent appropriate" means in this context. The '219 application claims priority "to the extent appropriate" and fails to identify with detailed particularity the specific material incorporated and fails to clearly indicate where that material is found in the various documents. *See also* MPEP 211.02 ("In view of this requirement for a specific reference in the later-filed application, the right to rely on a prior art application may be waived by an applicant if a proper reference to the prior application is not included in the later-filed application."). This ambiguity creates an additional concern regarding the chain of priority for the '219 application.

In view of the present record, Petitioner has demonstrated that one or more of the applications in the priority chain for the '147 patent lack written description support for challenged claims 18 and 19. Patent Owner, on this record, has not presented persuasive arguments or evidence that claims 18 and 19 of the '147 patent are entitled to a priority date earlier than April 6, 2009, the filing date of the '219 patent.

E. Discretion to Deny Institution

1. 35 U.S.C. § 325 (d)

Patent Owner contends we should deny institution under 35 U.S.C. § 325(d) because "Petitioners fail to demonstrate any pressing need for a separate review of two claims of this patent." Prelim. Resp. 1. Patent Owner further asserts that "Petitioners have already demonstrated that they may raise a priority date dispute in their primary petition," therefore, "the

Board should deny this petition as duplicative and an unnecessary burden on the Board and the parties." *Id.* (citing IPR2020-00834, Paper 16).

Section 325(d) provides that in determining whether to institute an *inter partes* review, "the Director may take into account whether, and reject the petition or request because, the same or substantially the same prior art or arguments previously were presented to the Office." The Board uses a two-part framework in determining whether to exercise its discretion under § 325(d), specifically:

> (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of the first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.

Advanced Bionics, LLC v. Med-El Elektromedizinische Geräte GmbH, IPR2019-01469, Paper 6, 8 (PTAB Feb. 13, 2020) (precedential).

We have reviewed Patent Owner's arguments and evidence of record and determine that the *Advanced Bionics* factors weigh against exercising our discretion under § 325(d). Patent Owner does not allege that the Examiner considered any reference offered in the instant Petition or that the same or similar arguments were before the Office during prosecution of the '147 patent. *See generally* Prelim. Resp. 1. And, though Patent Owner argues that this Petition is "duplicative [of Petitioner's primary petition] and an unnecessary burden," Patent Owner fails to explain how the prior art and arguments of the instant Petition—filed contemporaneously with Petitioner's primary petition—that *were not previously presented to the Office* implicates the concerns addressed by the statutory language of § 325(d). Without

more, we decline to exercise our discretion to deny the Petition under 35 U.S.C. § 325(d).

2. 35 U.S.C. § 314(a)

Under § 314(a), we have discretion to deny institution of an *inter partes* review. *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016); *SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1356 (2018); *Harmonic Inc.*, 815 F.3d at 1367 ("[T]he PTO is permitted, but never compelled, to institute an IPR proceeding."); *see also* 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director."). In deciding whether to institute an *inter partes* review, we consider the guidance provided in the Consolidated Trial Practice Guide, which states that

> [b]ased on the Board's prior experience, one petition should be sufficient to challenge the claims of a patent in most situations. Two or more petitions filed against the same patent at or about the same time . . . may place a substantial and unnecessary burden on the Board and the patent owner and could raise fairness, timing, and efficiency concerns.

Patent Trial and Appeal Board Consolidated Trial Practice Guide ("Consolidated TPG") 64 (Nov. 2019), https://www.uspto.gov/sites/default/files/documents/ tpgnov.pdf, 59.

Here, Petitioner filed two petitions on the same day, one challenging claims 18 and 19 and the other challenging claims 17–20 of the '147 patent. Pet. 1; IPR2020-00926, Paper 2, 1.[8] In this Petition, Petitioner presents two obviousness grounds, one based on Lissianski-Presentation as the main reference and the other based on Sjostrom as the main reference. Pet. 10. In

[8] Patent Owner statutorily disclaimed the non-'in-flight' claims of the '147 patent, i.e., claim 1–16 and 21–25, leaving only claim 17–20 remaining. IPR2020-00926, Paper 13.

IPR2020-00926, Petitioner presents four obviousness challenges, the two based on Nelson[9] and Olson-Paper[10] and the remaining two based on Downs-Halogenation,[11] Olson-Paper, and Lissianski.[12] IPR2020-00926, Paper 2, 10.

Petitioner "request[s] that the Board institute on both petitions" but explain that two petitions are warranted because the two petitions assert different priority dates and assert different references, citing the Consolidated Trial Practice Guide's statement that "more than one petition may be necessary . . . when there is a dispute about priority date requiring arguments under multiple prior art references." Explanation 1, 3 (quoting Consolidated TPG 59). According to Petitioner,

> Petitioners expect Patent Owner to argue that all the claims of the '147 Patent can trace priority back to a provisional application filed August 30, 2004, while Petitioners dispute this. Petitioners assert that two of the claims—Claims 18 and 19—have no support in the Provisional or intervening applications, and thus the earliest priority date for these two claims is the filing date of what became the '147 Patent, April 9, 2009.

Id. at 1. The Explanation ranks this Petition second to the Petition in IPR2020-00926. *Id.* at 2.

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[9] Nelson, Jr., US 6,953,494 B2, issued October 11, 2005 (Ex. 1012, "Nelson").
[10] E.S. Olson et al., *Chemical mechanisms in mercury emission control technologies*, 107 J. Phys. IV France 979–982 (2003) (Ex. 1079, "Olson-Paper").
[11] Downs et al., US 2007/0180990 A1, published August 9, 2007 (Ex. 1015, "Downs-Halogenation").
[12] Lissianski et al., US 7,514,052 B2, issued April 7, 2009 (Ex. 1036, "Lissianski").

Petitioner further argues that the issues presented to the Board by the two Petitions are limited, because the Petition in this proceeding uses two primary references and a single secondary reference, whereas the Petition in IPR2020-00926 uses two primary references and two secondary reference. *Id.* at 3. Petitioner also argues that they joined efforts to provide efficiency instead of each party individually filing separate petitions. *Id.* at 4–5.

We find Petitioner's arguments persuasive. The Petitions include different prior art references that address potentially different priority date arguments. Such a situation is contemplated by the Consolidated Trial Practice Guide, which states that "more than one petition may be necessary . . . when there is a dispute about priority date requiring arguments under multiple prior art references." Consolidated TPG 59. Notwithstanding Petitioner's and Patent Owner's post-Petition arguments regarding the similarity of the priority date arguments, the fact remains that the Petitions themselves present different priority date arguments and rely on different prior art references. The Petitions are the documents to which the Patent Owner will be responding in the *inter partes* review proceeding. For the reasons discussed below, *inter partes* review will be instituted in this proceeding. We also institute *inter partes* review in IPR2020-00926 for the reasons discussed in that proceeding.

3. 35 U.S.C. § 312(a)(2)

Patent Owner argues that "35 U.S.C. § 312(a)(2) provides that a petition may only be considered if 'the petition identifies all real parties in interest.'" Prelim. Resp. 1–2. Patent Owner contends that Petitioner lists "dozens of 'potential real parties in interest,' without explanation as to their relationship to petitioners," that this "is not an identification of *all real*

parties in interest," and that, if instituted, this proceeding would be under a cloud of uncertainty because the ambiguity in Petitioner's list "will likely lead to confusion and disputes as to which parties are real parties in interest and which are bound by the estoppel provisions of 35 U.S.C. § 315." *Id.* at 2. For instance, Patent Owner asserts that Petitioner identifies various vendors and suppliers as "potential real parties in interest" but states that "[n]one of these companies or any unnamed entity is funding, controlling, or directing, or otherwise has an opportunity to control or direct this Petition or proceeding" and this implies that these entities are not actually real parties in interest. *Id.* In addition, Patent Owner argues that some entities are identified both as "potential real parties in interest" and "real parties in interest," which creates ambiguity and conflict in the listing of entities. *Id.* For these reasons, Patent Owner contends that "Petitioners have not met their burden of identifying all real parties in interest" and "the Board should deny institution for failure to comply with § 312(a)(2)." *Id.* at 3, 11–12.

We are not aware of, and Patent Owner does not direct us to, any rule, statute, or case law that prohibits Petitioner from identifying multiple real parties-in-interest or multiple potential real parties-in-interest. Petitioner's identification of about a dozen real parties-in-interest does not appear problematic or overly burdensome. Pet. 1–2. Petitioner's identification of numerous potential real parties-in-interest, albeit unusual, also does not appear problematic. *Id.* at 2–6. To the extent Petitioner has identified an entity as both a real party-in-interest and as a potential real party-in-interest, we interpret that to mean that party is identified as a real party-in-interest. Petitioner's reasons for identifying numerous potential real parties-in-interest reasons appear plausible: Petitioner identifies these parties "out of

an abundance of caution" because they "are vendors and suppliers" in the related litigation but have not "agreed to be listed as a real party-in-interest" in this Petition. Pet. 1–6. This provides the Board and Patent Owner notice that other potential entities may be indirectly involved, but also provides reasons for not committing those parties to the real party-in-interest category. Ordinarily, problems regarding identification of real parties-in-interest arise when a petitioner fails to identify a real party-in-interest. *See, e.g., Ventex Co., Ltd. v. Columbia Sportswear N. Am., Inc.*, IPR2017-00651, Paper 152 (PTAB Jan. 24, 2019) (precedential) (terminating proceeding where Petition failed to name time-barred RPI and privy). Here, the alleged problem is over-identification of potential real parties-in-interest. Without express violation of a known rule, statute, or case law, this does not appear to be a problem warranting a denial on institution of *inter partes* review.

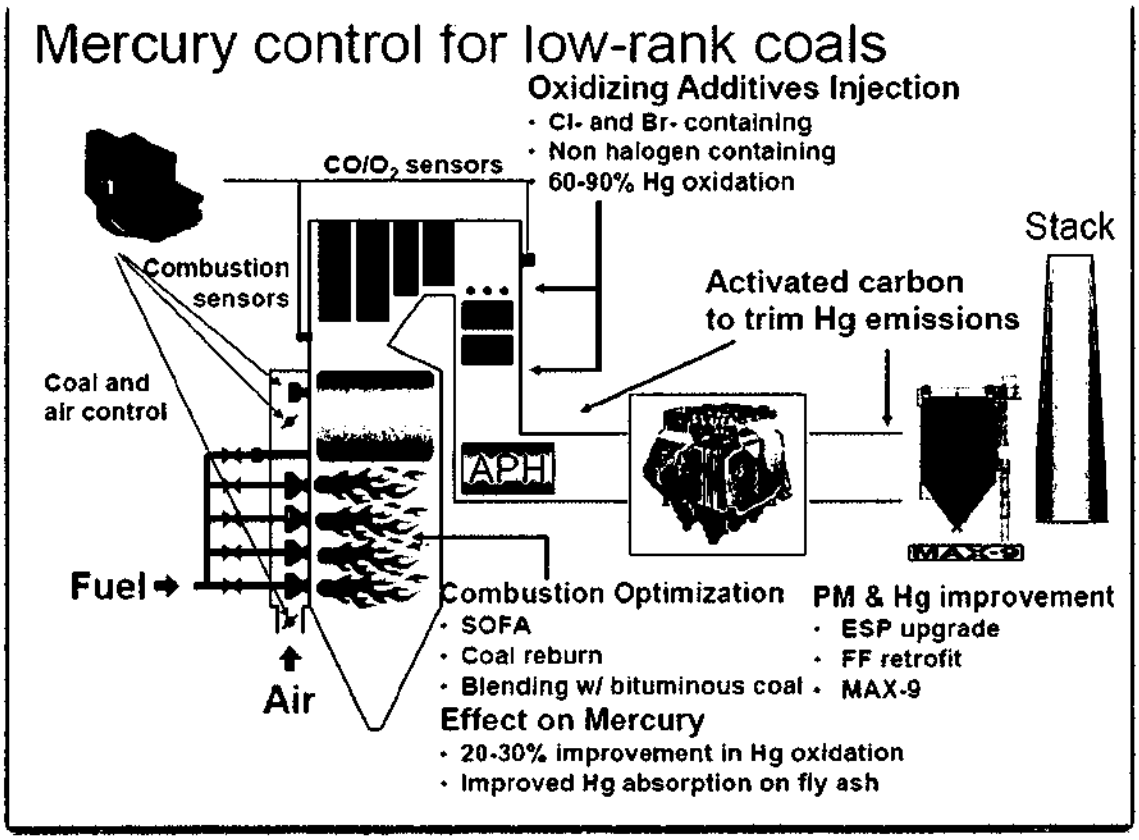
F. Alleged Obviousness Based on Lissianski-Presentation and Olson

Petitioner contends claims 18 and 19 are rendered obvious over the combination of Lissianski-Presentation and Olson. Pet. 34–75. Petitioner also relies on the testimony of Dr. Niksa to support its arguments. *Id.*

1. Lissianski-Presentation (Ex. 1011)

Lissianski-Presentation relates to removing mercury from flue gas of coal-fired power plants using activated-carbon sorbent and halogen-promoter injection. Ex. 1011, 9.

Lissianski-Presentation illustrates a mercury capture process in a figure titled "Mercury control for low-rank coals," reproduced below. Ex. 1011, 9.



The figure on page 9 shows coal introduced into a combustion chamber to generate a flue gas, followed by an injection of oxidizing additives including chlorine and bromine into the flue gas stream. *Id.* Activated carbon is then introduced into the flue gas stream before being fed through an electrostatic precipitator and baghouse filter to remove mercury. *Id.* Lissianski-Presentation describes the activated carbon sorbent as "Darco FGD." *Id.* at 8.

2. Olson (Ex. 1014)

Olson is the patent application publication of the '163 application, from which the '147 patent claims priority. Ex. 1001, code (60). Petitioner contends that because the '163 application does not support claims 18 and 19 of the '147 patent, Olson qualifies as prior art as of its publication date on

March 9, 2006, prior to the filing date of the '147 patent on April 6, 2009. *See* Pet. 42.

Olson describes the mechanism by which a bromine-promoted activated carbon sorbent captures mercury from flue gas, as illustrated in Figure 2, reproduced below. Ex. 1014 ¶ 54.

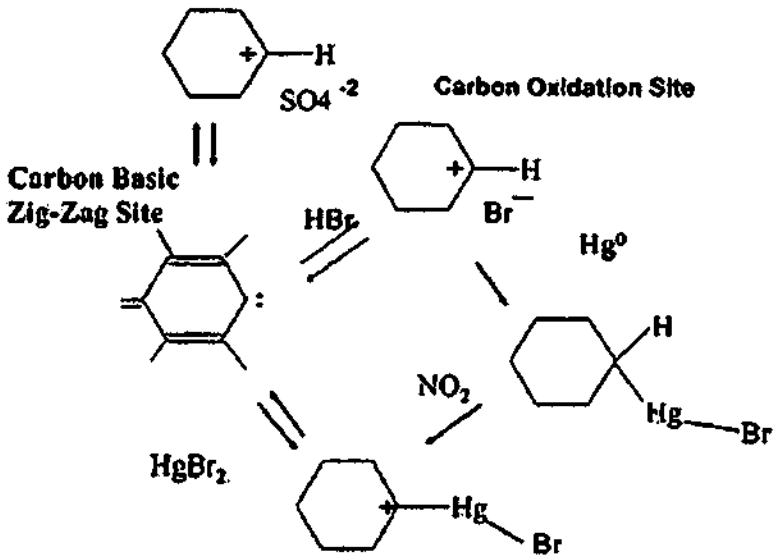


FIG. 2

Figure 2 "illustrates a proposed mechanistic model of the chemical reactions resulting in the oxidation and capture of mercury." *Id.* ¶ 33. Olson discloses that hydrogen bromide reacts with the unsaturated structure of the active carbon by way of a carbene species on the edge of the graphene sheet structures of the carbon. *Id.* ¶ 54.

3. Public Accessibility of Lissianski-Presentation

Petitioner contends that Lissianski-Presentation was a presentation "delivered at the Electric Utilities Environment Conference ("EUEC") in January 2006 and mailed on CD to conference participants within a few

weeks." Pet. at 36. Accordingly, Petitioner contends Lissianski-Presentation qualifies as prior art under: (1) 35 U.S.C. § 102(a) "because it was made available to the relevant public and POSITAs on January 24, 2006 when it was presented" and (2) 35 U.S.C. § 102(b) because it was mailed on CD in February 2006, meeting the standard for public accessibility set forth in *GoPro, Inc. v. Contour IP Holding LLC*, 908 F.3d 690, 693 (Fed. Cir. 2018). *Id.* at 39.

Patent Owner does not dispute whether Lissianski-Presentation was publicly accessible. *See generally* Prelim. Resp.

On this record, Petitioner has demonstrated a reasonable likelihood that Lissianski-Presentation was publicly available. *Hulu, LLC v. Sound View Innovations, LLC*, IPR2018-01039 (PTAB Dec. 20, 2019) (Paper 29) (for purposes of institution, a petitioner must show a reasonable likelihood that an asserted reference qualifies as a printed publication). Petitioner provides evidence that Lissianski-Presentation was presented at the 2006 EUEC on January 22–25, 2006, and that there were over a thousand attendees. *Id.* at 36–37 (citing Ex. 1003 ¶¶ 259–264; Ex. 1047, 27; Ex. 1049, 1–30; Ex. 1048). Petitioner's evidence does not indicate that attendance of the 2006 EUEC was restricted. *Id.* Petitioner also provides evidence of the CD that was mailed to the conference attendees and copies of the Lissianski-Presentation presentation from the CD, without any apparent restriction or expectation of confidentiality. *Id.* at 36–39 (citing Ex. 1003 ¶¶ 269–272; Ex. 1047, 24, 27; Ex. 1049, 1–30; Ex. 1048; *GoPro*, 908 F.3d at 694–95). Therefore, on this record, Petitioner has met its burden of showing that Lissianski-Presentation qualify as printed publications.

4. Analysis of Claims 18 and 19

Although claim 1 is disclaimed and claim 17 is not asserted in the instant Petition, claims 18 and 19 depend from and include the limitations of claims 1 and 17. Ex. 1001, 24:34–41. Accordingly, we review Petitioner's contentions as to claim 1, followed by the additional limitations of claim 17, before we address challenged claims 18 and 19. *See generally id.*, claims.

Petitioner contends that much of claim 1 is suggested by Lissianski-Presentation. Pet. 47–67. Petitioner relies primarily on page 9 of Lissianski-Presentation, reproduced above, to illustrate its contentions. Ex. 1011, 9. With reference to claim 1, Petitioner asserts that Lissianski-Presentation teaches a method for separating mercury from a mercury-containing flue gas because Lissianski-Presentation describes separately introducing both bromine and a chemical sorbent, i.e., activated carbon into a flue gas. Pet. 47–48 (citing Ex. 1011, 1–2, 9), 49–50 (citing Ex. 1003 ¶¶ 538–540). Petitioner asserts that "[t]he system of Lissianski-Presentation would have formed a promoted brominated sorbent that would adsorb mercury to form a mercury/sorbent chemical composition" and then would have used "particulate material separators to remove the mercury-sorbent chemical composition from the flue gas, such as an ESP and a fabric filter (or baghouse)." *Id.* at 48 (citing Ex. 1011, 9); 65–68 (citing Ex. 1001, 9, 10; Ex. 1003 ¶¶ 559–561).

According to Petitioner, a person of ordinary skill in the art "would have understood that the bromine and activated carbon would have contacted and reacted in the flue gas to form promoted-brominated sorbent." *Id.* at 51 (citing Ex. 1003 ¶ 541). Relying on the testimony of Dr. Niksa, Petitioner explains that "at least some of the bromine-containing promoter

injected into the flue gas of Lissianski-Presentation would have contacted the sorbent in mercury-containing gas, at or downstream[,] of the sorbent injection point, because not all of the bromine would have been consumed in oxidizing mercury in the gas-phase." *Id.* at 53–54 (citing Ex. 1003 ¶ 546). Petitioner states that "even though Lissianski-Presentation identifies oxidation of the mercury with bromine, it would have been obvious to use a sufficient amount of bromine such that the sorbent also is promoted" because "[i]t was well-known . . . that halogens improve the ability of activated carbon to capture mercury." *Id.* at 54–55 (citing Ex. 1003 ¶¶ 547; Ex. 1062, 2–3, 1079, 979). And Olson similarly "teaches the advantages of promoting activated-carbon sorbent with bromine containing promoter" that comprises "gaseous HBr or Br_2." *Id.* at 55 (citing Ex. 1014 ¶¶ 43, 66), 56–57 (citing Ex. 1014, 12, 54; Ex. 1003 ¶¶ 549–551), 58–59 (describing gaseous bromine) (citing Ex. 1011, 9; 1014, ¶¶ 52, 66; 1003 ¶¶ 128–129, 150–163; Ex. 1041).

Both Lissianski-Presentation and Olson exemplify Darco FGD, i.e., the activated carbon sorbent, which Olson teaches includes graphene sheets having a carbene species on edge sites. *Id.* at 59–61 (Ex. 1014 ¶¶ 54, 95; Ex. 1003 ¶¶ 554–555). Petitioner argues that Olson provides details of the chemical reaction that occurs between the bromine species and the unsaturated carbon. *Id.* at 61–62 (citing Ex. Ex. 1014 ¶¶ 93, 96; Ex. 1003 ¶ 556). And, according to Petitioner, a person of ordinary skill in the art "would have understood that the promoted brominated sorbent . . . would have chemically reacted with elemental mercury in the mercury containing gas (i.e., flue gas) to form a mercury/sorbent chemical composition," as

described in Olson. *Id.* at 62–64 (citing Ex. 1011, 9; Ex. 1014 ¶¶ 43, 128; Ex. 1003 ¶¶ 557–558).

Petitioner contends that the skilled artisan would have had reason to combine the teachings of Lissianski-Presentation and Olson because Olson teaches that a halogen, like bromine, can be used "to increase the effectiveness of a conventional sorbent (activated carbon) to capture mercury from coal flue gas" and that Olson "provides certain implementational details . . . such as which specific 'Br-containing' chemicals to use and the ratios of bromine promoter to activated-carbon sorbent." *Id.* at 42–47 (citing Ex. 1011, 1–2, 8–9, 19; Ex. 1014 ¶¶ 54, 66, 75, 95, 111, 113; Ex. 1003 ¶¶ 529–537).

Petitioner similarly alleges that the subject matter of claim 17 is suggested by the combination of Lissianski-Presentation and Olson. *Id.* at 68–73. Specifically, Petitioner contends that Lissianski-Presentation separately injects the bromine promoter and activated carbon sorbent into the flue gas stream. *Id.* at 68–70 (citing Ex. 1011, 9; 1014 ¶¶ 57, 66, Fig. 3; Ex. 1003 ¶ 562). Petitioner argues that a person of ordinary skill in the art would have understood that an in-flight reaction would occur between the bromine promoter and activated carbon. *Id.* at 70–72 (citing Ex. 1014 ¶¶ 11, 22, 24, 27, 43, 62, 66, 77–78; Ex. 1003 ¶¶ 563–566). Finally, Petitioner contends that Olson discloses a bromine promoter to sorbent ratio "from about 1 to about 30 grams per 100 grams of activated carbon." *Id.* at 72 (quoting Ex. 1014 ¶ 23, claims 3, 17, 37, 47).

Claim 18 additionally requires that the "gas stream is a mercury containing gas." Ex. 1001, 24:42–43. Petitioner contends that Lissianski-Presentation "discloses injecting the bromine-containing promoter into

mercury-containing flue gas upstream of the air preheater ("APH"), and separately injecting the activated-carbon sorbent either between the APH and [electrostatic precipitator ("ESP")], or between the ESP and fabric filter" ("FF"). Pet. 74. Petitioner contends that a person of ordinary skill in the art "would have understood that coal combustion produced a mercury containing flue gas, which would be created at or before the bromine injection points." *Id.* at 74–75 (citing Ex. 1003 ¶ 570).

Claim 19 additionally requires that the "gas stream is a transport gas." Ex. 1001, 24:44–45. Petitioner contends that Lissianski-Presentation "discloses an in-flight reaction in the flue gas between bromine and activated carbon to form an improved sorbent. A [person of ordinary skill in the art] would have understood that coal combustion produced a mercury-containing flue gas, and that the mercury-containing gas transported the bromine-containing promoter of Lissianski-Presentation to the activated-carbon sorbent." *Id.* at 75 (citing Ex. 1003 ¶ 571).

Patent Owner does not substantively address Petitioner's contentions regarding the teachings of Lissianski-Presentation and Olson, but rather rests on arguments advanced above regarding the priority date of claims 18 and 19 of the '147 patent. *See generally* Prelim. Resp.; *see also id.* at 1 n.1 ("For purposes of this preliminary response only, Patent Owner does not dispute that the asserted art renders the claims at issue unpatentable, and will only focus on the priority dispute."). Based on the preliminary record before us, we determine that Petitioner's arguments and evidence are sufficient to show each limitation of claims 18 and 19 is present in the combination of Lissianski-Presentation and Olson. Because we determined above (*supra* Section II.D.) that claims 18 and 19 of the '147 patent are not entitled to a

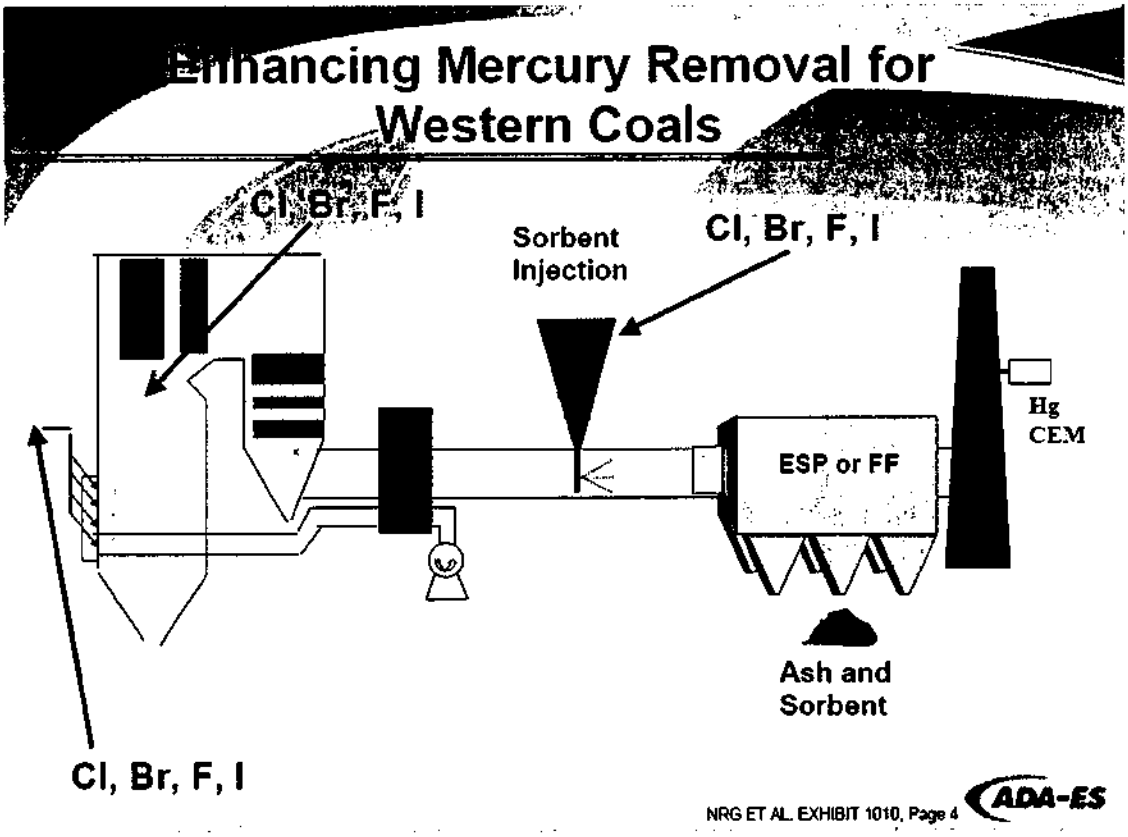
date of invention prior to the filing of date of the '147 patent, i.e., April 6, 2009, we determine that Petitioner has established a reasonable likelihood of prevailing on its challenge to claims 18 and 19 as obvious over the combination of Lissianski-Presentation and Olson.

G. Alleged Obviousness Based on Sjostrom and Olson

Petitioner contends claims 18 and 19 are rendered obvious over the combination of Sjostrom and Olson. Pet. 75–104. Petitioner also relies on the testimony of Dr. Niksa to support its arguments. *Id.*

1. Sjostrom (Ex. 1010)

Sjostrom relates to methods for enhancing mercury removal from coal flue gas. Ex. 1010, 4. Sjostrom illustrates a mercury capture process in a figure titled "Enhancing Mercury Removal for Western Coals," reproduced below. Ex. 1010, 4.



The figure on page 4 illustrates a coal combustion process including combusting coal, injecting halogens, separately injecting a halogenated sorbent, and collecting particulates. *See id.* Sjostrom discloses using Powder River Basin "(PRB") coal having a mercury content of "0.04–0.1 ppm-dry." *Id.* 12, 18. Sjostrom discloses that flue gas treated with existing equipment, i.e., without halogen-promoted activated carbon, contains 11.2 μg/dncm mercury. *Id.*, 3.

2. Public Accessibility of Sjostrom

Petitioner contends that Sjostrom was a presentation "delivered at the EUEC in January 2005 and mailed on CD to conference participants within a few weeks." Pet. at 78. Accordingly, Petitioner contends Sjostrom qualifies as prior art under: (1) 35 U.S.C. § 102(a) "because it was made available to the relevant public and POSITAs on January 25, 2005—the date it was presented" and (2) 35 U.S.C. § 102(b) because it was mailed on CD in February 2005. *Id.* at 80.

Patent Owner does not dispute whether Sjostrom was publicly accessible. *See generally* Prelim. Resp.

On this record, Petitioner has demonstrated a reasonable likelihood that Sjostrom was publicly available. *Hulu*, IPR2018-01039 (Paper 29) (for purposes of institution, a petitioner must show a reasonable likelihood that an asserted reference qualifies as a printed publication). Petitioner provides evidence that Sjostrom was presented in Tucson, Arizona on January 25, 2005, at the 2005 EUEC and that there were over eight hundred attendees. Pet. 78 (citing Ex. 1003 ¶¶ 265–268; Ex. 1030, 2–3, 23, 106–118; Ex. 1031). Petitioner's evidence does not indicate that attendance of the 2005 EUEC was restricted. *Id.* Petitioner also provides evidence of the CD that was

mailed to the conference attendees and copies of the Sjostrom presentation from the CD, without any apparent restriction or expectation of confidentiality. Ex. 1003 ¶ 267–268; Ex. 1030, 2–3; Ex. 1010; Ex. 1011; *GoPro*, 908 F.3d at 694–95. Therefore, on this record, Petitioner has met its burden of showing that Sjostrom qualifies as printed publications.

3. Analysis of Claims 18 and 19

Although claim 1 is disclaimed and claim 17 is not asserted in the instant Petition, claims 18 and 19 depend from and include the limitations of claims 1 and 17. Ex. 1001, 24:34–41. Accordingly, we review Petitioner's contentions as to claims 1 and 17, before we address the additional limitations of challenged claims 18 and 19. *See generally id.*, claims.

Petitioner contends that much of claim 1 is suggested by Sjostrom. Pet. 84–96. Petitioner relies primarily on page 4 of Sjostrom, reproduced below, to illustrate its contentions. *Id.* With reference to claim 1, Petitioner asserts that Sjostrom teaches a method for separating mercury from a mercury-containing flue gas because Sjostrom describes separately introducing both bromine and a chemical sorbent into a flue gas, from a coal-fired power plant, followed by the removal of particulate material. *Id.* at 84–85 (citing Ex. 1010, 1, 12, 18; Ex. 1003 ¶¶ 107–108, 579). Petitioner explains that "Sjostrom describes passing the flue gas through an electrostatic precipitator (ESP) or fabric filter (FF) after the bromine and sorbent injection, each of which separate mercury/sorbent particulates and fly ash." *Id.* at 95–96 (citing Ex. 1003 ¶¶ 597–599; Ex. 1010, 4).

According to Petitioner, a person of ordinary skill in the art "would have understood that the bromine and activated carbon would have contacted and reacted in the flue gas to form promoted-brominated sorbent"

when implementing the embodiment where bromine is added at location 2. *Id.* at 85–86 (citing Ex. 1003 ¶ 580–581; Ex. 1010, 4). Petitioner argues that a person of ordinary skill in the art "would have understood that the bromine-containing promoter added at Location 2 of Sjostrom would have contacted the sorbent in the flue gas at or downstream of the sorbent injection point" and that introducing bromine would have "improved mercury capture both by reacting with mercury in the gas-phase to oxidize mercury, and also by reacting with the activated-carbon sorbent." *Id.* at 88 (citing Ex. 1010, 4; Ex. 1003 ¶ 583). Petitioner asserts that like Sjostrom, Olson "proposes that reactions between HBr(g) and/or Br_2(g) and activated-carbon sorbent are one of promotion, as described" by the claims. *Id.* at 89 (citing Ex. 1014 ¶ 12); *see id.* at 88–90 (citing Ex. 1010, 4; Ex. 1014 ¶¶ 12, 14, 43, 54, 66; Ex. 1003 ¶¶ 583–587).

Petitioner contends that Sjostrom and Olson each describe using activated carbon sorbents, particularly Darco FGD. *Id.* at 87 (citing Ex. 1010, 4, 10–11, 16, 20), 91 (citing Ex. 1010, 16; Ex. 1014 ¶ 95). Olson describes its sorbent as having "a carbene species on the edge of the graphene sheet structure of the activated carbon." *Id.* at 91 (citing Ex. 1014 ¶¶ 54, 95). According to Petitioner, Olson describes "the brominated carbon contains both covalent carbon-bound (organic) bromide as well as ***anionic bromide***" and "that this reaction "provides a highly reactive bromine containing reagent that can oxidize the mercury and promote its capture on the activated carbon." *Id.* at 93 (citing Ex. 1014 ¶¶ 93, 96; Ex. 1003 ¶ 594). Petitioner further asserts that a person of ordinary skill in the art would have understood that the brominated sorbent would have chemically reacted with the mercury in the flue gas to form a mercury/sorbent composition," as

described in Olson. Pet. 93–94 (citing Ex. 1010, 16; Ex. 1014 ¶¶ 43, 128; Ex. 1003 ¶¶ 595–596).

Petitioner contends that the skilled artisan would have had reason to combine the teachings of Sjostrom and Olson because Olson provides "well-known details regarding the chemicals and proposed reaction mechanisms underlying the system of Sjostrom for mercury control from coal flue gas" and because Olson describes specific bromine species, i.e., HBr or Br_2, as useful in a bromination reaction. *Id.* at 80–84 (citing Ex. 1011, 1–2, 4, 10–11, 15–16; Ex. 1014 ¶¶ 22, 54, 66, 95, Fig. 2; Ex. 1003 ¶¶ 572–578).

Petitioner further alleges that the subject matter of claim 17 is suggested by the combination of Sjostrom and Olson. *Id.* at 97–102. Specifically, Petitioner contends that "Sjostrom teaches injecting bromine into the boiler, upstream of the sorbent injection point." *Id.* at 97 (citing Ex. 1010, 4; Ex. 1003 ¶ 600–601). Petitioner asserts that a person of ordinary skill in the art would have understood that the halogen is injected at Location 2, while an untreated carbon is separately injected into the flue gas. *Id.* at 98–99 (citing Ex. 1010, 4, 16; Ex. 1003 ¶ 601; Ex. 1009, 4676). Alternatively, Petitioner alleges that "even if a [person of ordinary skill in the art] were to include bromine at both Location 2 and Location 3 (i.e., creating a brominated sorbent at Location 3), this brominated sorbent is still a 'sorbent material comprising activated carbon,' which means that [the] sorbent can include other components besides activated-carbon, such as halogens." *Id.* at 99–100 (citing Ex. 1001, 7:44–46, 10:34–57; Ex. 1003 ¶ 602). Petitioner argues that an in-flight reaction occurs between the bromine promoter and activated carbon. *Id.* at 100–101 (citing Ex. 1014 ¶¶ 11, 22, 24, 27, 62, 66, 77–78; Ex. 1003 ¶¶ 603–605). Lastly, Petitioner

contends that Olson discloses a bromine promoter to sorbent ratio "from about 1 to about 30 grams per 100 grams of activated carbon." *Id.* at 102 (quoting Ex. 1014 ¶ 23, claims 3, 17, 37, 47 and citing Ex. 1003 ¶¶ 606–607).

With respect to claim 18, Petitioner contends that "Sjostrom describes injecting 'Br' promoter into a coal-fired boiler (e.g., combustion chamber)." Pet. 102 (citing Ex. 1010, 4). Petitioner contends that Sjostrom discloses both the coal and the flue gas contain mercury; thus, the Sjostrom discloses injecting bromine into a mercury-containing gas. *Id.* at 103–104. Petitioner further contends that "the sorbent is also injected into a mercury-containing gas." *Id.* at 104. Sjostrom shows injection of the sorbent into the flue-gas ductwork prior to the ESP or FF. Ex. 1010, 4.

Petitioner further asserts that Sjostrom "discloses an in-flight reaction in the mercury-containing flue gas between bromine and activated carbon to form an improved sorbent. A POSITA would have understood that coal combustion produced a mercury containing flue gas, and that the mercury-containing gas transported the bromine containing promoter of Sjostrom to the activated-carbon sorbent" as required by claim 19. *Id.* at 104 (citing Ex. 1003 ¶ 611).

Patent Owner does not substantively address Petitioner's challenge of claims 18 and 19, aside from arguing the priority of the '147 patent, as discussed above. *See generally* Prelim. Resp.; *see also id.* at 1 n.1 ("For purposes of this preliminary response only, Patent Owner does not dispute that the asserted art renders the claims at issue unpatentable, and will only focus on the priority dispute."). On this record, we determine that Petitioner's arguments and evidence are sufficient to suggest each of the

limitations of claims 18 and 19 is present in the combination of Sjostrom and Olson. Because we determined above (*supra* Section II.D.) that claims 18 and 19 of the '147 patent are not entitled to a date of invention prior to the filing of date of the '147 patent, i.e., April 6, 20009, we determine that Petitioner has established a reasonable likelihood of prevailing on its challenge to claims 18 and 19 as obvious over the combination of Sjostrom and Olson.

III. CONCLUSION

For the reasons set forth above, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing with respect to at least one challenged claim of the '147 patent. Thus, we institute an *inter partes* review on all challenged claims and on all grounds presented.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that an *inter partes* review is instituted on each of the grounds asserted in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial, which shall commence on the entry date of this decision.

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AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court **District of Delaware** on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	7/17/2019	District of Delaware

PLAINTIFF	DEFENDANT
Midwest Energy Emissions Corp. and MES Inc.	Vistra Energy Corp., et al.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 10,343,114 B2	7/9/2019	Midwest Energy Emissions Corp.
2	US 8,168,147 B2	5/1/2012	Midwest Energy Emissions Corp.
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3

CONFIRMATION NO. 1149

21186
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POWER OF ATTORNEY NOTICE

OC000000113387798

Date Mailed: 12/18/2019

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/11/2019.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(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**.

/dtdinh/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/419,219	04/06/2009	Edwin S. Olson	4820.001US3

CONFIRMATION NO. 1149

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

POA ACCEPTANCE LETTER

OC000000113387857

Date Mailed: 12/18/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/11/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/dtdinh/

Amended PTO/AIA/82B(07-13)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: **21186**

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

☒ The address associated with the above mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

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

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Midwest Energy Emissions Corp.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	John Pavlish	Date (Optional)	6/9/2017
Name	John Pavlish		
Title	Chief Technology Officer		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Fee Status

Please charge Deposit Account 19-0743 in the amount of $160.00 which is required under 37 C.F.R. § 1.20(d) to file a statutory disclaimer. The Commissioner of Patents and Trademarks is hereby authorized to charge any additional fees or deficiencies, or credit any overpayments, to Deposit Account No. 19-0743.

Respectfully submitted,

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

Date December 11, 2019

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Edwin S. Olson et al. Examiner: Amber Orlando
Serial No.: 12/419,219; U.S. Patent No.: 8,168,147 Group Art Unit: 1776
Filed: April 6, 2009 Docket No.: 4820.001US3
Customer No.: 21186 Confirmation No.: 1149
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

STATUTORY DISCLAIMER PURSUANT TO 37 C.F.R. § 1.321(a)

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

I, Nicholas P. Lanzatella, am an attorney of record for the above-identified patent as evidenced by the Power of Attorney filed herewith. This Statutory Disclaimer is submitted on behalf of Midwest Energy Emissions Corp, the assignee of the entire right, title, and interest in the above-identified patent, as evidenced by the assignments recorded on 8/29/2014 at reel 033643, frames 0538-0544; on 8/29/2014 at reel 033643, frames 0339-0345; on 8/29/2014 at reel 033643, frames 0436-0442; on 9/9/2014 at reel 033698, frames 0612-0621; and on 6/8/2017 at reel 042647, frames 0351-0359. As an attorney of record, I am empowered to act on behalf of Midwest Energy Emissions Corp and, in accordance with 37 C.F.R. § 1.321(a)(1), to sign this Statutory Disclaimer.

Statutory Disclaimer

Midwest Energy Emissions Corp, the owner of the entire right, title and interest in and to the above-identified patent, hereby statutorily disclaims the following complete claims in U.S. Patent No. 8,168,147: claims 1-16 and 21-25.

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.:	4820.001US3	Serial No.:	12/419,219
Filed:	April 6, 2009	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	1149

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

We are transmitting herewith the following attached items (as indicated with an "X"):

X Statutory Disclaimer Pursuant to 37 C.F.R. § 1.321(a) (2 pgs.)
X Authorization to charge Deposit Account 19-0743 in the amount of $160 to cover the Statutory Disclaimer fee.
X Power of Attorney (1 pg)

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

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

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Janal M. Kalis/Megan Reed
Attorney Docket Number:	3338.005US3

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	160	160
		Total in USD ($)		**160**

Electronic Acknowledgement Receipt

EFS ID:	38002540
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Janal M. Kalis/Megan Reed
Filer Authorized By:	Janal M. Kalis
Attorney Docket Number:	3338.005US3
Receipt Date:	11-DEC-2019
Filing Date:	06-APR-2009
Time Stamp:	17:06:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$160
RAM confirmation Number	E2019BAH07505281
Deposit Account	
Authorized User	

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

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SIGNED_4820_001US3_StatutoryDisclaimerPOA.pdf	3391952 e6abbc396371446a76116f94bd364a8e9fb90126	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	4	4
	Applicant Arguments/Remarks Made in an Amendment	3	3
	Statutory disclaimers per MPEP 1490	2	2
	Transmittal Letter	1	1

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30432 4d2061f9206bc55f81c01319e15489e069c18b6a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3422384		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/419,219	05/01/2012	8168147	3338.005US3	1149

21186 7590 04/11/2012

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

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

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

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

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

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

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

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

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	1,984,164	12-11-1934	Stock			
	3,194,629	07-13-1965	Dreibelbis, et al.			
	3,662,523	05-16-1972	Revoir			
	3,786,619	01-22-1974	Melkersson			
	3,826,618	07-1974	Capuano			
	3,849,267	11-19-1974	Hilgen			
	4,101,631	07-18-1978	Ambrsini, et al.			
Change(s) applied to document, /J.L.B./ 2/13/2012	4,196,173	04-01-1980	Delong, et al.			
	4,500,327	02-19-1985	Nishino, et al.			
	4,708,853	11-24-1987	Matviya			
	4,786,483	11-22-1988	Audeh			
	4,814,152	03-21-1989	Yan			
	4,820,318	04-1989	Chang et al.			
	4,889,698	12-26-1989	Moller			
	4,956,162	09-11-1990	Smith			
	5,300,137	04-1994	Weyand et al.			
	5,409,522	04-1995	Durham et al.			
	5,505,766	04-09-1996	Chang			
	5,575,982	11-1996	Reiss et al.			
	5,607,496	03-04-1997	Brooks			
Change(s) applied to document, /J.L.B./ 2/16/2012	5,672,323	09-30-1997	Bhat			
	5,695,726	12-09-1997	Lerner			
	5,827,352	10-27-1998	Altman			
	5,891,324	04-06-1999	Ohtsuka			
	6,027,551	02-22-2000	Hwang			
	6,080,281	06/27/2000	Attia			

EXAMINER /Amber Orlando/	DATE CONSIDERED 01/07/2010

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.

*Substitute Disclosure Statement Form (PTO-1449) Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

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)

21186 7590 01/10/2012
SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

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

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

Marina Kraut	(Depositor's name)
/MKraut/	(Signature)
March 27, 2012	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

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	$1740	$300	$0	$2040	04/10/2012

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

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address Form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 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 Schwegman, Lundberg
2 & Woessner, P.A.
3

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

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document 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)

Energy & Environmental Research Center Foundation | Grand Forks, ND

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 190743 (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 /Geoffrey K Cooper/ Date March 27, 2012

Typed or printed name Geoffrey K. Cooper Registration No. 51,266

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.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	12/419,219	Group Art Unit:	1776
Filed:	April 6, 2009	Docket:	3338.005US3
Customer No.:	21186	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION CONCERNING PRIOR OR COPENDING APPLICATION(S)

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

Pursuant to the guidance of MPEP §§ 2001.06(b) and 2004(9), Applicants would like to bring the following additional application(s) to the Examiner's attention. The identification of these applications is not intended to suggest that the subject matter claimed in any listed application is, or has been, substantially similar to any claim or claims in the present application.

Serial No./ Patent No.	Filing Date	Attorney Docket	Title
12/201,595	August 29, 2008	3338.005US2	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 373-6911

Date March 27, 2012 By Geoffrey K. Cooper

Geoffrey K. Cooper
Reg. No. 51,266

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson et al.	Examiner: Amber Orlando	
Serial No.:	12/419,219	Group Art Unit: 1776	
Filed:	April 6, 2009	Docket No.: 3338.005US3	
Customer No.:	21186	Confirmation No.: 1149	
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION RE: FEE ADDRESS

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

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

Customer Number 21186

Please direct any inquiries to the undersigned attorney at (612) 373-6941.

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 373-6941

Date March 27, 2012 By _____
Geoffrey K. Cooper
Reg. No. 51,266

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 27 day of March, 2012.

Marina Kraut
Name

_____
Signature

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Robin A. Chadwick/Marina Kraut
Attorney Docket Number:	3338.005US3

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	1740	1740
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**2040**

Electronic Acknowledgement Receipt

EFS ID:	12404927
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Robin A. Chadwick/Marina Kraut
Filer Authorized By:	Robin A. Chadwick
Attorney Docket Number:	3338.005US3
Receipt Date:	27-MAR-2012
Filing Date:	06-APR-2009
Time Stamp:	16:31:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2040
RAM confirmation Number	3844
Deposit Account	190743
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)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		3338_005US3.pdf	402170 a3c8c3377319eb1132920a7974f0604d71541c0e	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Transmittal Letter	1	1
	Issue Fee Payment (PTO-85B)	2	2
	Miscellaneous Incoming Letter	3	3
	Miscellaneous Incoming Letter	4	4

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32350 e027572ecaf956955de5380b2c8ff37b009314be	no	2

Warnings:

Information:

Total Files Size (in bytes):	434520

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

Applicant: Edwin S. Olson et al.

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	3338.005US3	Serial No.:	12/419,219
Filed:	April 6, 2009	Due Date:	April 10, 2012
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	1149

Notice of Allowance Date: January 10, 2012

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

We are transmitting herewith the following:

X Authorization to charge Deposit 19-0743 in the amount of $1740.00 to cover the Large Entity Issue Fee Payment.
X Authorization to charge Deposit 19-0743 in the amount of $300.00 to cover the Publication Fee Payment.
X Issue Fee Transmittal (Form PTOL-85).
X Communication Concerning Prior or Copending Application(s) (1 page).
X Communication Re: Fee Address (1 page).

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

SCHWEGMAN, LUNDBERG & WOESSNER, P.A. By _____
Customer No.: 21186 Geoffrey K. Cooper
Reg. No. 51,266

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 27 day of March, 2012.

Marina Kraut
Name

/MKraut/
Signature

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

21186 7590 01/10/2012

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

EXAMINER	
ORLANDO, AMBER ROSE	
ART UNIT	PAPER NUMBER
1776	

DATE MAILED: 01/10/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

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	$1740	$300	$0	$2040	04/10/2012

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)

21186 7590 01/10/2012
SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. BOX 2938
MINNEAPOLIS, MN 55402

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

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being 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.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

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	$1740	$300	$0	$2040	04/10/2012

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

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 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.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

21186 7590 01/10/2012

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

EXAMINER	
ORLANDO, AMBER ROSE	

ART UNIT	PAPER NUMBER
1776	

DATE MAILED: 01/10/2012

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 0 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 0 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.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1776	

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

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

1. ☒ This communication is responsive to *the correspondence filed 10/27/2011*.

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

3. ☒ The allowed claim(s) is/are *34-36,39,40 and 42-61*.

4. ☐ 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.

5. ☐ 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.

6. ☐ 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).

7. ☐ 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

Allowable Subject Matter

1. Claims 34-36, 39, 40 and 42-61 are allowed.

2. The following is an examiner's statement of reasons for allowance: a method for separating mercury from a mercury containing gas comprising promoting at least a portion of a particulate sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the activated carbon contains grapheme sheets having carbine species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury could not be found within the 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 ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Mon.-Thurs. (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571) 272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Duane Smith/
Supervisory Patent Examiner, Art Unit 1776

AO

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1776

✓	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	01/11/2010	10/08/2010	02/22/2011	07/29/2011	01/03/2012				
2419	1	-	-	-	-	-				
	2	-	-	-	-	-				
	3	-	-	-	-	-				
	4	-	-	-	-	-				
	5	-	-	-	-	-				
	6	-	-	-	-	-				
	7	-	-	-	-	-				
	8	-	-	-	-	-				
	9	-	-	-	-	-				
	10	-	-	-	-	-				
	11	-	-	-	-	-				
	12	-	-	-	-	-				
	13	-	-	-	-	-				
	14	-	-	-	-	-				
	15	-	-	-	-	-				
	16	-	-	-	-	-				
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	18	-	-	-	-	-				
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	21	-	-	-	-	-				
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	23	-	-	-	-	-				
	24	-	-	-	-	-				
	25	-	-	-	-	-				
	26	-	-	-	-	-				
	27	-	-	-	-	-				
	28	-	-	-	-	-				
	29	-	-	-	-	-				
	30	-	-	-	-	-				
	31	-	-	-	-	-				
	32	-	-	-	-	-				
	33	-	-	-	-	-				
	34	✓	✓	✓	✓	=				
	35	✓	✓	✓	✓	=				
	36	✓	✓	✓	✓	=				

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1776

✓	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	01/11/2010	10/08/2010	02/22/2011	07/29/2011	01/03/2012				
	37	✓	-	-	-	-				
	38	✓	✓	-	-	-				
	39	✓	✓	✓	✓	=				
	40	✓	✓	✓	✓	=				
	41	✓	-	-	-	-				
	42	✓	✓	✓	✓	=				
	43	✓	✓	✓	✓	=				
	44	✓	✓	✓	✓	=				
	45	✓	✓	✓	✓	=				
	46	✓	✓	✓	✓	=				
	47	✓	✓	✓	✓	=				
	48	✓	✓	✓	✓	=				
	49	✓	✓	✓	✓	=				
	50	✓	✓	✓	✓	=				
	51	✓	✓	✓	✓	=				
	52	✓	✓	✓	✓	=				
	53	✓	✓	✓	✓	=				
	54	✓	✓	✓	✓	=				
	55	✓	✓	✓	✓	=				
	56	✓	✓	✓	✓	=				
	57	✓	✓	✓	✓	=				
	58		✓	✓	✓	=				
	59		✓	✓	✓	=				
	60		✓	✓	✓	=				
	61		✓	✓	✓	=				

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	Art Unit
	AMBER ORLANDO	1776

SEARCHED

Class	Subclass	Date	Examiner
110	345	1/11/2010	AO
423	210	1/11/2010	AO
95	134, 142	1/11/2010	AO
110	345	10/8/2010	AO
423	210	10/8/2010	AO
95	134, 142	10/8/2010	AO
110	345	2/22/2011	AO
423	210	2/22/2011	AO
95	135, 142	2/22/2011	AO
110	345	7/29/2011	AO
95	134, 142	7/29/2011	AO
423	210	7/29/2011	AO
110	345	1/3/2012	AO
423	210	1/3/2012	AO
95	134, 142	1/3/2012	AO

SEARCH NOTES

Search Notes	Date	Examiner
Inventor Search (eDAN)	1/11/2010	AO
Classes 95, 423 and 110 searched for separating mercury from a mercury containing gas. The method including a sorbent, a promotor and separating particulates from the mercury containing gas.	1/11/2010	AO
IDS search (EAST and eDAN)	1/11/2010	AO
Classes 95, 423 and 110 researched for new art.	10/8/2010	AO
Classes 95, 423 and 110 researched for new art.	2/22/2011	AO
Classes 95. 423. 110 researched for new art.	7/29/2011	AO
Classes 95, 423 and 110 researched for new art (EAST).	1/3/2012	AO

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
	SEE EAST SEARCH HISTORY	1/3/2012	AO

/AMBER ORLANDO/ Acting Examiner.Art Unit 1776	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1776

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
423	210	B 0 1 D 53 / 02 (2006.01.01)	

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
95	134	901			
423	103				
502	416	417			

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

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

/AMBER ORLANDO/ Acting Examiner.Art Unit 1776	01/03/2012	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	25	
/DUANE SMITH/ Supervisory Patent Examiner.Art Unit 1776	01/04/2012	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	34	1

PTO/SB/08A(04-07)
Modified form approved for use through 09/30/2007. OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	12/419,219
	Filing Date	April 6, 2009
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 3338.005US3	

US PATENT DOCUMENTS

Examiner Initial *	USP Document Number	Publication Date	Name of Patentee or Applicant of cited Document	Filing Date If Appropriate

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Foreign Document No	Publication Date	Name of Patentee or Applicant of cited Document	T 1

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 1
	Canadian Application Serial No. 2,584,327, Office Action mailed 03-03-09. 4 pgs.	

EXAMINER /Amber Orlando/ **DATE CONSIDERED** 01/03/2012

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

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

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	22	graphene sheets and carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:11
L2	30	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and crystal$4 with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:13
L3	0	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and crystal$4 with activated carbon and carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:14
L4	16	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and crystal$4 with activated carbon and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:15
L5	2	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and flake with activated carbon and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:17
L6	8	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and graphite with activated carbon and mercury	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:18
L8	23	"6136749"	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:22
L9	8	"6136749" and graphite	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:22

L15	75	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:34
L16	5	"4500327" and graphite	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:34
L17	0	"3662523" and graphite	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:35
L18	20	"3662523" \	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:35
L19	20	"3662523"	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 16:35
S1	1	"12419219"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:00
S2	29	"6471936"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:09
S3	1	graphene sheet with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:12
S4	5	graphene with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:12
S5	1	"20030136509"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:17
S6	1	graphene and sorbent with hydrocarbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:48
S7	6	graphene with carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:49
S8	68	graphene and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:51
S9	4	graphene with activated carbon and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:54
S10	57	graphene with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:55

S11	98	sheet with activated carbon and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:56
S12	1	sheet with activated carbon and sorbent and graphene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:56
S13	13	graphene same sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:26
S14	0	graphene same carbene site	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
S15	6	sorbent with carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
S16	7	carbon with carbene and sorbent with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
S17	2	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and graphene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:45
S18	4	(110/345.ccls. or 95/134.ccls. or 95/142.ccls. or 423/210.ccls.) and carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:45
S19	0	"2004003716"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/08/31 09:50
S20	1	"20040003716"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/08/31 09:50
S21	1897	graphene sheets	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 11:56
S22	168	graphene sheets and activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 11:56
S23	8	graphene sheets and activated carbon with particulate	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 11:56
S24	5	graphene sheets and activated carbon and carbene'	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 12:01

S25	5	graphene sheets and activated carbon and carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2012/01/03 12:01

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L10	0	(bromide and sorbent and graphene and particulate and mercury).clm.	USPAT; UPAD	ADJ	ON	2012/01/03 16:25
L11	1	(bromide and sorbent and particulate and mercury).clm.	USPAT; UPAD	ADJ	ON	2012/01/03 16:25
L12	0	(activated carbon and bromine and sorbent and (graphene or graphite) and mercury).clm.	USPAT; UPAD	ADJ	ON	2012/01/03 16:26
L13	7	(activated carbon and bromine and sorbent and mercury).clm.	USPAT; UPAD	ADJ	ON	2012/01/03 16:26
L14	66	"4500327"	USPAT; UPAD	ADJ	ON	2012/01/03 16:33

1/3/2012 4:36:50 PM
C:\Documents and Settings\amillerharris\My Documents\EAST\Workspaces\12419219.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Edwin S. Olson et al. Examiner: Amber Orlando
Serial No.: 12/419,219 Group Art Unit: 1776
Filed: April 6, 2009
Docket No.: 3338.005US3 (IP 09-012 Continuation)
Customer No.: 21186 Confirmation No.: 1149
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

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

In response to the Office Action dated August 4, 2011, please amend the application as follows:

IN THE CLAIMS

Please amend the claims as follows:

1-33. (Canceled)

34. (Currently Amended) A method for separating mercury from a mercury containing gas comprising:

(a) promoting at least a portion of a particulate sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

35. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in gaseous form.

36. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in an organic solvent.

37-38. (Cancelled)

39. (Previously Presented) A method according to claim 34, wherein the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition.

40. (Previously Presented) A method according to claim 34, wherein at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition.

41. (Cancelled)

42. (Previously Presented) A method according to claim 34, wherein the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators.

43. (Previously Presented) A method according to claim 34, further comprising a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition for reuse.

44. (Previously Presented) A method according to claim 43, further comprising injecting the regenerated promoted brominated sorbent into a mercury containing gas.

45. (Previously Presented) A method according to claim 34, further comprising injecting an alkali component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

46. (Previously Presented) A method according to claim 45, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

47. (Previously Presented) A method according to claim 34, further comprising adding a second halogen or halide promoter to the promoted halogen containing sorbent.

48. (Previously Presented) A method according to claim 47, wherein the second halogen or halide promoter comprises HI, HBr, HCI, Group V element with halogen, or Group VI element with halogen.

49. (Previously Presented) A method according to claim 34, further comprising adding a stabilizing agent to the promoted brominated sorbent.

50. (Previously Presented) A method according to claim 49, wherein the stabilizing agent comprises at least one of S, Se, H_2S, $S0_2$, H_2Se, $Se0_2$, CS_2, P_2S_5, or mixtures thereof.

51. (Previously Presented) A method according to claim 34, wherein the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas.

52. (Previously Presented) A method according to claim 34, wherein the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

53. (Currently Amended) A method according to claim 34, further comprising injecting the particulate sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, 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 the sorbent material.

54. (Previously Presented) A method according to claim 53, wherein the gas stream is a mercury containing gas.

55. (Previously Presented) A method according to claim 54, wherein the gas stream is a transport gas.

56. (Previously Presented) A method according to claim 53, wherein the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas.

57. (Previously Presented) A method according to claim 34, wherein the composition of the promoted sorbent is controlled by the mercury content of the cleaned gas stream.

58. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises at least one of HBr, PBr_3, or Br_2

59. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises molecular bromine.

60. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a bromine compound.

61. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a Group V or Group VI bromide.

REMARKS

This responds to the Office Action dated August 4, 2011.

Claim 34 and 53 are amended and as a result, claims 34-36, 39, 40 and 42-61 are now pending in this application.

Interview Summary

Applicants thank Examiner Amber Orlando for the courtesy of a telephone interview on August 31, 2011 with Applicants' representatives Nicholas P. Lanzatella and Ramani V. Marakani. During the interview, it was proposed to amend claim 34 to include "a particulate sorbent material" in place of "a sorbent material". It was agreed upon that with the amendment, Applicants would overcome the rejections under 35 U.S.C. § 112 and §103.

The Rejection of Claims Under § 112

Claims 34, 53 and 56 were rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement.

Claims 34 and 53 are amended to include "particulate sorbent material" in order to overcome the rejection. The support for the amendment may at least be found in paragraphs [0011], [0016], [0026], [0052] and [0054] to [0062] of the present application, published as US2010/0047146, which clarify the particulate nature of the sorbent material. Paragraph [0011] states that 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 and activated carbon with an average particle size greater than that of flyash. All these materials are well known in the art to be particulate material. In one embodiment, the activated carbon has a particle size of greater than 40 microns, allowing its separation from flyash.

As described in paragraph [0016], the material remains in particulate form after treatment with the bromine containing promoter (e.g., bromine gas). It is stated in paragraph [0016] that the reaction product of the starting activated carbon and the bromine containing promoter can

have "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."

Further, the Examiner is respectfully directed to paragraph [0026] of the application as filed, wherein it is stated that a "particulate activated carbon sorbent with a mass mean size greater than 40μm 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."

Furthermore, paragraph [0052] explains how activated carbon reacts with bromine containing promoters, such as molecular bromine, at the molecular level. The "graphene sheet structures of the carbon" is referred to, making clear that the activated carbon used in the claimed process is formed of graphene sheets in association. Figure 2 is described therein as showing the chemistry whereby the graphene sheets that in bulk make up the activated carbon used herein react at an edge carbene site with the bromine to form a mercury-reactive species capable of capturing the mercury in elemental form from the waste gas stream. The description of Figure 3 found in the paragraphs [0054] to [0062] explain the physical process whereby the particulate activated carbon material is promoted by bromine, reacts with the waste gas stream and is collected as a particulate.

With respect to claims 53 and 56, it is clear that the rate of injection of the graphene sheets follows directly from the rate of injection of the particulate activated carbon. The graphene sheet is part of a particulate material, activated carbon, as is made clear from the above discussion.

Accordingly, it is clear from the amended claims 34 and 53 and the description of the application as filed that every step of the process of mercury removal is within ordinary understanding in conjunction with the knowledge of the person of ordinary skill in the art. Therefore, Applicants submit that the claims meet the requirements of §112 concerning enablement, and that the claims are in condition for allowance, which is earnestly solicited.

The Rejection of Claims Under § 103

Claims 34, 35, 39, 40, 42, 49-52 and 58-60 were rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716) in view of Yang et al. (US 2002/0134242).

Applicants respectfully traverse the rejections, and request reconsideration and withdrawal of the rejections with respect to claim 34 and to all other rejected dependent claims.

The Examiner's arguments for rejection of claims 34 and claims 35, 39, 40, 42, 49-52 and 58-60 dependent thereon over Nelson and Yang do not properly create a *prima facie* case of obviousness, at least because the two cited documents fail to disclose or suggest all elements of the rejected claims.

The Examiner admits that Nelson does not disclose or suggest the activated carbon being graphene sheets, or edge sites of graphene sheets being carbenes. It also does not disclose or suggest the reaction of the carbene sites with a bromine containing promoter to yield bromide anion paired carbocation sites on the carbon as being the sites reactive with mercury, which serve to react with and immobilize mercury vapor from the waste gas stream.

Yang does not remedy this deficiency. Yang neither discloses nor teaches using activated carbon containing graphene sheets. Yang discloses using carbon nanotubes as a sorbent to remove dioxin from an exhaust gas. Yang asserts that carbon nanotubes are better sorbents than activated carbon as the nanotubes desorb dioxin at a higher temperature than the activated carbon. Yang further discloses a principal problem associated with the use of activated carbon. Clearly, Yang teaches away from using activated carbon for treating the exhaust gas. Support for this argument may at least be found from paragraphs [0015] to [0017] of Yang.

A person skilled in the art would not be motivated to combine the teachings of Nelson and Yang because Yang clearly teaches away from using activated carbon. Therefore, the combination of Nelson and Yang fails to create a *prima facie* case of obviousness. Further, the combination of the cited documents fails to disclose or suggest activated carbon containing graphene sheets with carbene species edge cites that react with a bromine containing promoter to produce carbocationic sites that can react with and immobilize mercury atoms.

Applicants respectfully submit that claims 34, 35, 39, 40, 42, 49-52 and 58-60 are in condition for allowance, which is earnestly solicited.

Claim 36 was rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716) and Yang et al. (US 2002/013424) as applied in claim 34 above, and further in view of Nishino et al. (US 4,500,327).

Applicants traverse this rejection, and request reconsideration and withdrawal of the rejections with respect to claim 36.

The introduction of an organic solvent into the promotion reaction as discussed by Nishino does not cure the fundamental deficiency, as discussed above, concerning activated carbon containing graphene sheets, carbene-containing edge sites of the graphene sheets and reaction with bromine promoting agents, and the resulting production of carbocations that can react with and immobilize vaporized mercury. Accordingly, a prima facie case of the obviousness of claim 36 over the three cited documents has not been properly made. Applicants respectfully submit that claim 36 is in condition for allowance, which is earnestly solicited.

Claims 43 and 44 were rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716) and Yang et al. (US 2002/013424) as applied in claim 34 above, and further in view of de Jong (CA 1099490).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claims 43 and 44.

The introduction of regeneration step for an absorbent as discussed by de Jong, does not cure the fundamental deficiency, as discussed above, concerning activated carbon containing graphene sheets, carbene-containing edge sites of the graphene sheets and reaction with bromine promoting agents, and the resulting production of carbocations that can react with and immobilize vaporized mercury. Accordingly, a *prima facie* case of the obviousness of claims 43 and 44 over the cited documents has not been properly made. Applicants respectfully submit that claims 43 and 44 are in condition for allowance, which is earnestly solicited.

Claim 45 was rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716) and Yang et al. (US 2002/013424) as applied in claim 34 above, and further in view of Gadkaree et al. (US 6,136,749).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 45.

Again, the addition of Gadkaree's discussion of alkali injection in the treatment of mercury-containing flue gases to the set of cited documents does not cure the deficiency, as discussed above, concerning activated carbon containing graphene sheets, carbene-containing edge sites of graphene sheets and reaction with bromine promoting agents, and production of

carbocations. Accordingly, a *prima facie* case of the obviousness of claims 45 over the cited documents has not been properly made. Applicants respectfully submit that claim 45 is in condition for allowance, which is earnestly solicited.

Claim 46 was rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716), Yang et al. (US 2002/013424) and de Jong (CA 1099490) as applied in claim 43 above, and further in view of Gadkaree et al. (US 6,136,749).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 46.

The addition of Gadkaree and de Jong, with their discussion of alkali injection and various options for specific alkaline salts, does not cure the deficiencies of Nelson and Yang as applied to claim 34 or 45, upon which claim 46 depends. The combination of the four cited documents fails to disclose or suggest the use of activated carbon that contains graphene sheets, carbene-containing edge sites of the graphene sheets and reaction with bromine promoting agents, and production of carbocations. Accordingly, a *prima facie* case of obviousness of claim 46 over the four cited documents has not been properly made. Applicants respectfully submit that claim 46 is in condition for allowance, which is earnestly solicited.

Claims 47, 48, 53-55 and 61 were rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716) and Yang et al. (US 2002/013424) as applied in claim 34 above, and further in view of Srinivasachar et al. (US 6,848,374).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claims 47, 48, 53-55 and 61.

Srinivasachar discusses the use of a second halogen-containing reagent. However, this fails to cure the deficiences of the combination of Nelson and Yang, as discussed above.

Accordingly, a *prima facie* case of the obviousness of claims 47, 48, 53-55 and 61 over the cited documents has not been properly made. Applicants respectfully submit that claims 47, 48, 53-55 and 61 are in condition for allowance, which is earnestly solicited.

Claim 56 was rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716), Yang et al. (US 2002/013424) and Srinivasachar et al. (US 6,848,374) as applied in claim 53 above, and further in view of Vosteen et al. (US 6,878,358).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 56.

The combination of the cited documents fails to make claim 56 obvious at least because the combination of Nelson and Yang fails to make claim 34, upon which claim 56 depends, obvious.

Accordingly, a *prima facie* case of the obviousness of claim 56 over the cited documents has not been properly made. Applicants respectfully submit that claim 56 is in condition for allowance, which is earnestly solicited.

Claim 57 was rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. (US 2004/003716) and Yang et al. (US 2002/013424) as applied in claim 34 above, and further in view of Vosteen et al. (US 6,878,358).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 57.

The addition of Vosteen to the proposed combination of Nelson Jr. and Yang does not cure the defects noted earlier as to the rejection of claim 34, upon which claim 57 depends. Applicants respectfully submit that claim 57 is in condition for allowance, which is earnestly solicited.

CONCLUSION

Applicants respectfully submit that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicants' representative at (612) 373-6941 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402--0938
(612) 373-6941

Date October 27, 2011

By Geoffrey K. Cooper
Geoffrey K. Cooper
Reg. No. 51,266

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	12/419,219	Group Art Unit:	1776
Filed:	April 6, 2009	Docket:	3338.005US3
Customer No.:	21186	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

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

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, the enclosed materials are brought to the attention of the Examiner for consideration in connection with the above-identified patent application. Applicants respectfully request that this Information Disclosure Statement be entered and the documents listed on the attached PTO 1449 Form be considered by the Examiner and made of record. Pursuant to the provisions of MPEP 609, Applicants request that a copy of the PTO 1449 Form, initialed as being considered by the Examiner, be returned to the Applicants with the next official communication.

Pursuant to 37 C.F.R. § 1.97(c)(2), Applicants hereby authorize the Commissioner to charge the fee of $180.00 as set forth in 37 C.F.R. § 1.17(p), to Deposit Account No. 19-0743. Please charge any additional fees or deficiencies, or credit any overpayment to Deposit Account No. 19-0743.

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicants acknowledge the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 373-6941

Date October 27, 2011 By /Geoffrey K Cooper/

Geoffrey K. Cooper
Reg. No. 51,266

PTO/SB/08A(04-07)
Modified form approved for use through 09/30/2007. OMB 651-0031
US Patent & Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** (Use as many sheets as necessary)	*Complete if Known*	
	Application Number	12/419,219
	Filing Date	April 6, 2009
	First Named Inventor	Edwin S. Olson
	Group Art Unit	1776
	Examiner Name	Amber Orlando
Sheet 1 of 1	Attorney Docket No: 3338.005US3	

US PATENT DOCUMENTS				
Examiner Initial *	**USP Document Number**	**Publication Date**	**Name of Patentee or Applicant of cited Document**	**Filing Date If Appropriate**

FOREIGN PATENT DOCUMENTS				
Examiner Initial *	**Foreign Document No**	**Publication Date**	**Name of Patentee or Applicant of cited Document**	**T 1**

OTHER DOCUMENTS – NON PATENT LITERATURE DOCUMENTS		
Examiner Initial *	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T 1**
	Canadian Application Serial No. 2,584,327, Office Action mailed 03-03-09. 4 pgs.	

EXAMINER **DATE CONSIDERED**

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

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Joseph P. Mehrle/Anne Richards
Attorney Docket Number:	3338.005US3

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:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	11280143
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	21186
Filer:	Joseph P. Mehrle/Anne Richards
Filer Authorized By:	Joseph P. Mehrle
Attorney Docket Number:	3338.005US3
Receipt Date:	27-OCT-2011
Filing Date:	06-APR-2009
Time Stamp:	14:41:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	1031
Deposit Account	190743
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)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		3338005us3respSIGNED.pdf	214005 61e230b0bfb9be51903b268e90f7e445534ae7b7	yes	16

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	1	1
Amendment/Req. Reconsideration-After Non-Final Reject	2	2
Claims	3	6
Applicant Arguments/Remarks Made in an Amendment	7	13
Transmittal Letter	14	15
Information Disclosure Statement (IDS) Form (SB08)	16	16

Warnings:

Information:

2	Non Patent Literature	3338005us3caoa.pdf	206541 7e4ea5ff5cf87fa46f37b928f780b573de24dc6e	no	4

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	30711 8ca76d835151ae4d7b891b05685e0cf548be2bf4	no	2

Warnings:

Information:

Total Files Size (in bytes):	451257

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

Applicant: Edwin S. Olson et al.

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	3338.005US3	Serial No.:	12/419,219
Filed:	April 6, 2009	Due Date:	November 4, 2011
Examiner:	Amber Orlando	Group Art Unit:	1776
Customer No.:	21186	Confirmation No.:	1149

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

We are transmitting herewith the following attached items (as indicated with an "X"):

X Amendment and Response under 37 C.F.R. § 1.111 (12 pgs.)
X Supplemental Information Disclosure Statement (2 pgs.), Form 1449 (1 pg.) and copy of one cited document.
X Authorization to charge Deposit Account 19-0743 in the amount of $180.00 to cover the fee for consideration of Information Disclosure Statement under 37 C.F.R. § 1.97(c).

If not provided for in a separate paper filed herewith, please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

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

By: Geoffrey K. Cooper
Geoffrey K. Cooper
Reg. No. 51,266

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
12/419,219	04/06/2009	

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 10/27/2011	(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	** 26	= 0	X $ =		OR	X $60=	0
Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	X $ =		OR	X $250=	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:
/JEFFERY L. OLSEN/

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.

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.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

21186 7590 09/23/2011

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

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

NOTIFICATION DATE	DELIVERY MODE
09/23/2011	ELECTRONIC

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

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

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

uspto@slwip.com
request@slwip.com

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1776	

All participants (applicant, applicant's representative, PTO personnel):

(1) *AMBER ORLANDO*. (3)_____.

(2) *NICHOLAS LANZATELLA*. (4)_____.

Date of Interview: *31 August 2011*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *34,53 and 56*.

Identification of prior art discussed: *Yang et al. US 2002/0134242*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The 112 rejections concerning the graphene sheet being particulate matter was discussed, as well as possible amendments to overcome the rejections. The Yang et al. reference was discussed and how it differs from the current inventions. The examiner stated that the amendments discussed would help overcome the previous 103 rejections.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/AMBER ORLANDO/ Acting Examiner of Art Unit 1776	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

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.
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3	1149

21186 7590 08/04/2011

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

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

NOTIFICATION DATE	DELIVERY MODE
08/04/2011	ELECTRONIC

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

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

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

uspto@slwip.com
request@slwip.com

Office Action Summary	Application No.	Applicant(s)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1776	

-- 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 *25 May 2011*.

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) *34-36,39,40 and 42-61* 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) *34-36,39,40 and 42-61* 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 correspondence filed 05/25/2011.

Claims 34-36, 39-40 and 42-61 are rejected.

Claims 34-36, 39-40 and 42-61 are pending and have been examined.

Claim Rejections - 35 USC § 112

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

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 34, 53 and 56 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. For claim 34, the claim states the sorbent is activated carbon which contains graphene sheets, that react with bromine, then react with elemental mercury, and lastly separating particulates from the mercury containing gas, the particulates including the mercury/sorbent chemical composition. The state of the prior art does not provide evidence on how a graphene sheet would become a mercury/sorbent particulate which can then be separated from the mercury containing gas. One having ordinary skill in the art would not find the graphene sheet somehow becoming particulate matter predictable in the art as there no direction or guidance within the claims or the specification reciting how the graphene sheets would becoming particulate matter (grinding steps etc.). There

is an absence of working examples showing how a graphene **sheet** would become a mercury/sorbent **particulate** which can then be separated from the mercury containing gas. There would be an extended period of experimentation needed to make use of the claimed invention, as there is not sufficient direction or guidance within the specification as to how the graphene sheets would become particulate matter to therefore be separated from the mercury containing gas.

3. For claims 53 and 56, the claims pertain to injecting the sorbent material (graphene sheets), and the injection rate. The state of the prior art does not provide evidence on how a graphene sheet would be injected at an injection rate. One having ordinary skill in the art would not find the graphene sheet somehow becoming particulate matter in order to be injected at an injection rate predictable in the art as there no direction or guidance within the claims or the specification reciting how the graphene sheets would becoming particulate matter (grinding steps etc.). There is an absence of working examples showing how a graphene **sheet** would become a mercury/sorbent **particulate** which can be injected at an injection rate. There would be an extended period of experimentation needed to make use of the claimed invention, as there is not sufficient direction or guidance within the specification as to how the graphene sheets would become particulate matter which can be injected at an injection rate.

Claim Rejections - 35 USC § 103

1. 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.

2. 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.

3. 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).

4. Claims 34, 35, 39, 40, 42, 49-52 and 58-60 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/0003716 (further referred to as 716) in view of Yang et al. US 2002/0134242.

5. Regarding claims 34, 35, 39, 40, and 42, the 716 reference discloses a method for separating mercury from a mercury containing gas comprising: (a) promoting at least a portion of a sorbent material by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent; (b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; (c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition, the bromine containing promoter is in gaseous form, the activated carbon contains basic binding sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury, the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition, at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition (paragraphs [0043], [0044], [0046], [0047] and [0053]), the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators (paragraphs [0043]). The reference does not disclose the activated carbon being graphene sheets and the binding sites being carbene species edge sites.

6. The 242 reference discloses the activated carbon being graphene sheets having binding sites being carbene species edge sites (paragraph [0018).

7. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference so that the activated carbon is graphene sheets having binding sites being carbene species edge sites (242 reference paragraph [0018) so as to adsorb and desorb dioxins easily. Furthermore it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin,* 125 USPQ 416.

8. For claims 49 and 50, the 716 discloses adding a stabilizing agent to the promoted halogen containing sorbent wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof (paragraph [0045 and [0064]).

9. For claim 51, the 716 reference discloses the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas (paragraph [0055]).

10. For claim 52, the 716 reference discloses the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

11. For claims 58-60, the 716 reference discloses the bromine containing promoter comprises at least one of HBr, PBr_3 or Br_2, molecular bromine, or a bromine compound (paragraph [0041]).

12. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Yang et al. US 2002/013424 as applied in claim 34 above, and further in view of Nishino et al. US 4,500,327 (further referred to as 327).

13. For claim 36, the 716 reference discloses the promoter bromine (paragraph [0041]). The reference does not disclose using an organic solvent.

14. The 327 reference discloses using the organic solvent (column 3, lines 35-53).

15. It would have been obvious to one having ordinary skill in the art a the time the invention was made to have modified the 716 reference to include using the organic solvent (327, column 3, lines 35-53) in order to allow the molecular halogen to go into solution and be sprayed onto the activated carbon.

16. Claims 43 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Yang et al. US 2002/013424 as applied in claim 34 above, and further in view of de Jong CA 1099490 (further referred to as 490).

17. For claims 43 and 44, the 716 reference does not disclose a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas.

18. The 490 reference discloses a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (page 4-5, lines 24-3). The reference does not explicitly state the sorbent being a brominated sorbent. The

reference the carbon being "washed with water to get rid of any clogging salts" which would include bromine. Furthermore the 490 reference discloses such a regeneration method with a chlorinated sorbent. Chlorine and bromine are very similar in there chemical characteristics, and there would be a reasonable expectation of success when using the same methods to regenerate a brominated sorbent as is used for a chlorinated sorbent.

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 716 reference to include a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (490, page 4-5, lines 24-3) in order to be able to reuse the promoted activated carbon, and therefore reduce material costs.

20. Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Yang et al. US 2002/013424 as applied in claim 34 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

21. For claim 45, the 716 reference does not disclose injecting an alkaline component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

22. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

23. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

24. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Yang et al. US 2002/013424 and Jong CA 1099490 (further referred to as 490) as applied in claim 43 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

25. For claim 46, the 716 reference does not disclose the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

26. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

27. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

28. Claims 47, 48, 53-55 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Yang et al. US 2002/013424 as applied in claim 34 above, and further in view of Srinivasachar et al. US 6,848,374 (further referred to as 374).

29. For claims 47 and 48, the 716 reference does not disclose adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen.

30. The 374 reference discloses adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (column 6, lines 3-18).

31. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (374, column 6, lines 3-18) to ensure that a maximum amount of promoter is reacted/adsorbed onto the activated carbon, to thereby allow for a greater amount of mercury to be removed.

32. For claim 53-55, the 716 reference discloses, the promoter is reacted in the gas phase or as a vapor (paragraphs [0041] and [0051]) and the promoter is added at from about 1 to about 30 grams per 100 grams of the sorbent material (paragraphs [0054]

and [0069]). The reference does not disclose injecting the sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, the gas stream is a mercury containing gas and the gas stream is a transport gas.

33. The 374 reference discloses injecting the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (columns 5-6, lines 59-18) and the gas stream being a transport gas (columns 5-6, lines 55-18). The reference does not explicitly state injecting the two streams (promoter and sorbent material) into a mercury containing gas stream. The reference does disclose combining two streams (promoter and sorbent) into one stream, and then subsequently injecting the one stream into the mercury containing gas stream (columns 5-6, lines 55-18). It would have been well within the knowledge of one having ordinary skill in the art to combine the two steps, to make one step (e.g. co-injecting the streams into the mercury containing gas) in order to cut down production costs and time needed to complete the process. The mere combination of known steps does not provide patentability.

34. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (374, columns 5-6, lines 59-18), the gas stream is a mercury

containing gas (374 columns 5-6lines 55-18) and the gas stream being a transport gas (374, columns 5-6, lines 55-18).

35. For claim 61, the 716 reference does not disclose the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof.

36. The 374 reference discloses the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof (column 6, lines 3-18).

37. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference so that the halogen or halide promoter comprises at least one of Group V bromide, Group VI bromide, or mixtures thereof (374 column 6, lines 3-18) because the active portion of the molecule is still the bromine, which is shown above to be desirable by 716, and there would be reasonable expectation of success when using the same active ingredient for the reaction between the promoter and the activated carbon.

38. Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Yang et al. US 2002/013424 and Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 53 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

39. For claim 56, the 716 and 374 references do not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

40. The 358 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 have been 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 promoter injection rate and the sorbent injection rate into the gas must be changed in correspondence to the monitored mercury content of the cleaned gas within the 358 reference.

41. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the combination of the 716 and 374 reference to include the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

42. Claim 57 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Yang et al. US 2002/013424 as applied in claim 34 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

43. For claim 57, the 716 reference does not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

44. The 358 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 have been obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content (increase) within the cleaned flue gas,

the sorbent composition must be changed just as that of the bromine within the 358 reference.

45. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

Response to Arguments

Applicant's arguments filed 05/20/2011 with regard to the 112 rejections have been fully considered but they are not persuasive.

The applicant contends that the specification provides evidence of the particulate nature of the activated carbon.

The examiner disagrees. While the specification does show certain types of activated carbon being in a particulate form, the specification does not show the graphene sheets being in particulate form. The applicant must provide evidence on how the graphene sheet is in particulate form and is introduced into the system. If the graphene sheet is not in particulate form, then it will not be capable of being separated from the mercury containing gas in particulate form as claimed.

Applicant's arguments, see pages 9 and 10, filed 05/20/2011, with respect to the rejection(s) of claim(s) 34 under 35 U.S.C 103(a) have been fully considered and are

persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of newly found prior art.

Conclusion

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on (571) 272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Duane Smith/
Supervisory Patent Examiner, Art Unit 1776

AO

Notice of References Cited	Application/Control No. 12/419,219	Applicant(s)/Patent Under Reexamination OLSON ET AL.	
	Examiner AMBER ORLANDO	Art Unit 1776	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2002/0134242	09-2002	Yang et al.	95/107
	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					
	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
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1776

✓	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	01/11/2010	10/08/2010	02/22/2011	07/29/2011					
2419	1	-	-	-	-					
	2	-	-	-	-					
	3	-	-	-	-					
	4	-	-	-	-					
	5	-	-	-	-					
	6	-	-	-	-					
	7	-	-	-	-					
	8	-	-	-	-					
	9	-	-	-	-					
	10	-	-	-	-					
	11	-	-	-	-					
	12	-	-	-	-					
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	30	-	-	-	-					
	31	-	-	-	-					
	32	-	-	-	-					
	33	-	-	-	-					
	34	✓	✓	✓	✓					
	35	✓	✓	✓	✓					
	36	✓	✓	✓	✓					

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	**Art Unit**
	AMBER ORLANDO	1776

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

CLAIM		DATE								
Final	Original	01/11/2010	10/08/2010	02/22/2011	07/29/2011					
	37	✓	-	-	-					
	38	✓	✓	-	-					
	39	✓	✓	✓	✓					
	40	✓	✓	✓	✓					
	41	✓	-	-	-					
	42	✓	✓	✓	✓					
	43	✓	✓	✓	✓					
	44	✓	✓	✓	✓					
	45	✓	✓	✓	✓					
	46	✓	✓	✓	✓					
	47	✓	✓	✓	✓					
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	54	✓	✓	✓	✓					
	55	✓	✓	✓	✓					
	56	✓	✓	✓	✓					
	57	✓	✓	✓	✓					
	58		✓	✓	✓					
	59		✓	✓	✓					
	60		✓	✓	✓					
	61		✓	✓	✓					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	13	graphene same sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:26
L2	0	graphene same carbene site	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
L3	6	sorbent with carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
L4	7	carbon with carbene and sorbent with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:29
L5	2	(110/345.ccls. or 95/134.ccls. or 95/142. ccls. or 423/210.ccls.) and graphene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:45
L6	4	(110/345.ccls. or 95/134.ccls. or 95/142. ccls. or 423/210.ccls.) and carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 20:45
S1	1	"12419219"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:00
S2	29	"6471936"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:09
S3	1	graphene sheet with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:12
S4	5	graphene with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:12
S5	1	"20030136509"	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:17
S6	1	graphene and sorbent with hydrocarbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:48

S7	6	graphene with carbene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:49
S8	68	graphene and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:51
S9	4	graphene with activated carbon and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:54
S10	57	graphene with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:55
S11	98	sheet with activated carbon and sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:56
S12	1	sheet with activated carbon and sorbent and graphene	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/07/29 16:56

EAST Search History (Interference)

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	Art Unit
	AMBER ORLANDO	1776

SEARCHED

Class	Subclass	Date	Examiner
110	345	1/11/2010	AO
423	210	1/11/2010	AO
95	134, 142	1/11/2010	AO
110	345	10/8/2010	AO
423	210	10/8/2010	AO
95	134, 142	10/8/2010	AO
110	345	2/22/2011	AO
423	210	2/22/2011	AO
95	135, 142	2/22/2011	AO
110	345	7/29/2011	AO
95	134, 142	7/29/2011	AO
423	210	7/29/2011	AO

SEARCH NOTES

Search Notes	Date	Examiner
Inventor Search (eDAN)	1/11/2010	AO
Classes 95, 423 and 110 searched for separating mercury from a mercury containing gas. The method including a sorbent, a promotor and separating particulates from the mercury containing gas.	1/11/2010	AO
IDS search (EAST and eDAN)	1/11/2010	AO
Classes 95, 423 and 110 researched for new art.	10/8/2010	AO
Classes 95, 423 and 110 researched for new art.	2/22/2011	AO
Classes 95. 423. 110 researched for new art.	7/29/2011	AO

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

/AMBER ORLANDO/ Acting Examiner.Art Unit 1776	

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/419,219	04/06/2009	Edwin S. Olson	3338.005US3

CONFIRMATION NO. 1149

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

POA ACCEPTANCE LETTER

OC000000048158389

Date Mailed: 06/14/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/01/2011.

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.

/vvan/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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S/N 12/419,219 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	12/419,219	Group Art Unit:	1774
Filed:	April 6, 2009	Docket:	3338.005US3
Customer No.	21186	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

REVOCATION AND POWER OF ATTORNEY
CERTIFICATE UNDER 37 CFR § 3.73(b)
&
CHANGE OF CORRESPONDENCE ADDRESS

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

In accordance with 37 C.F.R. Section 1.36, M.P.E.P. Section 402.05 and 402.07, please revoke any existing Powers of Attorney, if any, and appoint the following attorneys and/or patent agents to prosecute this application and to transact all business in the Patent and Trademark Office in connection therewith:

Customer Number: 21186

CERTIFICATE UNDER 37 CFR § 3.73(b)

Energy & Environmental Research Center Foundation hereby certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of an assignment from the inventor(s) recorded 11/22/2005 at Reel 016810, Frames 0286 - 0288. To the best of my knowledge and belief, title is in Energy & Environmental Research Center Foundation, the assignee.

Pursuant to 37 C.F.R. § 3.73(b) I hereby declare that I am empowered to sign this certificate on behalf of Energy & Environmental Research Center Foundation, the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true.

Please direct all correspondence in this case to:

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

Date 5/27/2011

By _____
Name: Thomas E. Bechtel
Title: EERC Foundation President

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Attn: Amber Orlando
Patent Examining Corps
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FAX NUMBER 571-273-8300

FROM: David W. Black

OUR REF: 3338.005US3

*** Please deliver to Examiner Amber Orlando in Art Unit 1774. ***

Document(s) Transmitted: **Revocation and Power of Attorney, Certificate Under 37 CFR 3.73(b) & Change of Correspondence Address (1 pg.)**

Total pages of this transmission, including cover letter: 2

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In re. Patent Application of: Edwin S. Olson et al.
Serial No.: 12/419,219
Filed: April 6, 2009
Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Examiner: Amber Orlando
Group Art Unit: 1774
Docket No.: 3338.005US3

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By: /David W. Black/
Name: David W. Black
USPTO Reg. No. 42,331

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/Mandy Brown/
Mandy Brown

June 1, 2011
Date of Transmission

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Edwin S. Olson et al.

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	3338.005US3	Serial No.:	12/419,219
Filed:	April 6, 2009	Due Date:	N/A
Examiner:	Amber Orlando	Group Art Unit:	1774
Customer No.:	21186	Confirmation No.:	1149

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

We are transmitting herewith the following attached items (as indicated with an "X"):

X Communication Regarding Change of Entity Status (1 pg.)
X Authorization to charge Deposit Account in the amount of $405 for the difference in entity size fee(s)

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.

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

By: /D.W.B./
David W. Black
Reg. No. 42,331

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Edwin S. Olson et al.	Examiner: Amber Orlando	
Serial No.:	12/419,219	Group Art Unit: 1774	
Filed:	April 6, 2009	Docket No.: 3338.005US3	
Customer No.:	21186	Confirmation No.: 1149	
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

COMMUNICATION REGARDING CHANGE OF ENTITY STATUS

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

It has been brought to the attention of Applicant's Representatives that as of September 1, 2010, the Applicant no longer qualifies for Small Entity Status, and in accordance with the duty set forth in 37 C.F.R. § 1.27, the entitlement to small entity status is withdrawn.

The following table is a schedule of fee payments submitted to the USPTO since September 1, 2010, the current large entity fees, and the difference due:

date of payment	description of fee	small entity fee paid	large entity fee due at this time	Difference Due
02/14/2011	RCE Fee	$405.00	$810.00	$405.00
			TOTAL	$405.00

Please charge $405.00 to Deposit Account No. 19-0743, to cover the difference between small entity fees and large entity fees due in this matter. If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
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Date May 25, 2011

By /D. W. Black/
David W. Black
Reg. No. 42,331

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Joseph P. Mehrle/Anne Richards
Attorney Docket Number:	16291.0003USC1

Filed as Small 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:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	2801	1	405	405
		Total in USD ($)		**405**

Electronic Acknowledgement Receipt

EFS ID:	10169379
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Joseph P. Mehrle/Anne Richards
Filer Authorized By:	Joseph P. Mehrle
Attorney Docket Number:	16291.0003USC1
Receipt Date:	25-MAY-2011
Filing Date:	06-APR-2009
Time Stamp:	18:42:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$405
RAM confirmation Number	7089
Deposit Account	190743
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)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		3338005us3changeentitySIGNED.pdf	144893 8f3b4c409d2cf1be3e2f5fcfd378938eb07659d5	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Miscellaneous Incoming Letter	1	1
	Miscellaneous Incoming Letter	2	2

Warnings:

Information:

2	Fee Worksheet (PTO-875)	fee-info.pdf	30574 5f6c06855baac5fe70af7f58f73da087ddf46c82	no	2

Warnings:

Information:

Total Files Size (in bytes):	175467

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Edwin S. Olson et al. Examiner: Amber Orlando

Serial No.: 12/419,219 Group Art Unit: 1774

Filed: April 6, 2009

Docket No.: 3338.005US3 (IP 09-012 Continuation)

Customer No.: 21186 Confirmation No.: 1149

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

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

In response to the Office Action dated February 23, 2011, please amend the application as follows:

IN THE SPECIFICATION

Please amend the specification as follows:

Paragraph [0001] is amended as follows:

[0001] This application is a divisional of U.S. Patent Application No. 11/209,163 filed August 22, 2005, entitled "Sorbents for the Oxidation and Removal of Mercury", now issued as U.S. Patent No. 7,435,286, which claims the benefit of U.S. Provisional Application Serial No. 60/605,640, filed August 30, 2004, both applications are hereby incorporated herein by reference in their entirety for all purposes.

IN THE CLAIMS

Please amend the claims as follows:

1-33. (Canceled)

34. (Previously Presented) A method for separating mercury from a mercury containing gas comprising:

(a) promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

35. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in gaseous form.

36. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in an organic solvent.

37-38. (Cancelled)

39. (Previously Presented) A method according to claim 34, wherein the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition.

40. (Previously Presented) A method according to claim 34, wherein at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition.

41. (Cancelled)

42. (Previously Presented) A method according to claim 34, wherein the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators.

43. (Previously Presented) A method according to claim 34, further comprising a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition for reuse.

44. (Previously Presented) A method according to claim 43, further comprising injecting the regenerated promoted brominated sorbent into a mercury containing gas.

45. (Previously Presented) A method according to claim 34, further comprising injecting an alkali component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

46. (Previously Presented) A method according to claim 45, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

47. (Previously Presented) A method according to claim 34, further comprising adding a second halogen or halide promoter to the promoted halogen containing sorbent.

48. (Previously Presented) A method according to claim 47, wherein the second halogen or halide promoter comprises HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen.

49. (Previously Presented) A method according to claim 34, further comprising adding a stabilizing agent to the promoted brominated sorbent.

50. (Previously Presented) A method according to claim 49, wherein the stabilizing agent comprises at least one of S, Se, H_2S, $S0_2$, H_2Se, $Se0_2$, CS_2, P_2S_5, or mixtures thereof.

51. (Previously Presented) A method according to claim 34, wherein the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas.

52. (Previously Presented) A method according to claim 34, wherein the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

53. (Previously Presented) A method according to claim 34, further comprising injecting the sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, 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 the sorbent material.

54. (Previously Presented) A method according to claim 53, wherein the gas stream is a mercury containing gas.

55. (Previously Presented) A method according to claim 54, wherein the gas stream is a transport gas.

56. (Previously Presented) A method according to claim 53, wherein the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas.

57. (Previously Presented) A method according to claim 34, wherein the composition of the promoted sorbent is controlled by the mercury content of the cleaned gas stream.

58. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises at least one of HBr, PBr_3, or Br_2

59. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises molecular bromine.

60. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a bromine compound.

61. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a Group V or Group VI bromide.

REMARKS

This responds to the Office Action dated February 23, 2011.

No claims are amended, no claims are canceled, and no claims are added; as a result, claims 34-36, 39-40, and 42-61 are now pending in this application.

The Rejection of Claims Under § 112

Claims 34, 53 and 56 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement.

Applicants respectfully traverse the rejections, and request reconsideration and withdrawal of the rejections.

Applicants respectfully would like to draw the Examiner's attention to the well-known fact that activated carbon is itself a particulate material, more specifically is a particulate material having a relatively high surface area. Paragraph [0009] of the application as filed characterizes an embodiment of the invention as a halide/halogen promoted activated carbon sorbent. The person of ordinary skill in the art is aware that an activated carbon sorbent is a particulate material.

Claim 34, and claims 53 and 56 dependent thereon, recite "a sorbent material comprising activated carbon" that is promoted by reaction of the activated carbon sorbent material with a bromine-containing promoter material. In other words, the sorbent material is activated with the bromine-containing promoter material to make it reactive with elemental mercury in a waste gas stream.

Paragraph [0011] further clarifies the particulate nature of the activated carbon sorbent, stating that in an embodiment, the activated carbon that is subsequently reacted with the bromine containing promoter is selected from among powdered activate carbon, granular activated carbon, carbon black, carbon fiber, aerogel carbon, pyrolysis char, and activated carbon with an average particle size greater than that of flyash. All these materials are well known in the art to be solid, particulate materials. In one embodiment the activated carbon has a particle size of greater than 40 microns, allowing its separation from flyash.

As described in paragraph [0016], the material remains particulate after treatment with the bromine containing promoter (e.g., bromine gas), as it is stated that the reaction product of the starting activated carbon and the bromine containing promoter can have "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.

For further clarity, the Examiner is respectfully directed to paragraph [0026] of the application as filed, wherein it is stated that a "particulate activated carbon sorbent with a mass mean size great than 40μm 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."

Paragraph [0052] goes on to explain how activated carbon reacts with bromine containing promoters, such as molecular bromine, at the molecular level. The "graphene sheet structures of the carbon" is referred to, making clear that the activated carbon used in the claimed process is formed of graphene sheets in association. Figure 2 is described therein as showing the chemistry whereby the graphene sheets that in bulk make up the activated carbon used herein react at an edge carbene site with the bromine, etc., to form a mercury-reactive species capable of capturing the mercury in elemental form from the waste gas stream. The description of Figure 3 found in paragraphs [0054] to [0062] explain the physical process whereby the particulate activated carbon material is promoted by bromine, reacts with the waste gas stream, and is collected as a particulate.

With respect to claims 53 and 56, it is clear that the rate of injection of the graphene sheets follows directly from the rate of injection of the particulate activated carbon. The graphene sheet does not "become a particulate material", as asserted by the Examiner, it is already part of a particulate material, activated carbon, as is made clear from the above discussion.

Accordingly, it is clear from the description of the application as filed that the process of mercury removal involves bringing the mercury-containing waste gas in contact with the particulate sorbent, then, removing the particulate material (including the mercury-bearing sorbent plus any fly ash that may be present in the waste gas stream) to provide a mercury-free waste gas stream. Every step of the process is within ordinary understanding based upon the

description provided in the application as filed, in conjunction with the knowledge of the person of ordinary skill in the art. Therefore, Applicants submit that the invention meets the requirements of §112 concerning enablement, and that the claims are in condition for allowance, which is earnestly solicited.

The Rejection of Claims Under § 103

Claims 34, 35, 39, 40, 42, 49-52 and 58-60 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716) in view of Chen et al. (U.S. 6,471,936) and Virtanen (U.S. 2003/0136509).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 34 and to all other rejected dependent claims.

The Examiner's arguments for rejection of claim 34 and claims 35, 39, 40, 42, 49-52 and 58-60 dependent thereon over Nelson, Chen, and Virtanen do not properly create a prima facie case of obviousness, at least because the three cited documents fail to disclose or suggest all elements of the rejected claims. Furthermore, Chen and Virtanen are not analogous art to which the person of ordinary skill seeking to modify the composition of Nelson for mercury removal from waste gas streams would turn.

The Examiner admits that Nelson does not disclose or suggest graphenes, or edge sites of graphene sheets being carbenes. It also does not disclose or suggest the reaction of the carbene sites with a bromine containing promoter to yield bromide anion paired carbocation sites on the carbon as being the sites reactive with mercury, which serve to react with and immobilize mercury vapor from the waste gas stream.

Chen does not remedy this deficiency. Applicants can find nowhere in the stated section (col 3, line 56 to col 4, line 13), or indeed anywhere in the publication, wherein the word "graphene" is mentioned with respect to activated carbon particulates. Chen uses the term to describe carbon nano-cones (line 13) and carbon nanotubes (line 32), which are not part of the instant invention. The discussion appears to largely concern carbon nanotubes, not planar sp2-hybridized carbon sheets like graphene. Chen does not disclose or suggest the use of graphene sheets as part of a particulate removal system for mercury. Nor is a hydrogen storage system such as discussed by Chen reasonably considered analogous art to which the person of ordinary

skill would turn in devising a system for removal of mercury from waste gas streams. While it may be generally known that sp2-hybridized carbon can form graphene sheets, Chen specifically discusses forms of graphene that have no edges, i.e., cones and cylinders (nanotubes), and thus lack the edge sites that are carbenic in nature.

Virtanen likewise fails to cure the deficiencies of Nelson in making the instant claims obvious. Virtanen's reference in the cited paragraph [0099] does not refer to activated carbon as a bulk material as used in the practice of the instantly claimed process, or as discussed in Nelson. Virtanen is referring to a chemically-activated single carbon atom when he uses the term "activated carbon" as is clear from the context, in which the chemistry of linker structures bearing reactive functional groups is being discussed. He states that "asymmetic linkers may display, as reactive groups, alcohols, amines, carboxylic acids, acid chlorides isocyanates, epoxides, cyclic amines, activated carbons such as carbanions, carbocations, carbenes, Grignard reagents, or any other carbon atom competent for the formation of carbon-carbon bonds . . . ".

Clearly, Virtanen is not disclosing or suggesting carbene sites on the edges of graphene sheets found in the bulk substance "activated carbon", but to individually activated carbon atoms that can themselves individually be carbanions, carbocations, carbenes, etc.

Therefore, the combination of Nelson, Chen, and Virtanen fails to create a prima facie case of obviousness, because the combination of the cited documents fails to disclose or suggest carbene sites on the edges of graphene sheets that react with a bromine containing promoter to produce carbocationic sites that can react with and immobilize mercury atoms.

Applicants respectfully submit that claims 34, 35, 39, 40, 42, 49-52 and 58-60 are in condition for allowance, which is earnestly solicited.

Claim 36 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al. and Virtanen, and further in view of Nishino et al. (U.S. 4,500,327).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 36.

The introduction of an organic solvent into the promotion reaction as discussed by Nishino does not cure the fundamental deficiency of the prima facie case of obviousness, as discussed above, concerning graphene sheets, their carbene-containing edge sites and reaction

with bromine promoting agents, and the resulting production of carbocations that can react with and immobilize vaporized mercury. Accordingly, a prima facie case of the obviousness of claims 36 over the four cited documents has not been properly made. Applicants respectfully submit that claim 36 is in condition for allowance, which is earnestly solicited.

Claims 43 and 44 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al. and Virtanen, and further in view of de Jong (CA 1099490).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 43 and 44

The introduction of regeneration step for an absorbent as discussed by de Jong, does not cure the fundamental deficiency of the prima facie case of obviousness, as discussed above, concerning graphene sheets, their carbene-containing edge sites and reaction with bromine promoting agents, and the resulting production of carbocations that can react with and immobilize vaporized mercury. Accordingly, a prima facie case of the obviousness of claims 43 and 44 over the four cited documents has not been properly made. Applicants respectfully submit that claims 43 and 44 are in condition for allowance, which is earnestly solicited.

Claim 45 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al. and Virtanen, and further in view of Gadkaree et al. (U.S. 6,136,749).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 45.

Again, the addition of Gadkaree's discussion of alkalai injection in the treatment of mercury-containing flue gases to the set of cited documents does not cure the deficiency in the prima facie case of obvious with respect to claim 34, upon which claim 45 depends, as discussed above, concerning graphene sheets, their carbene-containing edge sites and reaction with bromine promoting agents, and production of carbocations. Accordingly, a prima facie case of the obviousness of claims 45 over the four cited documents has not been properly made.

Applicants respectfully submit that claim 45 is in condition for allowance, which is earnestly solicited.

Claim 46 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al., Virtanen, and Jong, and further in view of Gadkaree et al.

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 36.

The addition of Gadkaree and de Jong, with their discussion of alkalai injection and various options for specific alkaline salts, does not cure the deficiencies of Nelson, Chen and Virtanen as applied to claims 34 or 45, upon which claim 46 depends. The combination of the five cited documents fails to disclose or suggest the use of graphene sheets, their carbene-containing edge sites and reaction with bromine promoting agents, and production of carbocations. Accordingly, a prima facie case of the obviousness of claims 46 over the four cited documents has not been properly made. Applicants respectfully submit that claim 46 is in condition for allowance, which is earnestly solicited.

Claims 47, 48, 53-55 and 61 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al. and Virtanen, and further in view of Srinivasachar et al. (U.S. 6,848,374).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claims 47, 48, 53-55 and 61.

Srinivasachar discusses the use of a second halogen-containing reagent. However, this fails to cure the deficiences of the Nelson / Chen / Virtanen combination in making obvious the characteristics of the bromine-promoted activated carbon, as discussed above.

Accordingly, a prima facie case of the obviousness of claims 47, 48, 53-55 and 61 over the four cited documents has not been properly made. Applicants respectfully submit that claims 47, 48, 53-55 and 61 are in condition for allowance, which is earnestly solicited.

Claim 56 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al., Virtanen and Srinivasachar et al., and further in view of Vosteen et al. (U.S. 6,878,358).

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 56.

The combination of the five cited documents fails to make claim 56 obvious at least because the combination of Nelson, Chen, and Virtanen fails to make claim 34, upon which claim 56 depends, obvious.

Accordingly, a prima facie case of the obviousness of claims 56 over the five cited documents has not been properly made. Applicants respectfully submit that claim 56 is in condition for allowance, which is earnestly solicited.

Claim 57 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Nelson Jr. (US 2004/0003716), Chen et al. and Virtanen, and further in view of Vosteen et al.

Applicants traverse the rejection, and request reconsideration and withdrawal of the rejections with respect to claim 57.

Again, Vosteen fails to cure the defects in the prima facie case of obviousness made out against claim 34, upon which claim 57 depends. Applicants respectfully submit that claim 57 is in condition for allowance, which is earnestly solicited.

CONCLUSION

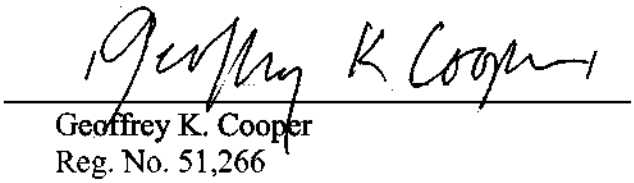
Applicants respectfully submit that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone the undersigned at (612) 373-6941 to facilitate prosecution of this application.

If necessary, please charge any additional fees or deficiencies, or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,

SCHWEGMAN, LUNDBERG & WOESSNER, P.A.
P.O. Box 2938
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(612) 373-6941

Date May 20, 2011

By 

Geoffrey K. Cooper
Reg. No. 51,266

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Edwin S. Olson et al.	Examiner:	Amber Orlando
Serial No.:	12/419,219	Group Art Unit:	1774
Filed:	April 6, 2009		
Docket:	3338.005US3 (IP 09-012 Continuation)		
Customer No.:	21186	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

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

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97 *et. seq.*, Applicants bring to the attention of the Examiner the following Office Actions and responses associated with one or more of the inventors of the instant application and/or the assignee of the instant application for consideration in connection with the above-identified patent application.. This material is available and accessible at the United States Patent and Trademark Office.

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
Application Serial No. 11/209,163, Preliminary Amendment filed 02-27-07, 9 pgs
Application Serial No. 11/209,163, Restriction Requirement mailed 06-07-07, 6 pgs
Application Serial No. 11/209,163, Response filed 07-09-07 to Restriction Requirement mailed 06-07-07, 2 pgs
Application Serial No. 11/209,163, Non Final Office Action mailed 08-13-07, 15 pgs
Application Serial No. 11/209,163, Response filed 11-13-07 to Non Final Office Action mailed 08-13-07, 19 pgs
Application Serial No. 11/209,163, Final Office Action mailed 01-23-08, 21 pgs
Application Serial No. 11/209,163, Response filed 03-24-08 to Final Office Action mailed 01-23-08, 29 pgs
Application Serial No. 11/209,163, Advisory Action mailed 04-21-08, 3 pgs
Application Serial No. 11/209,163, Notice of Allowance mailed 07-14-08, 7 pgs

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
Application Serial No. 12/201,595, Non Final Office Action mailed 04-16-09, 22 pgs
Application Serial No. 12/201,595, Response filed 10-16-09 to Non Final Office Action mailed 04-16-09, 18 pgs
Application Serial No. 12/201,595, Final Office Action mailed 03-10-10, 13 pgs

Pursuant to 37 C.F.R. § 1.98(a)(2), copies of cited U.S. Patents and Published Applications, and Non-Published Applications identifiable by USPTO Serial Number, are no longer required to be provided to the Office. Applicants acknowledge the requirement to submit copies of foreign patent documents and non-patent literature in accordance with 37 C.F.R § 1.98(a)(2).

The Examiner is invited to contact the undersigned at the telephone number indicated if there are any questions regarding this communication.

Respectfully submitted,

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Date May 20, 2011 By Geoffrey K. Cooper

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Electronic Acknowledgement Receipt

EFS ID:	10136840
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Joseph P. Mehrle/Anne Richards
Filer Authorized By:	Joseph P. Mehrle
Attorney Docket Number:	16291.0003USC1
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Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		3338005us3amendSIGNED.pdf	222046 4d3c4740839d962887319feb8f6088103983817c	yes	17

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Miscellaneous Incoming Letter	1	1
	Amendment/Req. Reconsideration-After Non-Final Reject	2	2
	Specification	3	3
	Claims	4	7
	Applicant Arguments/Remarks Made in an Amendment	8	15
	Transmittal Letter	16	17
Warnings:			
Information:			
	Total Files Size (in bytes):	222046	

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

Applicant: Edwin S. Olson et al.

Title: SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Docket No.:	3338.005US3 (IP 09-012 Continuation)	Serial No.: 12/419,219	
Filed:	April 6, 2009	Due Date:	May 23, 2011
Examiner:	Amber Orlando	Group Art Unit:	1774
Customer No.:	21186	Confirmation No.:	1149

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

We are transmitting herewith the following attached items (as indicated with an "X"):

X Amendment and Response under 37 C.F.R. § 1.111 (14 pgs.)
X Supplemental Information Disclosure Statement (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.

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

By: Geoffrey K. Cooper
Reg. No. 51,266

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
12/419,219	04/06/2009	

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))	26 minus 20 =	* 6	X $26 =	156	OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	* 0	X $110 =	0		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	156		TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 05/20/2011

	(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	** 26	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 1	Minus	*** 1	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

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:
/DAVID HAUGHTON/

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.
12/419,219	04/06/2009	Edwin S. Olson	16291.0003USC1	1149

23552 7590 02/23/2011

MERCHANT & GOULD PC
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EXAMINER	
ORLANDO, AMBER ROSE	
ART UNIT	PAPER NUMBER
1774	

MAIL DATE	DELIVERY MODE
02/23/2011	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)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1774	

-- 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 *15 February 2011*.

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) *34-36,39,40 and 42-61* 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) *34-36,39,40 and 42-61* 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 correspondence filed 02/15/2011.

Claim 34 is amended.

Claims 34-36, 39-40 and 42-61 are rejected.

Claims 34-36, 39-40 and 42-61 are pending and have been examined.

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 02/15/2011 has been entered.

Claim Rejections - 35 USC § 112

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

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 34, 53 and 56 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. For claim 34, the claim states the sorbent is activated carbon which contains

graphene sheets, that react with bromine, then react with elemental mercury, and lastly separating particulates from the mercury containing gas, the particulates including the mercury/sorbent chemical composition. The state of the prior art does not provide evidence on how a graphene sheet would become a mercury/sorbent particulate which can then be separated from the mercury containing gas. One having ordinary skill in the art would not find the graphene sheet somehow becoming particulate matter predictable in the art as there no direction or guidance within the claims or the specification reciting how the graphene sheets would becoming particulate matter (grinding steps etc.). There is an absence of working examples showing how a graphene **sheet** would become a mercury/sorbent **particulate** which can then be separated from the mercury containing gas. There would be an extended period of experimentation needed to make use of the claimed invention, as there is not sufficient direction or guidance within the specification as to how the graphene sheets would become particulate matter to therefore be separated from the mercury containing gas.

3. For claims 53 and 56, the claims pertain to injecting the sorbent material (graphene sheets), and the injection rate. The state of the prior art does not provide evidence on how a graphene sheet would be injected at an injection rate. One having ordinary skill in the art would not find the graphene sheet somehow becoming particulate matter in order to be injected at an injection rate predictable in the art as there no direction or guidance within the claims or the specification reciting how the graphene sheets would becoming particulate matter (grinding steps etc.). There is an absence of working examples showing how a graphene **sheet** would become a

mercury/sorbent **particulate** which can be injected at an injection rate. There would be an extended period of experimentation needed to make use of the claimed invention, as there is not sufficient direction or guidance within the specification as to how the graphene sheets would become particulate matter which can be injected at an injection rate.

Claim Rejections - 35 USC § 103

1. 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.

2. 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.

3. 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).

4. Claims 34, 35, 39, 40, 42, 49-52 and 58-60 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/0003716 (further referred to as 716) in view of Chen et al. US 6,471,936 (further referred to as 936) and Virtanen US 2003/0136509 (further referred to as 509).

5. Regarding claims 34, 35, 39, 40, and 42, the 716 reference discloses a method for separating mercury from a mercury containing gas comprising: (a) promoting at least a portion of a sorbent material by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent; (b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; (c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition, the bromine containing promoter is in gaseous form, the activated carbon contains basic binding sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury, the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition, at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition (paragraphs [0043], [0044], [0046], [0047] and [0053]), the step of separating

particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators (paragraphs [0043]). The reference does not disclose the activated carbon being graphene sheets and the binding sites being carbene species edge sites.

6. The 936 reference discloses the activated carbon being graphene sheets (column 3, line 56-column 4, line 13) and the 509 reference discloses the binding sites being carbene species edge sites (paragraph [0099]).

7. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference so that the activated carbon is graphene sheets (936, column 3, line 56-column 4, line13) the binding sites being carbene species edge sites (509 paragraph [0099]) since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin,* 125 USPQ 416.

8. For claims 49 and 50, the 716 discloses adding a stabilizing agent to the promoted halogen containing sorbent wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof (paragraph [0045 and [0064]).

9. For claim 51, the 716 reference discloses the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas (paragraph [0055]).

10. For claim 52, the 716 reference discloses the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

11. For claims 58-60, the 716 reference discloses the bromine containing promoter comprises at least one of HBr, PBr_3 or Br_2, molecular bromine, or a bromine compound (paragraph [0041]).

12. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further referred to as 936) and Virtanen (further referred to as 509) as applied in claim 34 above, and further in view of Nishino et al. US 4,500,327 (further referred to as 327).

13. For claim 36, the 716 reference discloses the promoter bromine (paragraph [0041]). The reference does not disclose using an organic solvent.

14. The 327 reference discloses using the organic solvent (column 3, lines 35-53).

15. It would have been obvious to one having ordinary skill in the art a the time the invention was made to have modified the 716 reference to include using the organic solvent (327, column 3, lines 35-53) in order to allow the molecular halogen to go into solution and be sprayed onto the activated carbon.

16. Claims 43 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further referred to as 936) and Virtanen (further referred to as 509) as applied in claim 34 above, and further in view of de Jong CA 1099490 (further referred to as 490).

17. For claims 43 and 44, the 716 reference does not disclose a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas.

18. The 490 reference discloses a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (page 4-5, lines 24-3). The reference does not explicitly state the sorbent being a brominated sorbent. The reference the carbon being "washed with water to get rid of any clogging salts" which would include bromine. Furthermore the 490 reference discloses such a regeneration method with a chlorinated sorbent. Chlorine and bromine are very similar in there chemical characteristics, and there would be a reasonable expectation of success when using the same methods to regenerate a brominated sorbent as is used for a chlorinated sorbent.

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 716 reference to include a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (490, page 4-5, lines 24-3) in order to be able to reuse the promoted activated carbon, and therefore reduce material costs.

20. Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further

referred to as 936) and Virtanen (further referred to as 509) as applied in claim 34 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

21. For claim 45, the 716 reference does not disclose injecting an alkaline component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

22. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

23. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

24. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further referred to as 936), Virtanen (further referred to as 509) and Jong CA 1099490 (further referred to as 490) as applied in claim 43 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

25. For claim 46, the 716 reference does not disclose the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

26. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

27. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

28. Claims 47, 48, 53-55 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further referred to as 936) and Virtanen (further referred to as 509) as applied in claim 34 above, and further in view of Srinivasachar et al. US 6,848,374 (further referred to as 374).

29. For claims 47 and 48, the 716 reference does not disclose adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen.

30. The 374 reference discloses adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (column 6, lines 3-18).

31. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (374, column 6, lines 3-18) to ensure that a maximum amount of promoter is reacted/adsorbed onto the activated carbon, to thereby allow for a greater amount of mercury to be removed.

32. For claim 53-55, the 716 reference discloses, the promoter is reacted in the gas phase or as a vapor (paragraphs [0041] and [0051]) and the promoter is added at from about 1 to about 30 grams per 100 grams of the sorbent material (paragraphs [0054] and [0069]). The reference does not disclose injecting the sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, the gas stream is a mercury containing gas and the gas stream is a transport gas.

33. The 374 reference discloses injecting the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (columns 5-6, lines 59-18) and the gas stream being a transport gas (columns 5-6, lines 55-18). The reference does not explicitly state injecting the two streams (promoter and sorbent material) into a mercury containing gas stream. The reference does disclose combining two streams (promoter and sorbent) into one stream, and then subsequently injecting the one stream into the mercury containing gas stream (columns 5-6, lines 55-18). It

would have been well within the knowledge of one having ordinary skill in the art to combine the two steps, to make one step (e.g. co-injecting the streams into the mercury containing gas) in order to cut down production costs and time needed to complete the process. The mere combination of known steps does not provide patentability.

34. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (374, columns 5-6, lines 59-18), the gas stream is a mercury containing gas (374 columns 5-6lines 55-18) and the gas stream being a transport gas (374, columns 5-6, lines 55-18).

35. For claim 61, the 716 reference does not disclose the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof.

36. The 374 reference discloses the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof (column 6, lines 3-18).

37. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference so that the halogen or halide promoter comprises at least one of Group V bromide, Group VI bromide, or mixtures thereof (374 column 6, lines 3-18) because the active portion of the molecule is still the bromine, which is shown above to be desirable by 716, and there would be reasonable expectation of success when using the same active ingredient for the reaction between the promoter and the activated carbon.

38. Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further referred to as 936), Virtanen (further referred to as 509) and Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 53 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

39. For claim 56, the 716 and 374 references do not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

40. The 358 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 have been 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 promoter injection rate and the sorbent injection rate into the gas must be changed in correspondence to the monitored mercury content of the cleaned gas within the 358 reference.

41. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the combination of the 716 and 374 reference to include the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

42. Claim 57 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716), Chen et al. US 6,471,936 (further

referred to as 936) and Virtanen (further referred to as 509) as applied in claim 34 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

43. For claim 57, the 716 reference does not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

44. The 358 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 have been obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content (increase) within the cleaned flue gas, the sorbent composition must be changed just as that of the bromine within the 358 reference.

45. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

Response to Arguments

4. Applicant's arguments with respect to claims 34, 35, 39-40, 49-52 and 58-60 with regards to the graphene sheets and the carbene species edge sites have been considered but are moot in view of the new ground(s) of rejection.

5. Applicant's arguments filed 02/15/2011 have been fully considered but they are not persuasive.

6. The applicant argues "Srinivasachar et al. fail to indicate an interest in obtaining a reaction between a bromine promoter and activated carbon, and fail to describe conditions that would achieve a reaction between a bromine promoter and activated carbon to provide a promoted brominated sorbent that can be used according to the presently claimed invention."

7. The examiner disagrees. The applicant is merely contacting two substances, the promoter and the sorbent. The Srinivasachar reference discloses contacting these same two substances, and therefore would result in the same product as the applicant's current invention. The applicant must show what conditions are different within the applicant's invention that would result in the combination of the same components providing differing results. The applicant is claiming that some how the outcome of these two substances contacting would be different without providing sufficient evidence on how this would occur. The applicant contends that water inhibits a reaction without provided any proof thereof. Furthermore the applicant is claiming bromine in vapor form which is disclosed by the Srinivasachar et al. reference (column 6, lines 14-16).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Mon.-Thurs. (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.

AO

/Walter D. Griffin/
Supervisory Patent Examiner, Art Unit 1774

Notice of References Cited	Application/Control No. 12/419,219	Applicant(s)/Patent Under Reexamination OLSON ET AL.	
	Examiner AMBER ORLANDO	Art Unit 1774	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,471,936	10-2002	Chen et al.	423/658.2
*	B	US-2003/0136509	07-2003	Virtanen, Jorma	156/310
	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					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

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

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	Art Unit
	AMBER ORLANDO	1774

SEARCHED

Class	Subclass	Date	Examiner
110	345	1/11/2010	AO
423	210	1/11/2010	AO
95	134, 142	1/11/2010	AO
110	345	10/8/2010	AO
423	210	10/8/2010	AO
95	134, 142	10/8/2010	AO
110	345	2/22/2011	AO
423	210	2/22/2011	AO
95	135, 142	2/22/2011	AO

SEARCH NOTES

Search Notes	Date	Examiner
Inventor Search (eDAN)	1/11/2010	AO
Classes 95, 423 and 110 searched for separating mercury from a mercury containing gas. The method including a sorbent, a promotor and separating particulates from the mercury containing gas.	1/11/2010	AO
IDS search (EAST and eDAN)	1/11/2010	AO
Classes 95, 423 and 110 researched for new art.	10/8/2010	AO
Classes 95, 423 and 110 researched for new art.	2/22/2011	AO

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

/AMBER ORLANDO/ Acting Examiner.Art Unit 1774	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1774

✓	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	01/11/2010	10/08/2010	02/22/2011						
2419	1	-	-	-						
	2	-	-	-						
	3	-	-	-						
	4	-	-	-						
	5	-	-	-						
	6	-	-	-						
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	8	-	-	-						
	9	-	-	-						
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	29	-	-	-						
	30	-	-	-						
	31	-	-	-						
	32	-	-	-						
	33	-	-	-						
	34	✓	✓	✓						
	35	✓	✓	✓						
	36	✓	✓	✓						

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1774

✓	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	01/11/2010	10/08/2010	02/22/2011						
	37	✓	-	-						
	38	✓	✓	-						
	39	✓	✓	✓						
	40	✓	✓	✓						
	41	✓	-	-						
	42	✓	✓	✓						
	43	✓	✓	✓						
	44	✓	✓	✓						
	45	✓	✓	✓						
	46	✓	✓	✓						
	47	✓	✓	✓						
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	57	✓	✓	✓						
	58		✓	✓						
	59		✓	✓						
	60		✓	✓						
	61		✓	✓						

Date Mailed: February ___, 2011

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson	
	Filing Date: 04/06/2009	Group Art Unit: 1774

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	US 7,514,052	04/07/2009	Lissianski et al.			

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
						YES	NO

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

23552
PATENT TRADEMARK OFFICE

EXAMINER /Amber Orlando/	DATE CONSIDERED 02/22/2011

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.

*Substitute Disclosure Statement Form (PTO-1449) Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	55	(remov$5 near3 mercury) and (carbon with sheet)	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:14
L2	4	(remov$5 near3 mercury) and (carbon with sheet with graphene)	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:15
L3	5	(remov$5 near3 mercury) and (carbon with graphene)	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:43
L4	14	(remov$5 near3 mercury) and (graphene)	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:43
L5	1091673	graphene sheet	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:44
L6	41094	graphene sheet and mercury	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:45
L7	4875	graphene sheet and mercury with remov$4	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:45
L8	1215542	graphene sheet and mercury with remov$4 and activated carbon	US-PGPUB; USPAT	OR	OFF	2011/02/22 09:45
L9	5	graphene sheet and mercury with remov$4 and activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:45
L10	8	graphene sheet and mercury with remov$4	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:46
L11	174	graphene sheet and mercury	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:46
L12	87	graphene sheet and exhaust	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:47
L13	79	graphene sheet and activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:47
L14	1	graphene sheet with activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:47
L15	116	graphene sheet$3 and activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:49
L16	1080	graphene sheet$3 with (activated carbon or carbon)	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:50

L17	3	graphene sheet$3 with (activated carbon)	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:50
L18	13	graphene sheet$3 with (carbon black)	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:52
L19	91	graphene sheet$3 with (carbon) and activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 09:58
L20	2	"7514052"	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 10:03
L21	2292055	95/134.ccls. and graphene sheet	US-PGPUB; USPAT; USOCR	OR	OFF	2011/02/22 10:40
L22	2	95/134.ccls. and graphene sheet	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 10:40
L23	1	423/210.ccls. and graphene sheet	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 10:41
L24	1	95/142.ccls. and graphene sheet	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 10:41
L25	1	110/345.ccls. and graphene sheet	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 10:42
L26	7	graphene sheet same activated carbon	US-PGPUB; USPAT	ADJ	OFF	2011/02/22 10:48
L27	9	graphene sheet and remov$4 with mercury	US-PGPUB; USPAT	ADJ	ON	2011/02/22 10:50
L28	4	graphene sheet with activated carbon	US-PGPUB; USPAT	ADJ	ON	2011/02/22 10:50
L29	14	graphene sheet with (carbon black)	US-PGPUB; USPAT	ADJ	ON	2011/02/22 10:51
L30	119	graphene sheet$3 and activated carbon	US-PGPUB; USPAT	ADJ	ON	2011/02/22 10:53
L31	5	carbene with edge and remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 11:16
L32	7	carbene with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/02/22 11:22
L33	10	carbene with activated carbon	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/02/22 11:22
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
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" |	US-PGPUB; USPAT; USOCR	OR	OFF	2007/07/24 10:48

		"5336835" | "5352647" | "5372619" | "5403548" | "5435980" | "5505766" | "5827352" | "6475461" | "6514907" | "6521021" | "6533842"). PN. OR ("6953494"). URPN. and inflight				
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
S97	0	110/345.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S98	5	423/210.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S99	0	(halogenated carbon with halide with covalently$5).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:05
S100	0	(carbon with haldie with sorbent and reduc$ with mercury).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:06
S101	0	(carbon with haldie with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
S102	1	(carbon with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
S103	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S104	55234	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S105	2	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S106	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S107	15	carbon with alkali same remov$4 with mercury and exhaust	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S108	4	mercury with exhaust and mercury with stabili $5 with reagent and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:29
S109	6	"6848374" and (stabili $4 or sulfur or sulfide)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:31

S110	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfer dioxide) and carbon with remov $4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S111	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov $4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S112	2	stabili$5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov $4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:35
S113	2	mercury with exhaust and mercury with stabili $5 with sulfur and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:36
S114	4	"6848374" and (organic or solvent)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S115	5	"6848374" and (organic or solvent or dissolv$4)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S116	7	carbon with alkali same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:21
S117	8	carbon with halogen same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:24
S118	5	carbon with halogen same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:30
S119	20	activated carbon same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:31
S120	0	activated carbon same remov$4 with mercury and activated carbong with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32

S121	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S122	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S123	67	"4,889,698"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 17:36
S124	125	95/134.ccls. and remov $4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:25
S125	20	95/134.ccls. and remov $4 with mercury and halogen	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26
S126	3	95/142.ccls. and remov $4 with mercury and carbon and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26
S127	0	11//345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S128	8	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S129	54	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S130	7	"6848374"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:34
S131	16	"5575982"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:35
S133	61	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/11 11:30

S135	547	"1984164" "3194629" "3662523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:38
S136	547	"1984164" "3194,629" "3662,523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646" and Group adj V	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:47

S137	10	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or "6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or "6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:50

S138	9	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or "6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or "6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI) and (Hg or mercury)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:52
S139	46	(Group V or Group VI) with (halide or halogen) and (Hg or mercury) with (filter or remov$4)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:53

S141	68	95/134.ccls. and remov $4 with mercury and (V or Nb or Ta or Db or Cr or Mo or W or Sg or Group V or Group VI)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:57
S142	10	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:08
S144	64	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:09
S145	267	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:08
S146	58	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:26
S147	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S148	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with (halide or halogen) same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S149	8287	hydrohalides	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45

S150	5	hydrohalides with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45
S151	143	hydrohalides.ti.	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:46
S152	5	"4490354"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:59
S153	10	"6,136,749"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/12 14:34
S154	8	110/345.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	OR	OFF	2010/10/08 22:15
S155	1	110/345.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:16
S156	1	95/134.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:16
S157	1	95/142.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17
S158	1	423/210.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17
S159	3	(carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17
S160	151	(activated carbon) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:18
S161	11	(activated carbon) with (promoter or halgoen) and remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:18
S162	36	(activated carbon) with (promoter or halgoen or bromine) and remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:20

S163	22	(activated carbon) with (promoter or halgoen or bromide) and remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:20
S164	64	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:21
S165	16	"6136749"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/10/08 23:46

EAST Search History (Interference)

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2/ 22/ 2011 11:56:55 AM
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1774
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

This paper is being filed electronically with the U.S. Patent Office

REQUEST FOR CONTINUED EXAMINATION UNDER 37 C.F.R. §1.114

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

23552
PATENT TRADEMARK OFFICE

Dear Sir:

Under 37 C.F.R. §1.114, it is respectfully requested that this application be accorded the benefits of Continued Examination.

Payment is being made via credit card in the amount of $405 to cover the required fee for a small entity. Please charge any additional fees or credit any overpayment to Deposit Account. No. 13-2725.

Respectfully submitted,

23552
PATENT TRADEMARK OFFICE

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: February 14, 2011

Dennis R. Daley
Reg. No. 34,994
DRD:mls

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1797
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

This paper is being filed electronically with the U.S. Patent Office

PETITION FOR EXTENSION OF TIME

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

Dear Sir:

In accordance with the provisions of 37 C.F.R. §1.136(a), it is respectfully requested that a two-month extension of time be granted in which to respond to the communication mailed October 14, 2010, the period of response being extended from January 14, 2011 to March 14, 2011.

Payment in the amount of $245.00 is made by credit card to cover the required extension fee for a small entity.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: February 15, 2011

Dennis R. Daley
Reg. No. 34,994
DRD:sll

23552
PATENT TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1797
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

This paper is being filed electronically with the U.S. Patent Office

AMENDMENT AND REQUEST FOR RECONSIDERATION

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

Dear Sir:

This is in response to the outstanding Office Action mailed on October 14, 2010. Entry of the following amendment and reconsideration of the outstanding rejections are requested.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Support for Amendment begins on page 6 of this paper.

Remarks begin on page 7 of this paper.

PAC ET AL. EXHIBIT 1025
Page 278

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in this application.

Listing of Claims:

1-33. (Canceled)

34. (Currently Amended) A method for separating mercury from a mercury containing gas comprising:

(a) promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

35. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in gaseous form.

36. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter is in an organic solvent.

37-38. (Cancelled)

39. (Currently Amended) A method according to claim ~~38~~ 34, wherein the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition.

40. (Currently Amended) A method according to claim ~~38~~ 34, wherein at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition.

41. (Cancelled)

42. (Previously Presented) A method according to claim 34, wherein the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators.

43. (Previously Presented) A method according to claim 34, further comprising a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition for reuse.

44. (Previously Presented) A method according to claim 43, further comprising injecting the regenerated promoted brominated sorbent into a mercury containing gas.

45. (Previously Presented) A method according to claim 34, further comprising injecting an alkali component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

46. (Previously Presented) A method according to claim 45, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

47. (Previously Presented) A method according to claim 34, further comprising adding a second halogen or halide promoter to the promoted halogen containing sorbent.

48. (Previously Presented) A method according to claim 47, wherein the second halogen or halide promoter comprises HI, HBr, HCI, Group V element with halogen, or Group VI element with halogen.

49. (Previously Presented) A method according to claim 34, further comprising adding a stabilizing agent to the promoted brominated sorbent.

50. (Previously Presented) A method according to claim 49, wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof.

51. (Previously Presented) A method according to claim 34, wherein the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas.

52. (Previously Presented) A method according to claim 34, wherein the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

53. (Previously Presented) A method according to claim 34, further comprising injecting the sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, 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 the sorbent material.

54. (Previously Presented) A method according to claim 53, wherein the gas stream is a mercury containing gas.

55. (Previously Presented) A method according to claim 54, wherein the gas stream is a transport gas.

56. (Previously Presented) A method according to claim 53, wherein the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas.

57. (Previously Presented) A method according to claim 34, wherein the composition of the promoted sorbent is controlled by the mercury content of the cleaned gas stream.

58. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises at least one of HBr, PBr_3, or Br_2

59. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises molecular bromine.

60. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a bromine compound.

61. (Previously Presented) A method according to claim 34, wherein the bromine containing promoter comprises a Group V or Group VI bromide.

Support for Amendment:

Independent claim 34 is amended to include the features of dependent claim 38. In addition, independent claim 34 is amended to characterize the activated carbon as active carbon contacting graphene sheets having carbene species edge sites. The carbene species edge sites react with the bromine containing promoter to form a carbocation paired with a bromide anion. Support can be found in the Specification at, for example, paragraphs 47-53 and 71.

Claim 38 is cancelled, and claims 39 and 40 are amended so that they depend on independent claim 34 rather than cancelled claim 38.

No new matter is introduced by this Amendment, and entry thereof is requested. Upon entry, claims 34-46, 39, 40, and 42-61 are active in this application.

REMARKS

The presently claimed invention is directed to a method for separating mercury from a mercury containing gas. The method includes the steps of:
(a) promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form, and wherein the activated carbon contains graphene sheets having carbene species edge sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury;
(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and
(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition. The Applicants discovered that by providing activated carbon containing graphene sheets having carbene species edge sites, a bromine containing promoter can react with the carbene species edge sites to form a promoted brominated sorbent that is desirable for capturing mercury in a mercury containing gas.

1. Rejection under 35 USC §102(e) over Nelson, Jr.

Claims 34, 35, 38-40, 42, 49-52, and 58-60 stand rejected under 35 USC §102(b) over U.S. Patent Publication No. U.S. 2004/0003716 to Nelson, Jr. This rejection is traversed.

As a preliminary matter, it is submitted that the basis for rejecting the claims under 35 U.S.C. § 102(b) is incorrect. Nelson, Jr. identifies a publication date of January 8, 2004. In contrast, the above-identified patent application claims the benefit of U.S. Provisional Application Serial No. 60/605,640 that was filed with the United States Patent and Trademark Office on August 30, 2004. Accordingly, the Examiner is requested to reconsider whether the rejection is appropriately made under 35 U.S.C. § 102(b).

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

In view of the above comments, the claimed invention is not anticipated by Nelson, Jr., and would not have been obvious from Nelson, Jr. Accordingly, withdrawal of this rejection is requested.

2. Rejection Under 35 USC §103(a) over Nelson, Jr. and Nishino et al.

Claim 36 stands rejected under 35 U.S.C. § 103(a) over Nelson, Jr. and U.S. Patent No. 4,500,327 to Nishino et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing

graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

It appears that the outstanding Office Action relies upon Nishino et al. for the disclosure of solvents at column 3, line 35-53. See the outstanding Office Action at page 5, paragraph 6. It is pointed out that this portion of Nishino et al. is directed at supporting fine particles of sulfur on activated carbon. It is not understood how this disclosure would have suggested to one skilled in the art the use of activated carbon containing graphene sheet having carbine edge species.

In view of the above comments, the claimed invention would not have been obvious from Nelson, Jr. and Nishino et al. Accordingly, withdrawal of the rejection is requested.

3. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr. and DeJong.

Claims 43 and 44 stand rejecting under 35 U.S.C. § 103(a) over Nelson, Jr. and Canadian Publication No. CA 1099490 to DeJong. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

The outstanding Office Action apparently relies upon de Jong et al. for describing regenerating a promoted halogenated sorbent at page 4, line 24 through page 5, line 3. See the outstanding Office Action at page 5, paragraph 10. De Jong et al., however, fail to describe a promoted brominated sorbent according to the presently claimed invention. Accordingly, it is submitted that one having ordinary skill in the art would not have received the suggestion from de Jong et al. to modify Nelson, Jr. to achieve the presently claimed invention.

In view of the above comments, the claimed invention would not have been obvious over Nelson, Jr. and de Jong et al. Accordingly, withdrawal of this rejection is requested.

4. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr. and Gadkaree et al.

Claim 45 stands rejected under 35 U.S.C. § 103(a) over Nelson, Jr. and U.S. Patent No. 6,136,749 to Gadkaree et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

The outstanding Office Action relies upon Gadkaree et al. for the disclosure of adding an alkali or alkaline first element to a mercury containing gas at column 3, lines 54-65. See the outstanding Office Action at page 6, paragraph 14. It is pointed out that this portion of Gadkaree

et al. is directed at the use of a co-catalyst. Gadkaree et al., however, would not have suggested modifying Nelson, Jr. by using an activated carbon containing graphene sheets having carbene edge species to achieve a promoted brominated sorbent.

In view of the above comments, the claimed invention would not have been obvious over Nelson, Jr. and Gadkaree et al. Accordingly, withdrawal of this rejection is requested.

5. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr., DeJong, and Gadkaree et al.

Claim 46 stands rejected under 35 U.S.C. § 103(a) over Nelson, Jr., DeJong, and Gadkaree et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

De Jong et al. fail to describe a promoted brominated sorbent according to the presently claimed invention. Accordingly, it is submitted that one having ordinary skill in the art would not have received the suggestion from de Jong et al. to modify Nelson, Jr. to achieve the presently claimed invention.

The outstanding Office Action relies upon Gadkaree et al. for the disclosure of adding an alkali or alkaline first element to a mercury containing gas at column 3, lines 54-65. See the

outstanding Office Action at page 7, paragraph 18. It is pointed out that this portion of Gadkaree et al. is directed at the use of a co-catalyst. Gadkaree et al., however, would not have suggested modifying Nelson, Jr. by using an activated carbon containing graphene sheets having carbene edge species to achieve a promoted brominated sorbent.

In view of the above comments, the claimed invention would not have been obvious over Nelson, Jr., DeJong, and Gadkaree et al. Accordingly, withdrawal of this rejection is requested.

6. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr. and Srinivasachar et al.

Claims 47, 48, 53-55, and 61 stand rejected under 35 U.S.C. § 103(a) over Nelson, Jr. and U.S. Patent No. 6,848,374 to Srinivasachar et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

Srinivasachar et al. are directed at the production of a carbonaceous sorbent for the capture of elemental mercury. In addition, Srinivasachar et al. are directed at the "treatment of the carbonaceous sorbent to enhance the capture of elemental mercury." See Srinivasachar et al. at column 2, line 10-18. The treatment of the carbonaceous sorbent involves

"condensing/adsorbing" a halogen 58 onto a sorbent 28. See Srinivasachar et al. at column 6, lines 13-22, and figure 1. Because Srinivasachar et al. describe "condensing/adsorbing" the halogen onto the sorbent, there is clearly no intention by Srinivasachar et al. of reacting the halogen and the sorbent. Furthermore, Srinivasachar et al. fail to describe conditions that provide for reacting a promoter and activated carbon according to the presently claimed invention.

Srinivasachar et al. state:

> "the sorbent particles 28 are sent along a path 38 from the silo 30 to 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."

See Srinivasachar et al. at column 5, line 65 through column 6, line 13. Clearly, Srinivasachar et al. describes a process where the sorbent particles are treated to render the outer surfaces of the particles hydrophilic so that a spray of halogen (in water) adsorbs onto the hydrophilic surface of the particles. The solution 50 described by Srinivasachar et al. at column 6, lines 7-10, can include halogen acids dissolved in water. It is expected that this type of aqueous solution would condense and adsorb onto the particles according to Srinivasachar et al.

There are several reasons why the sorbent particles and halogen acids dissolved in water described by Srinivasachar et al. would not react. Srinivasachar et al. clearly describe depositing a halogen on the surface of the sorbent particles, and "condensing/adsorbing" the halogen onto the sorbent. Nowhere do Srinivasachar et al. mention a reaction between the halogen and the sorbent. One having ordinary skill in the art would not expect a reaction to occur inherently according to the disclosure in Srinivasachar et al. It is pointed out that Srinivasachar et al. describe a solution 50 where the various components are dissolved in water. The Examiner's attention is directed to Srinivasachar et al. at column 6, lines 6-9. One having ordinary skill in the art would clearly understand that Srinivasachar et al. teach oxidizing the surface of sorbent particles 28 so that they are hydrophilic, and then "condensing/adsorbing" a halogen 58 provided in an aqueous solution 50 onto the sorbent particles 28. The Examiner's attention is directed to

Srinivasachar et al. at column 5, lines 62 through column 6, line 22. In contrast to Srinivasachar et al., the bromine containing promoter is provided in gaseous form, vapor form, or non-aqueous liquid form.

Srinivasachar et al. teach that the sorbent particles are treated with an oxidizing agent to increase the hydrophilicity of the outer surface of the sorbent particles. Oxidizing agents would add oxygen to the exterior surface of the sorbent particles to enhance the "condensing/adsorbing" of halogen in aqueous solution to the sorbent particles. The conditions described by Srinivasachar et al. simply provide for depositing a halogen on the surface of the sorbent particles contacted by an oxidizing agent. According to Srinivasachar et al.:

> "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. The solution 50 is chosen from potassium iodide, iodine dissolved in potassium iodide, alkali halides (e.g., NaCl), and halide salts (e.g., $CaCl_2$), or halogen acids (e.g., HCl, HI, HBr, HF) dissolved in water."

See Srinivasachar et al. at column 6, lines 4-12. Clearly, Srinivasachar et al. do not take steps to provide a reaction product resulting from a reaction of a bromide containing promoter and activated carbon according to the presently claimed invention. In fact, Srinivasachar et al. describe spraying the solution of halogen acid dissolved in water onto carbon black, and carbon black is not a material that contains a site for reaction. The Examiner's attention is directed to Srinivasachar et al. at column 6, lines 23-55. At this location of Srinivasachar et al., carbon black and activated carbon are both mentioned. In the case of carbon black, mercury removal performance improved from 20% to 100%. For activated carbon, the mercury removal performance improved from 75% to 90%. Clearly, this shows that higher performance resulted from the use of carbon black as the sorbent as opposed to activated carbon as the sorbent. This means that Srinivasachar et al. do not achieve the benefit of reacting the halogen to the activated carbon. Had Srinivasachar et al. achieved a reaction between the halogen and the activated carbon, Srinivasachar et al. would have seen greater improvement. The Examiner's attention is additionally directed to Srinivasachar et al. at column 9, lines 33-52. This portion of Srinivasachar et al. clearly reflects a preference for utilizing carbon black rather than activated carbon. One skilled in the art would clearly understand that this means that Srinivasachar et al. do not recognize an advantage of reacting a bromine containing promoter with activated carbon

to form a promoted brominated sorbent effective for the removal of mercury from a gas stream according to the presently claimed invention. The reason that Srinivasachar et al. do not recognize an advantage of reacting a bromine containing promoter with activated carbon to form a promoted brominated sorbent is that Srinivasachar et al. do not, in fact, react a bromine containing promoter with activated carbon to form a promoted brominated sorbent. If Srinivasachar et al. had formed a promoted brominated sorbent according to the presently claimed invention, it is submitted that Srinivasachar et al. would have realized significant improvement in mercury removal.

Srinivasachar et al. recite mercury removal efficiencies from an air stream in Table 1 and Figure 6 with various sorbents with or without iodine. One having ordinary skill in the art would know that iodine is adsorbed on a carbon black surface, but does not chemically react with it. In fact, iodine is desorbed from a carbon black surface upon heating. Iodine adsorbed on carbon black has intercalated iodine molecules not carbon oxidation sites. Srinivasachar et al. clearly state in column 6, lines 34-38, that addition of iodine to sorbent leads to "1 percent I_2 in carbon after treatment." In other words, no chemical reaction between the sorbent and iodine occurs.

Srinivasachar et al. fail to indicate any interest in obtaining a reaction between a bromine promoter and activated carbon, and fail to describe conditions that would achieve a reaction between a bromine promoter and activated carbon to provide a promoted brominated sorbent that can be used according to the presently claimed invention. Accordingly, Srinivasachar et al. would not have suggested reacting a bromine promoter with activated carbon containing graphene sheets having carbene species edge sites thereon.

In view of the above comments, the claimed invention would not have been obvious from Nelson, Jr. and Srinivasachar et al. Accordingly, withdrawal of the rejection is requested.

7. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr., Srinivasachar et al., and Vosteen et al.

Claim 56 stands rejected under 35 U.S.C. § 103(a) over Nelson, Jr. Srinivasachar et al., and U.S. Patent No. 6,878,358 to Vosteen et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine

containing promoter with activated carbon containing carbene species edge sites to form a carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

As discussed above, Srinivasachar et al. fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because Srinivasachar et al. fail to describe a promoted brominated sorbent, Srinivasachar et al. are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while Srinivasachar et al. do not. First, the Applicants utilize activated carbon containing graphene sheets having carbene species edge sites thereon which are capable of reacting with a bromine containing promoter. Srinivasachar et al. fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon containing graphene sheets having carbene species edge sites thereon which can react with a bromine containing promoter. If Srinivasachar et al. intended a reaction to occur, Srinivasachar et al. would clearly have indicated a preference for activated carbon containing graphene sheets having carbene species edge sites thereon. Second, the present invention

provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, Srinivasachar et al. describe their halogen as provided in an aqueous solution. In particular, Srinivasachar et al. describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See Srinivasachar et al. at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon containing graphene sheets having carbene species edge sites thereon to form a promoted brominated sorbent. Third, there is no indication by Srinivasachar et al. that a reaction occurs between the solution 50 and the sorbent particles 28. See Srinivasachar et al. at column 5, line 62 through column 6, line 22. Nowhere do Srinivasachar et al. indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

The outstanding Office Action relies upon Vosteen et al. for the disclosure of monitoring mercury content of a cleaned flue gas at column 5, lines 47-63. See the outstanding Office Action at page 11, paragraph 33. It is submitted that this is not a suggestion to modify Nelson, Jr. by using activated carbon containing graphene sheets having carbene species edge sites thereon.

In view of the above comments, the claimed invention would not have been obvious over Nelson, Jr., Srinivasachar et al., and Vosteen et al. Accordingly, withdrawal of the rejection is requested.

8. Rejection Under 35 U.S.C. § 103(a) over Nelson, Jr., and Vosteen et al.

Claim 57 stands rejected under 35 U.S.C. § 103(a) over Nelson, Jr. and Vosteen et al. This rejection is traversed.

Nelson, Jr. fails to disclose activated carbon containing graphene sheets having carbene species edge sites therein. Furthermore, Nelson, Jr. fails to disclose reacting a bromine containing promoter with activated carbon containing carbene species edge sites to form a

carbocation paired with a bromide anion in a promoted brominated sorbent according to the presently claimed method for separating mercury from a mercury containing gas.

Nelson, Jr. describes exemplary activated carbons at paragraph 69. Nelson, Jr. fails to characterize the presence of carbene species edge sites on any of his identified activated carbons. Furthermore, Nelson, Jr. fails to recognize that a bromine containing promoter can react with carbene species edge sites on activated carbon to form a promoted brominated sorbent useful for removing mercury from a mercury containing gas. The Examiner's attention is directed to the examples reported by Nelson, Jr. The test results tend to demonstrate that the selection of activated carbon according to Nelson, Jr. is not particularly significant. It is submitted that the reason for this is that Nelson, Jr. fails to appreciate that utilizing activated carbon containing graphene sheets having carbene species edge sites, and reacting the carbene species edge sites with a bromine containing promoter, is beneficial for the removal of mercury form a mercury containing gas.

The outstanding Office Action relies upon Vosteen et al. for the disclosure of monitoring mercury content of a cleaned flue gas at column 5, lines 47-63. See the outstanding Office Action at page 11, paragraph 36. It is submitted that this is not a suggestion to modify Nelson, Jr. by using activated carbon containing graphene sheets having carbene species edge sites thereon.

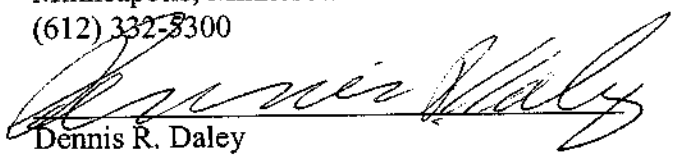
In view of the above comments, the claimed invention would not have been obvious over Nelson, Jr. and Vosteen et al. Accordingly, withdrawal of this rejection is requested.

It is believed that this application is in condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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23552
PATENT TRADEMARK OFFICE

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Dennis Robert Daley/Mona Steil
Attorney Docket Number:	16291.0003USC1

Filed as Small 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:				
Extension-of-Time:				
Extension - 2 months with $0 paid	2252	1	245	245

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	2801	1	405	405
		Total in USD ($)		**650**

Electronic Acknowledgement Receipt

EFS ID:	9446072
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Mona Steil
Filer Authorized By:	Dennis Robert Daley
Attorney Docket Number:	16291.0003USC1
Receipt Date:	15-FEB-2011
Filing Date:	06-APR-2009
Time Stamp:	12:05:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$650
RAM confirmation Number	9382
Deposit Account	132725
Authorized User	DALEY,DENNIS R.

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 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	IDS.PDF	105880 a2c0f8ce1a86bd80be666a9e55dd3fdeb8986d52	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	Request for Continued Examination (RCE)	RCE.PDF	36606 b8a1f83fd53495fa4303e3cf4a7dcdb0d9582d69	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
3	Extension of Time	Ext.PDF	34690 d7dee4ec3f9251beac04e0a11617f23b048f7c0e	no	1
Warnings:					
Information:					
4		Amd.PDF	951861 d89ba1e774f40f0cf3ab5ad691f0db54211 8c4b	yes	19

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment After Final	1	1
Claims	2	6
Applicant Arguments/Remarks Made in an Amendment	7	19

Warnings:					
Information:					
5	Fee Worksheet (PTO-875)	fee-info.pdf	32316 9a9cd48347afd85eb5d660a271cece40f9e01390	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1161353		

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

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1797
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT (37 C.F.R. § 1.97(b))

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

Dear Sir:

With regard to the above-identified application, the items of information listed on the enclosed Form 1449 are brought to the attention of the Examiner.

This statement should be considered because it is submitted before the mailing of a first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. § 1.114 or a CPA under 37 C.F.R. § 1.53(d). Accordingly, no fee is due for consideration of the items listed on the enclosed Form 1449.

In accordance with 37 C.F.R. §1.98(a)(2), a copy of each foreign patent and/or a copy of each publication, other than U.S. patents and U.S. patent application publications, listed on the accompanying Form 1449 is enclosed.

No representation is made that a reference is "prior art" within the meaning of 35 U.S.C. §§ 102 and 103 and Applicants reserve the right, pursuant to 37 C.F.R. § 1.131 or otherwise, to establish that the reference(s) are not "prior art." Moreover, Applicants do not represent that a reference has been thoroughly reviewed or that any relevance of any portion of a reference is intended.

Consideration of the items listed is respectfully requested. Pursuant to the provisions of M.P.E.P. 609, it is requested that the Examiner return a copy of the attached Form 1449, marked

as being considered and initialed by the Examiner, to the undersigned with the next official communication.

Please charge any additional fees or credit any overpayment to Deposit Account No. 13-2725.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: February 14, 2011

Dennis R. Daley
Reg. No. 34,994
DDaley:TPJ:rlk

23552
PATENT TRADEMARK OFFICE

Date Mailed: February ___, 2011

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson	
	Filing Date: 04/06/2009	Group Art Unit: 1774

U.S. PATENT DOCUMENTS

EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	US 7,514,052	04/07/2009	Lissianski et al.			

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
						YES	NO

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

23552
PATENT TRADEMARK OFFICE

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.

*Substitute Disclosure Statement Form (PTO-1449)

Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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
12/419,219	04/06/2009	

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 07/15/2010	(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))	* 26	Minus	** 24	= 2	X $26 =	52	OR	X $ =	
Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0	X $110 =	0	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	52	OR	TOTAL ADD'L FEE	

AMENDMENT 02/15/2011	(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))	* 25	Minus	** 26	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0	X $110 =	0	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	0	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:
/DIANE FLOYD/

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.

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.
12/419,219	04/06/2009	Edwin S. Olson	16291.0003USC1	1149

23552 7590 10/14/2010

MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

EXAMINER	
ORLANDO, AMBER ROSE	
ART UNIT	PAPER NUMBER
1774	

MAIL DATE	DELIVERY MODE
10/14/2010	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)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1774	

-- 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 *15 July 2010*.

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) *33-36,38-40 and 42-61* 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) *33-36,38-40 and 42-61* 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: _____.

Interview Summary	Application No.	Applicant(s)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	1774	

All participants (applicant, applicant's representative, PTO personnel):

(1) *AMBER ORLANDO*. (3)_____.

(2) *DENNIS DAILY*. (4)_____.

Date of Interview: *08 October 2010*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☐ No.
If Yes, brief description: _____.

Claim(s) discussed: *24 and 39*.

Identification of prior art discussed: *Srinivaschar et al. US 6,848,374*.

Agreement with respect to the claims f)☒ was reached. g)☐ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *See Continuation Sheet*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Continuation of Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: The applicant's representative described the current invention and how it differs from the Srinivasachar et al. reference. Specifically that there is a carbo cation created to remove elemental mercury from the flue gas, and the bromine containing promoter should have a limited amount of water present when applying the promoter to the activated carbon. Also that the current invention uses activated carbon versus carbon black, and bromide versus iodide. The examiner explained her position stating that the Srinivasachar et al. reference discloses using both activated carbon and bromide. The examiner further explained that by combining the claim language of claim 38 with independent claim 34, this would overcome the Srinivasachar et al. reference because the Srinivasachar et al. reference does not disclose "the activated carbon contains basic binding sites which react with the bromine containing promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury. The applicant authorized a claim amendment to claim 34 to include the content of claim 38 if claim 38 were to be found allowable.

.

DETAILED ACTION

This action is in response to the correspondence filed 07/15/2010.

Claims 34-36, 38, 39, 45 and 53 are amended.

Claims 58-61 are new.

Claims 34-36, 38-40 and 42-61 are rejected.

Claims 34-36, 38-40 and 42-61 are pending and have been examined.

Claim Rejections - 35 USC § 102

1. 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 –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 34, 35, 38-40, 42, 49-52 and 58-60 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Nelson Jr. US 2004/0003716 (further referred to as 716).

3. Regarding claims 34, 35, 38-40, and 42 the 716 reference discloses a method for separating mercury from a mercury containing gas comprising: (a) promoting at least a portion of a sorbent material by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent; (b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; (c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition, the bromine containing promoter is in gaseous form, the activated carbon contains basic binding sites which react with the bromine containing

promoter to form a carbocation paired with a bromide anion in the promoted brominated sorbent for oxidation of the mercury, the carbocation paired with a bromide anion chemically react with elemental mercury form the mercury/sorbent composition, at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition (paragraphs [0043], [0044], [0046], [0047] and [0053]), the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators (paragraphs [0043]).

4. For claims 49 and 50, the 716 discloses adding a stabilizing agent to the promoted halogen containing sorbent wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof (paragraph [0045 and [0064]).

5. For claim 51, the 716 reference discloses the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas (paragraph [0055]).

6. For claim 52, the 716 reference discloses the promoted brominated sorbent combines with at least 70% of the mercury present in the mercury containing gas.

7. For claims 58-60, the 716 reference discloses the bromine containing promoter comprises at least one of HBr, PBr_3 or Br_2, molecular bromine, or a bromine compound (paragraph [0041]).

Claim Rejections - 35 USC § 103

1. 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.

2. 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.

3. 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).

4. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) as applied in claim 34 above, and further in view of Nishino et al. US 4,500,327 (further referred to as 327).

5. For claim 36, the 716 reference discloses the promoter bromine (paragraph [0041]). The reference does not disclose using an organic solvent.

6. The 327 reference discloses using the organic solvent (column 3, lines 35-53).

7. It would have been obvious to one having ordinary skill in the art a the time the invention was made to have modified the 716 reference to include using the organic solvent (327, column 3, lines 35-53) in order to allow the molecular halogen to go into solution and be sprayed onto the activated carbon.

8. Claims 43 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) as applied in claim 34 above, and further in view of de Jong CA 1099490 (further referred to as 490).

9. For claims 43 and 44, the 716 reference does not disclose a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas.

10. The 490 reference discloses a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (page 4-5, lines 24-3). The reference does not explicitly state the sorbent being a brominated sorbent. The reference the carbon being "washed with water to get rid of any clogging salts" which would include bromine. Furthermore the 490 reference discloses such a regeneration method with a chlorinated sorbent. Chlorine and bromine are very similar in there chemical characteristics, and there would be a reasonable expectation of success when

using the same methods to regenerate a brominated sorbent as is used for a chlorinated sorbent.

11. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include a step of regenerating a promoted brominated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (490, page 4-5, lines 24-3) in order to be able to reuse the promoted activated carbon, and therefore reduce material costs.

12. Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) as applied in claim 34 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

13. For claim 45, the 716 reference does not disclose injecting an alkaline component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

14. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

15. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (749,

column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

16. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Jong CA 1099490 (further referred to as 490) as applied in claim 43 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

17. For claim 46, the 716 reference does not disclose the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

18. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

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 716 reference to include the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

20. Claims 47, 48, 53-55 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) as applied in claim 34 above, and further in view of Srinivasachar et al. US 6,848,374 (further referred to as 374).

21. For claims 47 and 48, the 716 reference does not disclose adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen.

22. The 374 reference discloses adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (column 6, lines 3-18).

23. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (374, column 6, lines 3-18) to ensure that a maximum amount of promoter is reacted/adsorbed onto the activated carbon, to thereby allow for a greater amount of mercury to be removed.

24. For claim 53-55, the 716 reference discloses, the promoter is reacted in the gas phase or as a vapor (paragraphs [0041] and [0051]) and the promoter is added at from about 1 to about 30 grams per 100 grams of the sorbent material (paragraphs [0054] and [0069]). The reference does not disclose injecting the sorbent material at a sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent, the gas stream is a mercury containing gas and the gas stream is a transport gas.

25. The 374 reference discloses injecting the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (columns 5-6, lines 59-18) and the gas stream being a transport gas (columns 5-6, lines 55-18). The reference does not explicitly state injecting the two streams (promoter and sorbent material) into a mercury containing gas stream. The reference does disclose combining two streams (promoter and sorbent) into one stream, and then subsequently injecting the one stream into the mercury containing gas stream (columns 5-6, lines 55-18). It would have been well within the knowledge of one having ordinary skill in the art to combine the two steps, to make one step (e.g. co-injecting the streams into the mercury containing gas) in order to cut down production costs and time needed to complete the process. The mere combination of known steps does not provide patentability.

26. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the sorbent material at an sorbent material injection rate and injecting separately the bromine containing promoter into a gas stream whereby in-flight reaction produces the promoted brominated sorbent (374, columns 5-6, lines 59-18), the gas stream is a mercury containing gas (374 columns 5-6lines 55-18) and the gas stream being a transport gas (374, columns 5-6, lines 55-18).

27. For claim 61, the 716 reference does not disclose the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof.

28. The 374 reference discloses the halogen or halide promoter comprises at least one of Group V halide, Group VI bromide, or mixtures thereof (column 6, lines 3-18).

29. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the halogen or halide promoter comprises at least one of Group V bromide, Group VI bromide, or mixtures thereof (374 column 6, lines 3-18) because the active portion of the molecule is still the bromine, which is shown above to be desirable by 716, and there would be reasonable expectation of success when using the same active ingredient for the reaction between the promoter and the activated carbon.

30. Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) and Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 53 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

31. For claim 56, the 716 and 374 references do not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

32. The 358 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 have been 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 promoter injection rate and the sorbent injection rate into the gas must be changed in correspondence to the monitored mercury content of the cleaned gas within the 358 reference.

33. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the combination of the 716 and 374 reference to include the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

34. Claim 57 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson Jr. US 2004/003716 (further referred to as 716) as applied in claim 34 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

35. For claim 57, the 716 reference does not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

36. The 358 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 have been obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content (increase) within the cleaned flue gas, the sorbent composition must be changed just as that of the bromine within the 358 reference.

37. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 716 reference to include the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas

stream (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

Response to Arguments

38. Applicant's arguments with respect to claims 34-36, 38-40 and 42-61 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

8. 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 ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Mon.-Thurs. (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.

AO

/Walter D. Griffin/
Supervisory Patent Examiner, Art Unit 1774

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1774

✓	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	01/11/2010	10/08/2010							
2419	1	-	-							
	2	-	-							
	3	-	-							
	4	-	-							
	5	-	-							
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	30	-	-							
	31	-	-							
	32	-	-							
	33	-	-							
	34	✓	✓							
	35	✓	✓							
	36	✓	✓							

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CLAIM		DATE								
Final	Original	01/11/2010	10/08/2010							
	37	✓	-							
	38	✓	✓							
	39	✓	✓							
	40	✓	✓							
	41	✓	-							
	42	✓	✓							
	43	✓	✓							
	44	✓	✓							
	45	✓	✓							
	46	✓	✓							
	47	✓	✓							
	48	✓	✓							
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	56	✓	✓							
	57	✓	✓							
	58		✓							
	59		✓							
	60		✓							
	61		✓							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	Art Unit
	AMBER ORLANDO	1774

SEARCHED

Class	Subclass	Date	Examiner
110	345	1/11/2010	AO
423	210	1/11/2010	AO
95	134, 142	1/11/2010	AO
110	345	10/8/2010	AO
423	210	10/8/2010	AO
95	134, 142	10/8/2010	AO

SEARCH NOTES

Search Notes	Date	Examiner
Inventor Search (eDAN)	1/11/2010	AO
Classes 95, 423 and 110 searched for separating mercury from a mercury containing gas. The method including a sorbent, a promotor and separating particulates from the mercury containing gas.	1/11/2010	AO
IDS search (EAST and eDAN)	1/11/2010	AO
Classes 95, 423 and 110 researched for new art.	10/8/2010	AO

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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

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" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:53

		"6521021" | "6533842").PN. OR ("6953494").URPN. and in-flight				
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
S97	0	110/345.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S98	5	423/210.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S99	0	(halogenated carbon with halide with covalently$5).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:05
S100	0	(carbon with haldie with sorbent and reduc $ with mercury).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:06
S101	0	(carbon with haldie with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07

S102	1	(carbon with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
S103	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S104	55234	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S105	2	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S106	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S107	15	carbon with alkali same remov$4 with mercury and exhaust	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S108	4	mercury with exhaust and mercury with stabili $5 with reagent and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:29
S109	6	"6848374" and (stabili $4 or sulfur or sulfide)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:31
S110	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfer dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S111	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S112	2	stabili$5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:35
S113	2	mercury with exhaust and mercury with stabili $5 with sulfur and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:36

S114	4	"6848374" and (organic or solvent)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S115	5	"6848374" and (organic or solvent or dissolv$4)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S116	7	carbon with alkali same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:21
S117	8	carbon with halogen same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:24
S118	5	carbon with halogen same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:30
S119	20	activated carbon same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:31
S120	0	activated carbon same remov$4 with mercury and activated carbong with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S121	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S122	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S123	67	"4,889,698"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 17:36
S124	125	95/134.ccls. and remov $4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:25
S125	20	95/134.ccls. and remov $4 with mercury and halogen	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26
S126	3	95/142.ccls. and remov $4 with mercury and carbon and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26

S127	0	11//345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S128	8	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S129	54	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S130	7	"6848374"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:34
S131	16	"5575982"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:35
S133	61	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/11 11:30
S135	547	"1984164" "3194629" "3662523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:38

S136	547	"1984164" "3194,629" "3662,523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646" and Group adj V	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:47
S137	10	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:50

		"6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or "6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI)				
S138	9	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or "6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:52

		"6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI) and (Hg or mercury)				
S139	46	(Group V or Group VI) with (halide or halogen) and (Hg or mercury) with (filter or remov$4)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:53
S141	68	95/134.ccls. and remov $4 with mercury and (V or Nb or Ta or Db or Cr or Mo or W or Sg or Group V or Group VI)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:57
S142	10	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:08
S144	64	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:09
S145	267	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:08
S146	58	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:26

S147	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S148	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with (halide or halogen) same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S149	8287	hydrohalides	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45
S150	5	hydrohalides with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45
S151	143	hydrohalides.ti.	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:46
S152	5	"4490354"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:59
S153	10	"6,136,749"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/12 14:34
S154	8	110/345.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	OR	OFF	2010/10/08 22:15
S155	1	110/345.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:16
S156	1	95/134.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:16
S157	1	95/142.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17

S158	1	423/210.ccls. and (carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17
S159	3	(carbocation or (carbon cation)) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:17
S160	151	(activated carbon) with (promoter or halgoen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:18
S161	11	(activated carbon) with (promoter or halgoen) and remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:18
S162	36	(activated carbon) with (promoter or halgoen or bromine) and remov $4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:20
S163	22	(activated carbon) with (promoter or halgoen or bromide) and remov $4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:20
S164	64	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/08 22:21
S165	16	"6136749"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/10/08 23:46

EAST Search History (Interference)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1797
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

This paper is being filed electronically with the U.S. Patent Office

AMENDMENT AND REQUEST FOR RECONSIDERATION

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

Dear Sir:

This is in response to the outstanding Office Action mailed January 15, 2010. Entry of the following amendment and reconsideration of the outstanding rejections are requested.

Amendments to the Claims are reflected in the listing of claims that begins on page 2 of this paper.

Support for Amendment begins on page 6 of this paper.

Remarks begin on page 7 of this paper.

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in this application.

Listing of Claims:

1-33. (Canceled)

34. (Currently Amended) A method for separating mercury from a mercury containing gas comprising:

~~(a) providing a sorbent material;~~

~~(b) providing a halogen or halide promoter;~~

~~(c)~~ (a) promoting at least a portion of ~~the~~ a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing ~~the halogen or halide~~ promoter to form a promoted ~~halogenated~~ brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form;

~~(d)~~ (b) chemically reacting elemental mercury in the mercury containing gas with the promoted ~~halogenated~~ brominated sorbent to form a mercury/sorbent chemical composition; and

~~(e)~~ (c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

35. (Currently Amended) A method according to claim 34, wherein the bromine containing promoter is ~~halogen or halide promoter comprises molecular halogen~~ in gaseous ~~vapor~~ form.

36. (Currently Amended) A method according to claim 34, wherein the bromine containing promoter is ~~halogen or halide promoter comprises molecular halogen~~ in an organic solvent.

37. (Cancelled)

38. (Currently Amended) A method according to claim 34, wherein the ~~sorbent material comprises base~~ activated carbon ~~that~~ contains basic binding sites which react with the bromine

containing promoter to form a carbocation paired with a bromide anion ~~halogens, hydrohalides, and Group V and Group 6 halides to form highly reactive acidic binding sites~~ in the promoted brominated sorbent for oxidation of the mercury.

39. (Currently Amended) A method according to claim 38, wherein the carbocation paired with a bromide anion ~~acidic binding sites in the promoted activated carbon~~ chemically react with elemental mercury form the mercury/sorbent composition.

40. (Previously Presented) A method according to claim 38, wherein at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition.

41. (Cancelled)

42. (Previously Presented) A method according to claim 34, wherein the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators.

43. (Previously Presented) A method according to claim 34, further comprising a step of regenerating a promoted brominated ~~halogenated~~ sorbent from the mercury/sorbent chemical composition for reuse.

44. (Previously Presented) A method according to claim 43, further comprising injecting the regenerated promoted brominated ~~halogenated~~ sorbent into a mercury containing gas.

45. (Currently Amended) A method according to claim 34, further comprising injecting an ~~alkaline~~ alkali component into the mercury containing gas for protecting mercury binding sites and capturing oxidized mercury.

46. (Previously Presented) A method according to claim 45, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

47. (Previously Presented) A method according to claim 34, further comprising adding a second halogen or halide promoter to the promoted halogen containing sorbent.

48. (Previously Presented) A method according to claim 47, wherein the second halogen or halide promoter comprises HI, HBr, HCI, Group V element with halogen, or Group VI element with halogen.

49. (Previously Presented) A method according to claim 34, further comprising adding a stabilizing agent to the promoted brominated ~~halogen containing~~ sorbent.

50. (Previously Presented) A method according to claim 49, wherein the stabilizing agent comprises at least one of S, Se, H_2S, $S0_2$, H_2Se, $Se0_2$, CS_2, P_2S_5, or mixtures thereof.

51. (Previously Presented) A method according to claim 34, wherein the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas.

52. (Previously Presented) A method according to claim 34, wherein the promoted brominated ~~halogen containing~~ sorbent combines with at least 70% of the mercury present in the mercury containing gas.

53. (Currently Amended) A method according to claim 34, further comprising injecting the sorbent material at ~~an~~ a sorbent material injection rate and injecting separately the bromine containing promoter ~~at least one promoter at a promoter injection rate~~ into a gas stream whereby in-flight reaction produces the promoted brominated ~~halogenated~~ sorbent, 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 the sorbent material.

54. (Previously Presented) A method according to claim 53, wherein the gas stream is a mercury containing gas.

55. (Previously Presented) A method according to claim 54, wherein the gas stream is a transport gas.

56. (Previously Presented) A method according to claim 53, wherein the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas.

57. (Previously Presented) A method according to claim 34, wherein the composition of the promoted sorbent is controlled by the mercury content of the cleaned gas stream.

58. (New) A method according to claim 34, wherein the bromine containing promoter comprises at least one of HBr, PBr_3, or Br_2

59. (New) A method according to claim 34, wherein the bromine containing promoter comprises molecular bromine.

60. (New) A method according to claim 34, wherein the bromine containing promoter comprises a bromine compound.

61. (New) A method according to claim 34, wherein the bromine containing promoter comprises a Group V or Group VI bromide.

Support for Amendment:

Claim 34 is amended to characterize the sorbent material as comprising activated carbon. This amendment is supported by the application at various locations including, for example, paragraphs 10-12, 41, and 47. Claim 34 is amended to characterize the promoter as a bromine containing promoter. This amendment is supported by the application at various locations. For example, see paragraphs 9 and 41 referring to the use of bromide for the treatment of activated carbon to form a promoted sorbent. New claims 58-61 characterize the bromine containing promoter based on the disclosures in the application at, for example, paragraphs 17, 18, 50, 52, and 53. Claim 34 is amended to characterize the promoter in gaseous form, vapor form, or non-aqueous liquid form. This amendment is supported by the specification at, for example, paragraphs 17 and 50. Claim 34 is additionally amended to remove the steps of "providing."

Dependent claims 35, 36, 38, 39, 43, 44, 49, 52, and 53 are amended to clarify antecedent in view of the amendment to claim 34.

Claims 38 and 39 are amended to clarify the presence of a carbocation paired with a bromide anion. This amendment is supported by the specification at, for example, paragraph 52.

Claim 45 is amended to refer to an "alkali component." This amendment is supported by the specification at, for example, paragraph 59. In addition, claim 45 is amended to reference the protection of mercury binding sites and the capture of oxidized mercury. This is supported by the specification at paragraph 74.

No new matter is introduced by this amendment, and entry thereof is requested. Upon entry, claims 34-36, 38-40, and 42-61 are active in this application.

REMARKS

The outstanding Office Action includes a rejection of claim 46 under 35 USC §112, second paragraph. In view of the amendment to claim 45, it is submitted that the rejection of claim 46 has been rendered moot. Accordingly, withdrawal of this rejection is requested.

The outstanding Office Action includes several prior art-based rejections. Each of the prior art-based rejections is discussed below.

1. Rejection under 35 USC §102(e) over Srinivasachar et al.

Claims 34, 35, 38-42, 47, 48, and 51-53 stand rejected under 35 USC §102(e) over US Patent No. 6,848,374 to *Srinivasachar et al.* This rejection is traversed.

The presently claimed invention is directed to a method for separating mercury from a mercury containing gas. The method includes the steps of:

(a) promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter to form a promoted brominated sorbent, wherein the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form;

(b) chemically reacting elemental mercury in the mercury containing gas with the promoted brominated sorbent to form a mercury/sorbent chemical composition; and

(c) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

Srinivasachar et al. fail to describe a promoted brominated sorbent comprising a reaction product of a bromine containing promoter and activated carbon, and fail to disclose using such a promoted brominated sorbent for the removal of mercury from a mercury containing gas according to the presently claimed invention.

Srinivasachar et al. are directed at the production of a carbonaceous sorbent for the capture of elemental mercury. In addition, *Srinivasachar et al.* are directed at the "treatment of the carbonaceous sorbent to enhance the capture of elemental mercury." See *Srinivasachar et al.* at column 2, line 10-18. The treatment of the carbonaceous sorbent involves "condensing/adsorbing" a halogen 58 onto a sorbent 28. See *Srinivasachar et al.* at column 6, lines 13-22, and figure 1. Because *Srinivasachar et al.* describe "condensing/adsorbing" the

halogen onto the sorbent, there is clearly no intention by *Srinivasachar et al.* of reacting the halogen and the sorbent. Furthermore, *Srinivasachar et al.* fail to describe conditions that provide for reacting a promoter and activated carbon according to the presently claimed invention.

Srinivasachar et al. state:

> "the sorbent particles 28 are sent along a path 38 from the silo 30 to 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."

See *Srinivasachar et al.* at column 5, line 65 through column 6, line 13. Clearly, *Srinivasachar et al.* describes a process where the sorbent particles are treated to render the outer surfaces of the particles hydrophilic so that a spray of halogen (in water) adsorbs onto the hydrophilic surface of the particles. The solution 50 described by *Srinivasachar et al.* at column 6, lines 7-10, can include halogen acids dissolved in water. It is expected that this type of aqueous solution would condense and adsorb onto the particles according to *Srinivasachar et al.*

No sufficient reason or explanation has been provided in the outstanding Office Action that would suggest that the disclosure by *Srinivasachar et al.* would result in a reaction of the halogen with the sorbent particles. Furthermore, there are several reasons why the sorbent particles and halogen acids dissolved in water described by *Srinivasachar et al.* would not react. Those reasons are explained below.

Srinivasachar et al. clearly describe depositing a halogen on the surface of the sorbent particles, and "condensing/adsorbing" the halogen onto the sorbent. Nowhere do *Srinivasachar et al.* mention a reaction between the halogen and the sorbent.

The outstanding Office Action appears to contend that *Srinivasachar et al.* describes a reaction between sorbent material and promoter at column 6, lines 3-17. See the outstanding Office Action at pages 2-3, paragraph 3. It is submitted that there is no disclosure of a reaction at this location of *Srinivasachar et al.*, and one having ordinary skill in the art would not expect a

reaction to occur inherently according to the disclosure in *Srinivasachar et al.* It is pointed out that *Srinivasachar et al.* describe a solution 50 where the various components are dissolved in water. The Examiner's attention is directed to *Srinivasachar et al.* at column 6, lines 6-9. One having ordinary skill in the art would clearly understand that *Srinivasachar et al.* teach oxidizing the surface of sorbent particles 28 so that they are hydrophilic, and then "condensing/adsorbing" a halogen 58 provided in an aqueous solution 50 onto the sorbent particles 28. The Examiner's attention is directed to *Srinivasachar et al.* at column 5, lines 62 through column 6, line 22. In contrast to *Srinivasachar et al.*, the bromine containing promoter is provided in gaseous form, vapor form, or non-aqueous liquid form.

Srinivasachar et al. teach that the sorbent particles are treated with an oxidizing agent to increase the hydrophilicity of the outer surface of the sorbent particles. Oxidizing agents would add oxygen to the exterior surface of the sorbent particles to enhance the "condensing/adsorbing" of halogen in aqueous solution to the sorbent particles. The conditions described by *Srinivasachar et al.* simply provide for depositing a halogen on the surface of the sorbent particles contacted by an oxidizing agent. According to *Srinivasachar et al.*:

> "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. The solution 50 is chosen from potassium iodide, iodine dissolved in potassium iodide, alkali halides (e.g., NaCl), and halide salts (e.g., $CaCl_2$), or halogen acids (e.g., HCl, HI, HBr, HF) dissolved in water."

See *Srinivasachar et al.* at column 6, lines 4-12. Clearly, *Srinivasachar et al.* do not take steps to provide a reaction product resulting from a reaction of a bromide containing promoter and activated carbon according to the presently claimed invention. In fact, *Srinivasachar et al.* describe spraying the solution of halogen acid dissolved in water onto carbon black, and carbon black is not a material that contains a site for reaction. The Examiner's attention is directed to *Srinivasachar et al.* at column 6, lines 23-55. At this location of *Srinivasachar et al.*, carbon black and activated carbon are both mentioned. In the case of carbon black, mercury removal performance improved from 20% to 100%. For activated carbon, the mercury removal performance improved from 75% to 90%. Clearly, this shows that higher performance resulted from the use of carbon black as the sorbent as opposed to activated carbon as the sorbent. This

means that *Srinivasachar et al.* do not achieve the benefit of reacting the halogen to the activated carbon. Had *Srinivasachar et al.* achieved a reaction between the halogen and the activated carbon, *Srinivasachar et al.* would have seen greater improvement. The Examiner's attention is additionally directed to *Srinivasachar et al.* at column 9, lines 33-52. This portion of *Srinivasachar et al.* clearly reflects a preference for utilizing carbon black rather than activated carbon. One skilled in the art would clearly understand that this means that *Srinivasachar et al.* do not recognize an advantage of reacting a bromine containing promoter with activated carbon to form a promoted brominated sorbent effective for the removal of mercury from a gas stream according to the presently claimed invention. The reason that *Srinivasachar et al.* do not recognize an advantage of reacting a bromine containing promoter with activated carbon to form a promoted brominated sorbent is that *Srinivasachar et al.* do not, in fact, react a bromine containing promoter with activated carbon to form a promoted brominated sorbent. If *Srinivasachar et al.* had formed a promoted brominated sorbent according to the presently claimed invention, it is submitted that *Srinivasachar et al.* would have realized significant improvement in mercury removal.

Srinivasachar et al. recite mercury removal efficiencies from an air stream in Table 1 and Figure 6 with various sorbents with or without iodine. One having ordinary skill in the art would know that iodine is adsorbed on a carbon black surface, but does not chemically react with it. In fact, iodine is desorbed from a carbon black surface upon heating. Iodine adsorbed on carbon black has intercalated iodine molecules not carbon oxidation sites. *Srinivasachar et al.* clearly state in column 6, lines 34-38, that addition of iodine to sorbent leads to "1 percent I_2 in carbon after treatment." In other words, no chemical reaction between the sorbent and iodine occurs.

Srinivasachar et al. fail to indicate any interest in obtaining a reaction between a bromine promoter and activated carbon, and fail to describe conditions that would achieve a reaction between a bromine promoter and activated carbon to provide a promoted brominated sorbent that can be used according to the presently claimed invention.

In view of the above comments, the claimed invention is not anticipated by *Srinivasachar et al.* and would not have been obvious from *Srinivasachar et al.* Accordingly, withdrawal of the rejection over *Srinivasachar et al.* is requested.

2. Rejection under 35 USC §103(a) over Srinivasachar et al. and Nishino et al.

Claims 36 and 37 stand rejected under 35 USC §103(a) over Srinivasachar et al. and US Patent No. 4,500,327 to Nishino et al. This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as

described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

It appears that the outstanding Office Action relies upon *Nishino et al.* for the disclosure of solvents at column 3, line 35-53. See the outstanding Office Action at page 6, paragraph 9, and page 7, paragraph 10. It is pointed out that this portion of *Nishino et al.* is directed at supporting fine particles of sulfur on activated carbon. It is not understood how this disclosure would have suggested to one skilled in the art the modification of the explicit disclosure by *Srinivasachar et al.* of halide salts and halogen acids dissolved in water for condensing/adsorbing onto sorbent particles 28 that have been oxidized and rendered hydrophilic. Furthermore, it is submitted that such a modification as *Srinivasachar et al.* would go against the teachings of *Srinivasachar et al.*

In view of the above comments, the claimed invention would not have been obvious from *Srinivasachar et al.* and *Nishino et al.* Accordingly, withdrawal of the rejection is requested.

3. Rejection under 35 USC §103(a) over Srinivasachar et al. and de Jong.

Claims 43 and 44 stand rejected under 35 USC §103(a) over *Srinivasachar et al.* and CA 1099490 to *de Jong et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is

capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

The outstanding Office Action apparently relies upon *de Jong et al.* for describing regenerating a promoted halogenated sorbent at page 4, line 24 through page 5, line 3. See the outstanding Office Action at page 7, paragraph 13. *De Jong et al.*, however, fail to describe a promoted brominated sorbent according to the presently claimed invention. Accordingly, it is submitted that one having ordinary skill in the art would not have received the suggestion from *de Jong et al.* to modify *Srinivasachar et al.* to achieve the presently claimed invention.

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* and *de Jong et al.* Accordingly, withdrawal of this rejection is requested.

4. Rejection under 35 USC §103(a) over Srinivasachar et al. and Gadkaree et al.

Claim 45 stands rejected under 35 USC §103(a) over *Srinivasachar et al.* and US Patent No. 6,136,749 to *Gadkaree et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do

Srinivasachar et al. indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

The outstanding Office Action relies upon *Gadkaree et al.* for the disclosure of adding an alkali or alkaline first element to a mercury containing gas at column 3, lines 54-65. See the outstanding Office Action at page 8, paragraph 17. It is pointed out that this portion of *Gadkaree et al.* is directed at the use of a co-catalyst. *Gadkaree et al.*, however, would not have suggested modifying *Srinivasachar et al.* by avoiding a step of oxidizing a surface of sorbents and applying a bromine containing promoter in gaseous form or in an organic solvent to activated carbon to achieve a promoted brominated sorbent.

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* and *Gadkaree et al.* Accordingly, withdrawal of this rejection is requested.

5. Rejection under 35 USC §103(a) over Srinivasachar et al. de Jong, and Gadkaree et al.

Claim 46 stands rejected under 35 USC §103(a) over *Srinivasachar et al.*, *de Jong et al.*, and *Gadkaree et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is

capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

De Jong et al. and *Gadkaree et al.* are discussed above. It is submitted that *de Jong et al.* and *Gadkaree et al.* would not have suggested modifying *Srinivasachar et al.* by removing the step of oxidizing sorbent particles, and by replacing the halogen in water with a bromine containing promoter in gaseous form, vapor form, or non-aqueous liquid form.

In view of the above comments, the claimed invention would not have been obvious from *Srinivasachar et al.*, *de Jong et al.*, and *Gadkaree et al.* Accordingly, withdrawal of this rejection is requested.

6. Rejection under 35 USC §103(a) over Srinivasachar et al. and Broderick.

Claims 49 and 50 stand rejected under 35 USC §103(a) over *Srinivasachar et al.* and US Patent No. 6,942,840 to *Broderick.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as

described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

Broderick is relied upon for the disclosure of a mercury-stabilizing reagent. See the outstanding Office action at page 9, paragraph 25. It is pointed out that this disclosure by *Broderick* refers to contacting a mercury-containing gas stream with a liquid, oxygen-containing oxidizing agent. It is submitted that the disclosure by *Broderick* would not have led one having ordinary skill in the art to modify *Srinivasachar et al.* by removing the step of oxidizing sorbent particles and by changing the halogen in water as described by *Srinivasachar et al.*

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* and *Broderick.* Accordingly, withdrawal of the rejection is requested.

7. Rejection under 35 USC §103(a) over Srinivasachar et al.

Claims 54 and 55 stand rejected under 35 USC §103(a) over *Srinivasachar et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.*

intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* Accordingly, withdrawal of the rejection is requested.

8. Rejection under 35 USC §103(a) over Srinivasachar et al. and Vosteen et al.

Claim 56 stands rejected under 35 USC §103(a) over *Srinivasachar et al.* and US Patent No. 6,878,358 to *Vosteen et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because

Srinivasachar et al. fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast, the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

The outstanding Office Action relies upon *Vosteen et al.* for the disclosure of monitoring mercury content of a cleaned flue gas at column 5, lines 47-63. See the outstanding Office Action at page 10, paragraph 31. It is submitted that this is not a suggestion to modify

Srinivasachar et al. by removing the step of oxidizing sorbent particles and by haltering the halogen in water component that is supposed to condense or adsorb onto the surface of the oxidized sorbent particles.

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* and *Vosteen et al.* Accordingly, withdrawal of the rejection is requested.

9. Rejection under 35 USC §103(a) over Srinivasachar et al. and Vosteen et al.

Claim 57 stands rejected under 35 USC §103(a) over *Srinivasachar et al.* and *Vosteen et al.* This rejection is traversed.

As discussed above, *Srinivasachar et al.* fail to disclose a method according to the present invention that includes a step of promoting at least a portion of a sorbent material comprising activated carbon by chemically reacting the sorbent material with a bromine containing promoter, wherein the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form, to form a promoted brominated sorbent. Furthermore, because *Srinivasachar et al.* fail to describe a promoted brominated sorbent, *Srinivasachar et al.* are unable to achieve the subsequent steps of chemically reacting and separating particulates according to the presently claimed invention.

There are several reasons why the present invention achieves a promoted brominated sorbent while *Srinivasachar et al.* do not. First, the Applicants utilize activated carbon which is capable of reacting with a bromine containing promoter. *Srinivasachar et al.* fail to appreciate a distinction between carbon black which will not react with a bromine containing promoter, and activated carbon which can react with a bromine containing promoter. If *Srinivasachar et al.* intended a reaction to occur, *Srinivasachar et al.* would clearly have indicated a preference for activated carbon. Second, the present invention provides that the bromine containing promoter is in gaseous form, vapor form, or non-aqueous liquid form. In contrast, *Srinivasachar et al.* describe their halogen as provided in an aqueous solution. In particular, *Srinivasachar et al.* describe oxidizing the surface of sorbent particles 28 in order to render the surface hydrophilic, and then condensing/adsorbing various halide salts or halogen acids dissolved in water onto the hydrophilic surface of the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. It is submitted that the water would inhibit a reaction. In contrast,

the present invention provides that the bromine containing promoter is in a gaseous form, vapor form, or non-aqueous liquid form so that the bromine containing promoter can react with the activated carbon to form a promoted brominated sorbent. Third, there is no indication by *Srinivasachar et al.* that a reaction occurs between the solution 50 and the sorbent particles 28. See *Srinivasachar et al.* at column 5, line 62 through column 6, line 22. Nowhere do *Srinivasachar et al.* indicate that a reaction is intended or even desirable. Furthermore, as described above, the presence of water would have a tendency to inhibit such a reaction from occurring.

In view of the above comments, there are plenty of reasons why one having ordinary skill in the art would understand that *Srinivasachar et al.* fail to disclose or suggest the presently claimed invention.

The outstanding Office Action relies upon *Vosteen et al.* for the disclosure of monitoring mercury content of a cleaned flue gas at column 5, lines 47-63. See the outstanding Office Action at page 11, paragraph 35. It is submitted that this is not a suggestion to modify *Srinivasachar et al.* by removing the step of oxidizing sorbent particles and by haltering the halogen in water component that is supposed to condense or adsorb onto the surface of the oxidized sorbent particles.

In view of the above comments, the claimed invention would not have been obvious over *Srinivasachar et al.* and *Vosteen et al.* Accordingly, withdrawal of the rejection is requested.

It is believed that this application is in condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: July 15, 2010

Dennis R. Daley
Reg. No. 34,994
DRD:sll

23552
PATENT TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edwin S. Olson	Examiner:	Amber Rose Orlando
Serial No.:	12/419,219	Group Art Unit:	1797
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Customer No.:	23552	Confirmation No.:	1149
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

This paper is being filed electronically with the U.S. Patent Office

PETITION FOR EXTENSION OF TIME

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

Dear Sir:

In accordance with the provisions of 37 C.F.R. §1.136(a), it is respectfully requested that a three-month extension of time be granted in which to respond to the communication mailed January 15, 2010, the period of response being extended from April 15, 2010 to July 15, 2010.

Payment in the amount of $555.00 is made by credit card to cover the required extension fee for a small entity.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: July 15, 2010

Dennis R. Daley
Reg. No. 34,994
DRD:sll

23552
PATENT TRADEMARK OFFICE

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	06-Apr-2009
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Dennis Robert Daley/Sherry Lumsden
Attorney Docket Number:	16291.0001USC1

Filed as Small 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:				
Extension-of-Time:				
Extension - 3 months with $0 paid	2253	1	555	555

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**555**

Electronic Acknowledgement Receipt

EFS ID:	8028149
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Sherry Lumsden
Filer Authorized By:	Dennis Robert Daley
Attorney Docket Number:	16291.0001USC1
Receipt Date:	15-JUL-2010
Filing Date:	06-APR-2009
Time Stamp:	20:12:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$555
RAM confirmation Number	5830
Deposit Account	132725
Authorized User	DALEY,DENNIS R.

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)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Amdt_re_011510_OA.PDF	1248349 6fbd1a2759e914208bc5b73605d986d15584c135f	no	22
Warnings:					
Information:					
2	Extension of Time	EoT_re_011510_OA.PDF	34794 3c562019e2767f3c0205651ca4ebac7375bf3f57	no	1
Warnings:					
Information:					
3	Fee Worksheet (PTO-875)	fee-info.pdf	30171 a2a4df299890400e9f1e84854b860277e36aa59a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1313314		

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
12/419,219	04/06/2009	

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 07/15/2010	(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))	* 24	Minus	** 24	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 1	Minus	*** 1	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

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:
/DONNA L. PRICE/

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 NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/419,219	04/06/2009	Edwin S. Olson	16291.0001USC1

CONFIRMATION NO. 1149

23552
MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

PUBLICATION NOTICE

OC000000040283896

Title:SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Publication No.US-2010-0047146-A1
Publication Date:02/25/2010

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/419,219	04/06/2009	Edwin S. Olson	16291.0001USC1	1149

23552 7590 01/15/2010

MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

EXAMINER	
ORLANDO, AMBER ROSE	
ART UNIT	**PAPER NUMBER**
1797	

MAIL DATE	DELIVERY MODE
01/15/2010	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)	
	12/419,219	OLSON ET AL.	
	Examiner	Art Unit	
	AMBER ORLANDO	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 *06 April 2009*.

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) *34-57* 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) *34-57* 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 *06 April 2009* 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

Claim Rejections - 35 USC § 112

1. 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.

2. Claim 46 recites the limitation "the alkali component" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

1. 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.

2. Claims 34, 35, 38-42, 47, 48 and 51-53 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Srinivasachar et al. US 6,848,374 (further referred to as 374).

3. Regarding claims 34, 35 and 52, the 374 reference discloses a method for separating mercury from a mercury containing gas comprising: (a) providing a sorbent material (column 5, lines 30-55); (b) providing a halogen or halide promoter; (c) promoting at least a portion of the sorbent material by chemically reacting the sorbent material with the halogen or halide promoter to form a promoted halogenated sorbent

(column 6, lines 3-17); (d) chemically reacting elemental mercury in the mercury containing gas with the promoted halogenated sorbent to form a mercury/sorbent chemical composition (column 6, lines 22-26 and Table 1); (e) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition (column 10, lines 39-46), the promoted halogen containing sorbent combines with at least 70% of the mercury present in the mercury containing gas (Column 6, lines 25-30), and the halogen or halide promoter comprises molecular halogen in vapor form (column 6, lines 13-18).

4. For claim 38, the 374 reference discloses the sorbent material comprises base activated carbon that contains basic binding sites, in the presence of halogens, hydrohalides, and Group V and Group VI halides (column 6, lines 1-18, halide salts includes some of Group V and Group VI halides e.g. Vanadium Chloride). The reference does not explicitly state the sorbent material reacting with the halogens, hydrohalides, and Group V and Group VI halides to form highly reactive acidic binding sites in the promoted sorbent for oxidation of the mercury. This reaction would occur to form highly reactive acidic binding sites in the promoted sorbent for oxidation of the mercury, because contacting the base activated carbon that contains basic binding sites, with the halogens, hydrohalides, and Group V and Group VI halides would inherently produce the same results as that of the present invention (e.g. cause the same reaction between the chemical compositions).

5. For claim 39, the 374 reference discloses the acidic binding sites in the promoted activated carbon chemically react with elemental mercury form the mercury/sorbent composition (column 6, lines 22-26 and Table 1).

6. For claim 40, the 374 reference discloses at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition (column 5, lines 20-21, mercury compounds includes oxidized mercury and column 6, lines 23-26).

7. For claim 41, the 374 reference discloses the base activated carbon material comprises at least one of powdered activated carbon, granular activated carbon, carbon black, carbon fiber, carbon honeycomb, aerogel carbon film, pyrolysis char, or mixtures thereof (column 5, lines 30-55).

8. For claim 42, the 374 reference discloses the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators (column 10, lines 39-46).

9. For claims 47 and 48, the 374 reference discloses adding a second halogen or halide promoter to the promoted halogen containing sorbent wherein the halogen or halide promoter comprises, HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen (column 6, lines 3-18).

10. For claim 51, the 374 reference discloses the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas (column 6, lines 3-18).

11. For claim 53, the 374 reference discloses injecting the sorbent material at an sorbent material injection rate and injecting separately at least one promoter at a promoter injection rate into a gas stream whereby in-flight reaction produces the promoted halogenated sorbent, 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 (columns 5-6, lines 59-18), wherein the promoter is added at from about 1 to about 30 grams per 100 grams of sorbent material (column 6, lines 23-25, and column 9, lines 49-51).

Claim Rejections - 35 USC § 103

1. 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.

2. 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.

3. 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).

4. Claims 36 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 34 above, and further in view of Nishino et al. US 4,500,327 (further referred to as 327).

5. For claim 36, the 374 reference discloses the promoter comprises molecular halogen (column 6, lines 13-18). The reference does not disclose using an organic solvent.

6. The 327 reference discloses using the organic solvent (column 3, lines 35-53).

7. It would have been obvious to one having ordinary skill in the art a the time the invention was made to have modified the 374 reference to include using the organic solvent (327, column 3, lines 35-53) in order to allow the molecular halogen to go into solution and be sprayed onto the activated carbon.

8. For claim 37, the 374 reference discloses the halogen or halide promoter comprises at least one of Group V halide, Group VI halide, or mixtures thereof (column 6, lines 3-18). The reference does not disclose the non-aqueous solvent.

9. The 327 reference discloses using the non-aqueous solvent (column 3, lines 35-53).

10. It would have been obvious to one having ordinary skill in the art a the time the invention was made to have modified the 374 reference to include using the non-aqueous solvent (327, column 3, lines 35-53) in order to allow the promoter to go into solution and be sprayed onto the activated carbon.

11. Claims 43 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 34 above, and further in view of de Jong CA 1099490 (further referred to as 490).

12. For claims 43 and 44, the 374 reference does not disclose a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas.

13. The 490 reference discloses a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (page 4-5, lines 24-3).

14. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition and injecting the regenerated promoted halogenated sorbent into a mercury containing gas (490, page 4-5, lines 24-3) in order to be able to reuse the promoted activated carbon, and therefore reduce material costs.

15. Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 34 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

16. For claim 45, the 374 reference does not disclose injecting an alkaline component into the mercury containing gas.

17. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

18. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, or phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

19. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) and Jong CA 1099490 (further referred to as 490) as applied in claim 43 above, and further in view of Gadkaree et al. US 6,136,749 (further referred to as 749).

20. For claim 46, the 374 reference does not disclose the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

21. The 749 reference discloses injecting an alkaline component into the mercury containing gas, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (column 3, lines 54-65).

22. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element (749, column 3, lines 54-65) because this will enhance the activity of the activated carbon catalyst.

23. Claims 49 and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 34 above, and further in view of Broderick US 6,942,840 (further referred to as 840).

24. For claims 49 and 50, the 374 reference does not disclose adding a stabilizing agent to the promoted halogen containing sorbent wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof.

25. The 840 reference discloses adding a stabilizing agent to the promoted halogen containing sorbent wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof (column 4, lines 12-25).

26. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include adding a stabilizing agent to the promoted halogen containing sorbent. wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof (840, column 4, lines 12-25) because this allows the mercury to be vented to the atmosphere without additional treatment.

27. Claims 54 and 55 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374).

28. For claims 54 and 55, the 374 reference discloses the gas stream being a transport gas (columns 5-6, lines 55-18). The reference does not explicitly state injecting the two streams (promoter and sorbent material) into a mercury containing gas stream. The reference does disclose combining two streams (promoter and sorbent) into one stream, and then subsequently injecting the one stream into the mercury containing gas stream (columns 5-6, lines 55-18). It would have been well within the knowledge of one having ordinary skill in the art to combine the two steps, to make one step (e.g. co-injecting the streams into the mercury containing gas) in order to cut down production costs and time needed to complete the process. The mere combination of known steps does not provide patentability.

29. Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 53 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

30. For claim 56, the 374 reference does not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

31. The 358 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 have been 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 promoter injection rate and the sorbent injection rate into the gas must be changed in correspondence to the monitored mercury content of the cleaned gas within the 358 reference.

32. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

33. Claim 57 is rejected under 35 U.S.C. 103(a) as being unpatentable over Srinivasachar et al. US 6,848,374 (further referred to as 374) as applied in claim 34 above, and further in view of Vosteen et al. US 6,878,358 (further referred to as 358).

34. For claim 57, the 374 reference does not disclose the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream.

35. The 358 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 have been obvious to one having ordinary skill in the art at the time the invention was made that in order to counteract the mercury content (increase) within the cleaned flue gas, the sorbent composition must be changed just as that of the bromine within the 358 reference.

36. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the 374 reference to include the composition of the promoted sorbent being controlled by the mercury content of the cleaned gas stream (358, column 5, lines 47-63) because this allows the maximum amount of mercury to be taken out of the stream.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AMBER ORLANDO whose telephone number is (571)270-3149. The examiner can normally be reached on Mon.-Thurs. (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.

AO

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

Notice of References Cited	Application/Control No. 12/419,219	Applicant(s)/Patent Under Reexamination OLSON ET AL.	
	Examiner AMBER ORLANDO	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-6,136,749	10-2000	Gadkaree et al.	502/183
	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					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

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

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	Art Unit
	AMBER ORLANDO	1797

SEARCHED			
Class	Subclass	Date	Examiner
110	345	1/11/2010	AO
423	210	1/11/2010	AO
95	134, 142	1/11/2010	AO

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Search (eDAN)	1/11/2010	AO
Classes 95, 423 and 110 searched for separating mercury from a mercury containing gas. The method including a sorbent, a promotor and separating particulates from the mercury containing gas.	1/11/2010	AO
IDS search (EAST and eDAN)	1/11/2010	AO

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/AMBER ORLANDO/ Acting Examiner.Art Unit 1797	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1797

✓	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	01/11/2010								
	1	-								
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	34	✓								
	35	✓								
	36	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12419219	OLSON ET AL.
	Examiner	**Art Unit**
	AMBER ORLANDO	1797

✓	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	01/11/2010								
	37	✓								
	38	✓								
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	40	✓								
	41	✓								
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	43	✓								
	44	✓								
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	54	✓								
	55	✓								
	56	✓								
	57	✓								

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USCI	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

U.S. PATENT DOCUMENTS						
EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	1,984,164	12-11-1934	Stock			
	3,194,629	07-13-1965	Dreibelbis, et al.			
	3,662,523	05-16-1972	Revoir			
	3,786,619	01-22-1974	Melkersson			
	3,826,618	07-1974	Capuano			
	3,849,267	11-19-1974	Hilgen			
	4,101,631	07-18-1978	Ambrsini, et al.			
	4,196,173	04-01-1980	Delong, et al.			
	4,500,327	02-19-198	Nishino, et al.			
	4,708,853	11-24-1987	Matviya			
	4,786,483	11-22-1988	Audeh			
	4,814,152	03-21-1989	Yan			
	4,820,318	04-1989	Chang et al.			
	4,889,698	12-26-1989	Moller			
	4,956,162	09-11-1990	Smith			
	5,300,137	04-1994	Weyand et al.			
	5,409,522	04-1995	Durham et al.			
	5,505,766	04-09-1996	Chang			
	5,575,982	11-1996	Reiss et al.			
	5,607,496	03-04-1997	Brooks			
	5,672,323	09-30-1997	Bhat			
	5,695,726	12-09-1997	Lerner			
	5,827,352	12-27-1998	Altman			
	5,891,324	04-06-1999	Ohtsuka			
	6,027,551	02-22-2000	Hwang			
	6,080,281	06/27/2000	Attia			

EXAMINER /Amber Orlando/	DATE CONSIDERED 01/07/2010

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.

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FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

U.S. PATENT DOCUMENTS						
EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	6,136,072	10/24/2000	Sjostrom			
	6,214,304	04-10-2001	Rosenthal			
	6,258,334	07-10-2001	Gadkaree			
	6,372,187	04/2002	Madden et al.			
	6,375,909	04-2002	Dangtran et al.			
	6,383,981	05-07-2002	Blankenship			
	6,528,030	03-04-2003	Madden et al.			
	6,818,043	11-2004	Chang et al.			
	6,848,374	02-2005	Srinivasachar et al.			
	6,878,358	04-2005	Vosteen et al.			
	6,942,840	09-2005	Broderick, Thomas E.			
	6,953,494	10-11-2005	Nelson, Jr.			
	7,435,286	10-14-2008	Olson et al.			
	2001/0002387	05-31-2001	Tsutsumi et al.			
	2001/0003116	06-07-2001	Neufert			
	2002/0150516	10-17-2002	Pahlman et al.			
	2004/0003716	01-08-2004	Nelson, Jr.			
	2004/0013589	01-22-2004	Vosteen et al.			
	2005/0019240	01-2005	Lu et al.			
	2006/0048646	03-2006	Olson et al.			

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FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
						YES	NO
	1099490	04/21/1981	Canada				
	2150529	12/29/1995	Canada				
	2400898	08/30/2001	Canada				
	3426059	01/1986	Germany				
	10233173	03/23/2006	Germany				
	0208490A1	01/1987	Europe				
	49-43197	11/1974	Japan				
	49-53593	05/24/1974	Japan			Abstract	
	50-6438	03/1975	Japan				
	01/62368	08/30/2001	PCT				

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

		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-EORI 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-Bases Sorbents: Effect of Temperature, Mercury Concenitration 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 Calcium Hydroxide Particles,* Combust. Sci. & Technol. 1993, 93, 277.
		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
		B. Vosteen et al.,*Chlor-und Bromgestützte Hg-Sorption an Elektrofilter-Flugaschen eines kohlegefeuerten Schmelzkammerkessels und an Zementrohmehl,* Matin-Luther-Universität Halle-Wittenberg, September 2003, pp 1-30

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CONFIRMATION NO. 1149

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/419,219	04/06/2009 RULE	095	1797	16291.0001USC1

APPLICANTS

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

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

This application is a CON of 12/201,595 08/29/2008
which is a DIV of 11/209,163 08/22/2005 PAT 7,435,286
which claims benefit of 60/605,640 08/30/2004

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

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
08/31/2009

Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☑ No		ND	7	24	1
Verified and Acknowledged	/AMBER ROSE ORLANDO/ Examiner's Signature	Initials				

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UNITED STATES

TITLE

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FILING FEE RECEIVED		
631	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

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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

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" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2007/07/24 10:53

		"6521021" | "6533842").PN. OR ("6953494").URPN. and in-flight				
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
S97	0	110/345.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S98	5	423/210.ccls. and remov $4 with mercury and carbon with halide	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 12:46
S99	0	(halogenated carbon with halide with covalently$5).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:05
S100	0	(carbon with haldie with sorbent and reduc $ with mercury).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:06
S101	0	(carbon with haldie with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07

S102	1	(carbon with sorbent and co-injecting).clm.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2008/07/01 13:07
S103	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S104	55234	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 16:18
S105	2	carbon with alkali (salts or elements) same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S106	135	carbon with alkali same remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S107	15	carbon with alkali same remov$4 with mercury and exhaust	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:19
S108	4	mercury with exhaust and mercury with stabili $5 with reagent and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:29
S109	6	"6848374" and (stabili $4 or sulfur or sulfide)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:31
S110	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfer dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S111	0	mercury with exhaust and mercury with stabili $5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:34
S112	2	stabili$5 with (hydrogen sulfide or sulfur dioxide) and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:35
S113	2	mercury with exhaust and mercury with stabili $5 with sulfur and carbon with remov$4 with mercury	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 16:36

S114	4	"6848374" and (organic or solvent)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S115	5	"6848374" and (organic or solvent or dissolv$4)	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 16:46
S116	7	carbon with alkali same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:21
S117	8	carbon with halogen same remov$4 with mercury and (fixed or moving) bed	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:24
S118	5	carbon with halogen same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:30
S119	20	activated carbon same remov$4 with mercury and (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:31
S120	0	activated carbon same remov$4 with mercury and activated carbong with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S121	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screens)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S122	2	activated carbon same remov$4 with mercury and activated carbon with (monolith or fiber screen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2009/04/01 17:32
S123	67	"4,889,698"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 17:36
S124	125	95/134.ccls. and remov $4 with mercury	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:25
S125	20	95/134.ccls. and remov $4 with mercury and halogen	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26
S126	3	95/142.ccls. and remov $4 with mercury and carbon and halide	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:26

S127	0	11//345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S128	8	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S129	54	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	OR	OFF	2009/04/01 19:28
S130	7	"6848374"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:34
S131	16	"5575982"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/04/01 19:35
S133	61	"4500327"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/11 11:30
S135	547	"1984164" "3194629" "3662523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:38

S136	547	"1984164" "3194,629" "3662,523" "3786619" "3826618" "3849267" "4101631" "4196173" "4500327" "4708853" "4786483" "4814152" "4820318" "4889698" "4956162" "5300137" "5409522" "5505766" "5575982" "5607496" "5672323" "5695726" "5827352" "5891324" "6027551" "6080281" "6136072" "6214304" "6258334" "6372187" "6375909" "6383981" "6528030" "6818043" "6848374" "6878358" "6942840" "6953494" "7435286" "20010002387" "20010003116" "20020150516" "20040003716" "20040013589" "20050019240" "20060048646" and Group adj V	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/11 14:47
S137	10	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:50

		"6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or "6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI)				
S138	9	("1984164" or "3194629" or "3662523" or "3786619" or "3826618" or "3849267" or "4101631" or "4196173" or "4500327" or "4708853" or "4786483" or "4814152" or "4820318" or "4889698" or "4956162" or "5300137" or "5409522" or "5505766" or "5575982" or "5607496" or "5672323" or "5695726" or "5827352" or "5891324" or "6027551" or "6080281" or "6136072" or "6214304" or "6258334" or "6372187" or "6375909" or "6383981" or "6528030" or	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:52

		"6818043" or "6848374" or "6878358" or "6942840" or "6953494" or "7435286" or "20010002387" or "20010003116" or "20020150516" or "20040003716" or "20040013589" or "20050019240" or "20060048646") and (Group V or Group VI) and (Hg or mercury)				
S139	46	(Group V or Group VI) with (halide or halogen) and (Hg or mercury) with (filter or remov$4)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:53
S141	68	95/134.ccls. and remov $4 with mercury and (V or Nb or Ta or Db or Cr or Mo or W or Sg or Group V or Group VI)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 14:57
S142	10	110/345.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:08
S144	64	423/210.ccls. and remov $4 with mercury and carbon and (halide or halogen)	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/01/11 15:09
S145	267	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:08
S146	58	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:26

S147	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with halide same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S148	4	(Vanadium or niobium or tantalum or Dubnium or chromium or molybdenum or tungsten or seaborgium) with (halide or halogen) same sorbent and (remov$4 or filter) with (mercury or Hg)	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:28
S149	8287	hydrohalides	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45
S150	5	hydrohalides with sorbent	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:45
S151	143	hydrohalides.ti.	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:46
S152	5	"4490354"	US-PGPUB; USPAT; USOCR	ADJ	ON	2010/01/12 13:59
S153	10	"6,136,749"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/01/12 14:34

EAST Search History (Interference)

< This search history is empty>

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Olson et al.	Examiner:	Unknown
Serial No.:	12/419,219	Group Art Unit:	1795
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

Electronically filed on December 1, 2009

INFORMATION DISCLOSURE STATEMENT (37 C.F.R. § 1.97(b))

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

Dear Sir:

With regard to the above-identified application, the items of information listed on the enclosed Form 1449 are brought to the attention of the Examiner.

This statement should be considered because it is submitted before the mailing date of a first Office Action on-the-merits. Accordingly, no fee is due for consideration of the items listed on the enclosed Form 1449.

In accordance with 37 C.F.R. §1.98(a)(2), a copy of each foreign patent and/or a copy of each publication, other than U.S. patents and U.S. patent application publications, listed on the accompanying Form 1449 is enclosed.

No representation is made that a reference is "prior art" within the meaning of 35 U.S.C. §§ 102 and 103 and Applicants reserve the right, pursuant to 37 C.F.R. § 1.131 or otherwise, to establish that the reference(s) are not "prior art." Moreover, Applicants do not represent that a reference has been thoroughly reviewed or that any relevance of any portion of a reference is intended.

Enclosed for the Examiner's information, as Attachment A, is a copy of a Communication from the European Patent Office dated January 25, 2008 and a copy of the "Third party's comments following 115 EPO about the patent applications EP 1796816A2 and related PTC patent applications as WO 2006/039007 of EERC" that is the subject of the Communication.

European patent application EP 1796816A2 and PCT publication WO 2006/039007 (PCT Application PCT/US05/030018) are related to the present application.

Also enclosed for the Examiner's information, as Attachment B, is a copy of the European Search Report for EP1796816, dated 14 April 2009. For the Examiner's reference, all citations within the European Search Report are identified on the accompanying Form 1449.

Also enclosed for the Examiner's information, as Attachment C, is a copy of an official action dated March 3, 2009 from the Canadian patent office relating to Canadian Patent Application 2,584,327. Canadian Patent Application 2,584,327 is related to the present application. For the Examiner's reference, all citations within the official action are identified on the accompanying Form 1449.

The Examiner's attention is directed to co-pending United States Patent Application Serial Nos. 12/429,058 and 12/201,595 (published as US2009/0062119). These applications are related to the present application.

Consideration of the items listed is respectfully requested. Pursuant to the provisions of M.P.E.P. 609, it is requested that the Examiner return a copy of the attached Form 1449, marked as being considered and initialed by the Examiner, to the undersigned with the next official communication.

Please charge any additional fees or credit any overpayment to Deposit Account No. 13-2725.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Date: November 12, 2009

Dennis R. Daley
Reg. No. 34,994
DDaley:TPJ:rlk

23552
PATENT TRADEMARK OFFICE

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USCI	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

U.S. PATENT DOCUMENTS						
EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	1,984,164	12-11-1934	Stock			
	3,194,629	07-13-1965	Dreibelbis, et al.			
	3,662,523	05-16-1972	Revoir			
	3,786,619	01-22-1974	Melkersson			
	3,826,618	07-1974	Capuano			
	3,849,267	11-19-1974	Hilgen			
	4,101,631	07-18-1978	Ambrsini, et al.			
	4,196,173	04-01-1980	Delong, et al.			
	4,500,327	02-19-198	Nishino, et al.			
	4,708,853	11-24-1987	Matviya			
	4,786,483	11-22-1988	Audeh			
	4,814,152	03-21-1989	Yan			
	4,820,318	04-1989	Chang et al.			
	4,889,698	12-26-1989	Moller			
	4,956,162	09-11-1990	Smith			
	5,300,137	04-1994	Weyand et al.			
	5,409,522	04-1995	Durham et al.			
	5,505,766	04-09-1996	Chang			
	5,575,982	11-1996	Reiss et al.			
	5,607,496	03-04-1997	Brooks			
	5,672,323	09-30-1997	Bhat			
	5,695,726	12-09-1997	Lerner			
	5,827,352	12-27-1998	Altman			
	5,891,324	04-06-1999	Ohtsuka			
	6,027,551	02-22-2000	Hwang			
	6,080,281	06/27/2000	Attia			

EXAMINER	DATE CONSIDERED
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.	

*Substitute Disclosure Statement Form (PTO-1449) Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

U.S. PATENT DOCUMENTS						
EXAMINER INITIAL	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	6,136,072	10/24/2000	Sjostrom			
	6,214,304	04-10-2001	Rosenthal			
	6,258,334	07-10-2001	Gadkaree			
	6,372,187	04/2002	Madden et al.			
	6,375,909	04-2002	Dangtran et al.			
	6,383,981	05-07-2002	Blankenship			
	6,528,030	03-04-2003	Madden et al.			
	6,818,043	11-2004	Chang et al.			
	6,848,374	02-2005	Srinivasachar et al.			
	6,878,358	04-2005	Vosteen et al.			
	6,942,840	09-2005	Broderick, Thomas E.			
	6,953,494	10-11-2005	Nelson, Jr.			
	7,435,286	10-14-2008	Olson et al.			
	2001/0002387	05-31-2001	Tsutsumi et al.			
	2001/0003116	06-07-2001	Neufert			
	2002/0150516	10-17-2002	Pahlman et al.			
	2004/0003716	01-08-2004	Nelson, Jr.			
	2004/0013589	01-22-2004	Vosteen et al.			
	2005/0019240	01-2005	Lu et al.			
	2006/0048646	03-2006	Olson et al.			

EXAMINER	DATE CONSIDERED
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.	

*Substitute Disclosure Statement Form (PTO-1449) Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FORM 1449* INFORMATION DISCLOSURE STATEMENT IN AN APPLICATION (Use several sheets if necessary)	Docket Number: 16291.0003USC1	Application Number: 12/419,219
	Applicant: Olson et al.	
	Filing Date: 04/06/2009	Group Art Unit: 1795

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
						YES	NO
	1099490	04/21/1981	Canada				
	2150529	12/29/1995	Canada				
	2400898	08/30/2001	Canada				
	3426059	01/1986	Germany				
	10233173	03/23/2006	Germany				
	0208490A1	01/1987	Europe				
	49-43197	11/1974	Japan				
	49-53593	05/24/1974	Japan			Abstract	
	50-6438	03/1975	Japan				
	01/62368	08/30/2001	PCT				

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

		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-EORI 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-Bases Sorbents: Effect of Temperature, Mercury Concenitration 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 Calcium Hydroxide Particles,* Combust. Sci. & Technol. 1993, 93, 277.
		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
		B. Vosteen et al.,*Chlor-und Bromgestützte Hg-Sorption an Elektrofilter-Flugaschen eines kohlegefeuerten Schmelzkammerkessels und an Zementrohmehl,* Matin-Luther-Universität Halle-Wittenberg, September 2003, pp 1-30

23552
PATENT TRADEMARK OFFICE

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form for next communication to the Applicant.

*Substitute Disclosure Statement Form (PTO-1449) Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(11) (A) No. 1099490

(45) ISSUED 810421

(52) CLASS 23-356.5
C.R. CL. 183-34

(51) INT. CL.[2] B01D 53/34

(19) (CA) **CANADIAN PATENT** (12)

(54) PROCESS FOR REMOVING MERCURY FROM MERCURY VAPOUR-CONTAINING GASES

(72) de Jong, Geert J.;
Vos, Hendrik J.,
Netherlands

(73) Granted to Akzo N.V.
Netherlands

(21) APPLICATION No. 312,054

(22) FILED 780925

(30) PRIORITY DATE Netherlands (7 710632) 770929

No. OF CLAIMS 4 - NO DRAWING

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ABSTRACT OF THE DISCLOSURE

APR 21 1981

Removal of mercury from mercury vapour-containing gases by passing them continuously through a bed of active carbon on which a halogen is adsorbed having a thickness of at most 5 cm, while maintaining the chlorine content of the active carbon between 5 and 12% by weight. This is preferably effected by adding to said gases chlorine in an amount such that the carbon is caused to absorb a quantity thereof which equals the quantity that is consumed during the adsorption of mercury.

The present invention relates to a process for removing mercury from mercury vapour-containing gases by contacting these gases with activated carbon on which a halogen is adsorbed.

A process of the type indicated above disclosed, inter alia, in United States Patent Specifications Nos. 1,984,164 and 3,849,267. According to the former patent specification a halogen, more particularly iodine, is previously applied to the carbon, whereas according to the latter patent specification a gas containing mercury and chlorine is passed over activated carbon, as a result of which the mercury content of the gas can be reduced to 0.01 mg/m^3.

Moreover, in Soviety Chemical Industry 1972 (no. 8) p. 535-536, and from Tsvet. Metally, 1958 (31) p. 31-37, the use is disclosed of carbon loaded with chlorine as adsorbent of mercury-containing gases. In these publications mention is made of chlorine contents of the carbon which do not exceed 4% of the carbon weight. For practical purposes the methods described are not attractive in that the filter thicknesses required are unacceptably high or the residual concentrations of mercury are higher than the ones obtained with the present invention.

Applicant has found that the long-term effectiveness of these methods is very much dependent on the halogen content of the activated carbon and that a process for the continuous removal of mercury vapour from large amounts of gas is only suitable to be applied in actual practice if the activated carbon contains chlorine in an amount which is between particular critical limits.

According to the present invention in a process of the type indicated heretofore the gas to be freed from mercury vapour is continuously passed through a bed of activated carbon having a maximum thickness of 5 cm, care being taken that during said passage the activated carbon has a chlorine content in the range of from 5 to 12% by weight.

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It has been found that the use of a lower chlorine content will result in the bed retaining a low percentage of mercury. A total absence of chlorine will cause this percentage to be lower than 50%; and after a few days it will drop to a few per cent. The total amount of mercury which can be retained by the carbon then will be well below 0.1% mercury, calculated on the weight of the carbon. At a chlorine content which is somewhat lower than the minimum amount required the percentage of mercury collected will initially be good (over 90% of the mercury present can be collected initially). But this percentage will rapidly decrease to below 60% and the carbon will be found to be irreversibly clogged. In other words the effectiveness of the carbon cannot be restored by a chlorinating treatment then and regeneration of the carbon by removing the mercury collected by it is not very well feasible. At a chlorine content above the above-mentioned maximum limit the carbon is found to release much chlorine during the process and moreover, especially when the air passed through contains a high percentage of moisture, the carbon will be attacked, resulting in mechanical weakening; it must therefore be sooner replaced than when the chlorine content is within the above-specified limits. The chlorine content can be kept between the afore-mentioned limits in a simple manner by adding such an amount of chlorine to the gas that the carbon will adsorb therefrom as much chlorine as will be lost from it during the adsorption of the mercury. This loss of chlorine during the adsorption of the mercury is the result on the one hand of desorption and on the other of the formation on the carbon of mercury chloride, and is moreover due to reactions between chlorine and other constituents of the air, particularly water. It has been found that a stable situation can be reached when the chlorine content of the gas is such that per atom of mercury 15 to 25 atoms of chlorine are present in it. To this continuous feeding of chlorine there may be very special advantages. Such is the case when the

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gases to be treated already contain some chlorine, which will inevitably be present in it in a very low concentration for instance in rooms in which common salt is subjected to hydrolysis. Chlorine need then be added only until the desired level has been reached.

It should be noted that according to United States Patent Specification 3,849,267 (column 2, lines 1-10) gas containing mercury and chlorine also is brought into contact with activated carbon. In that case, however, the chlorine content is not controlled; for as minimum concentration of mercury contained in the purified gas 0.01 mg per m^3 is mentioned. This points to the fact that the chlorine content of the carbon must have been beyond the limits indicated.

Another particularly attractive way of keeping the chlorine content of the activated carbon within the limits indicated consists in that the carbon is periodically contacted with a chlorine-containing gas. In this periodic chlorine make-up it must be ensured that the chlorine content of the activated carbon does not temporarily get beyond the limits indicated, in which case the above-described disadvantages may be encountered. In actual practice it is found that when the chlorine content is made up once a week very favourable results can be obtained. For in one week the collecting capacity of the carbon for mercury is reduced by as little as less than 5 per cent. By subsequently contacting the activated carbon with a chlorine-containing gas the original collecting capacity is restored. The amount of chlorine the activated carbon is made to adsorb when it is periodically treated with a chlorine-containing gas may for instance be 0.30-0.40% of the weight of the carbon.

It has been found that use of the process according to the invention may lead to very favourable results with gases having a mercury content of about 0.01-0.15 mg/m^3. According to the inven-

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tion, this content may be reduced to 0.001-0.008 mg/m^3, which is a level that is quite acceptable under all circumstances and cannot be attained with any of the known processes. At higher mercury contents of the gas to be purified it is recommended that the air should first be subjected to some other mercury-desorbing process, for instance by washing with a sodium hypochlorite solution or using the method described in United States Patent Specification 3,849,267.

Further advantages of the present method are that the desired result can be obtained with very short contacting times in the range of 25 to 100 milliseconds and that, depending on the initial mercury content and the chosen contacting time, the percentage mercury collected is between 85 and 99%. Owing to the short contacting times there is only need to use thin (and hence inexpensive) carbon beds. Excellent results are obtained with a carbon bed having a thickness of, for instance, 2 cm. With the process according to the invention it is generally possible with 1 kg of activated carbon to treat gas at a rate of 50 to 200 m^3 per hour. In the process according to the invention the effective life of the carbon is extraordinarily long. At a mercury content of the gas of 0.05 mg/m^3 and a passage of 100 m^3/h per kg of carbon the expected effective life obtained according to the present invention is over 400 days.

Should the carbon be loaded with mercury, i.e. mercury chloride, to such a degree that its effectiveness will decrease, then it can be regenerated in a simple manner for instance by washing with an aqueous liquid containing chloride ions. In a mercury electrolysis apparatus preferably use is made for this purpose of process liquids, so that the mercury compounds released upon regeneration are fed back into the process and no secondary contamination takes place during regeneration. After the greater part of the mercury present has been removed, the carbon is washed

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with water to get rid of any clogging salts. After drying and loading with chlorine the carbon is ready to beused in a new adsorption period.

Regeneration of the carbon loaded with mercury is possible in that the mercury is present on it in the form of mercury chloride which is converted into water-soluble complex compound in a chloride-containing aqueous solution.

An unduly high moisture content of the gas from which mercury is to be removed should be avoided because the effectiveness of the activated carbon is reduced then and water is collected instead of mercury. It is preferred that the relative humidity should be kept below 75%. The relative humidity can be controlled in such a way that the excess water is isolated by previous cooling or the gas is heated to a temperature such that the desired relative humidity is obtained.

In the process according to the invention use may be made of normal activated carbon.. So there is no need to employ specially prepared carbons or other costly sorbents. Preference is given to the use of extruded carbon granules having a diameter of about 1.5 mm. The process according to the invention may be applied in the removal of mercury from, for instance, hydrogen gas. The process is particularly suitable for the removal of mercury from air which is vented from plant buildings by fans. The mercury content of such air is usually low because people who have to work in it must not be exposed to high mercury concentrations. The volumes of air to be discharged then are therefore generally large.

The process according to the invention is attractive especially in that it provides an inexpensive treatment of very large volumes of air having a low mercury content. As a result, even small environmental pollution by mercury can still be further reduced. If the air to be purified is not dust-free, this does not present any difficulty because the presence of dust does not have

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any unfavourable influence on the process.

As the usual fans generally have a small head, the air to be vented by them can be passed only through filters having a low resistance. That is why the process according to the invention is so important; for the filters to be used need only have a small thickness.

The present invention is further illustrated by way of the following Examples.

Example 1

From a room in which sodium chloride is subjected to electrolysis by the amalgamation process air is withdrawn at a rate of 10.10^6 m^3 per hour by means of 25 fans.
This air contains mercury vapour in an amount of about 0.05 mg/m^3. Per fan, this air, which has a relative humidity of 50% at a temperature of 32°C, is passed through a filter bed having a surface area of 37 m^2. The air displacement per fan is 40×10^3 m/h. The bed is formed by a 1.6 cm thick layer of granules of activated carbon 1.5 mm in diameter. The pressure drop across the filters is less than 10 mm hydrostatic head. The amount of carbon is 358 kg per fan. Before use the carbon is contacted with a chlorine-containing gas until the chlorine content is 7% by weight. The air is passed through the filters at a rate of 0.6 m/sec., so that the contacting time is 27.10^{-3} sec. After the air has left the filter, its mercury content is less than 0.004 mg/cm^3, so that the effectiveness of the filter under these conditions is more than 92%. After the filter has been in use for a week, its effectiveness has decreased to 89%.

Then air containing 60 mg of chlorine per m^3 is passed through for 30 minutes and the free chlorine content of the activated carbon is restored to 7% by weight. Upon the subsequent passage of mercury-containing air the effectiveness of the mercury removal is again found to be more than 92%.

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After one year's operation of the system in the above-described way the mercury content of the carbon is 4.3% by weight. The carbon is then regenerated by washing for 10 hours with a concentrated hydrochloric acid solution. Subsequently the hydrochloric acid is removed by washing with water, after which the carbon is dried by passing air through it.

When the carbon is dry (drying time about 1 hour), it is loaded with chlorine up to the original level, after which it is ready again for further adsorption. In an experiment in which the chlorine content is made up when the effectiveness of the mercury removal is 86%, it can be restored to 92% in the above-described way. In an experiment in which the chlorine make-up is not carried out until the effectiveness of the mercury removal has decreased to 84%, it is found that it can no longer be restored to 92% by chlorine make-up. The chlorine content has then been reduced by adsorption to a level such that the decrease has become irreversible.

Example 2

From a room in which sodium chloride is subjected to electrolysis by the amalgamation process air is withdrawn in the way described in Example 1. The air is treated in the manner indicated in Example 1, except that the carbon is not periodically brought into contact with a chlorine-containing gas. In this case the chlorine content of the carbon is kept at the desired level by having the fan air continuously contain a small amount of chlorine.

The chlorine content of the air is 0.35 p.p.m.

In this way the effectiveness of the mercury removal can be kept at 92% for a year, with the mercury content of the purified air amounting to less than 0.004 mg/m^3.

When the chlorine content of the air has been reduced until the effectiveness is less than 84%, the decrease is found to be irreversible. By increasing the chlorine feed rate it can no long be restored then to the originally high level.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In a process for removing mercury from a mercury vapour-containing gas by contacting the gas with activated carbon on which a halogen is adsorbed, the improvement in which the gas to be freed from mercury vapour is continuously passed through a bed of activated carbon having a maximum thickness of 5 cm, care being taken that during said passage the activated carbon has a chlorine content in the range of from 5 to 12% by weight.

2. A process according to claim 1, in which the chlorine content of the activated carbon is kept within said limits by adding such an amount of chlorine as is lost from it during the adsorption of the mercury.

3. A process according to claim 2, in which the chlorine content of the gas is such that per atom of mercury 15 to 20 atoms of chlorine are present.

4. A process according to claim 1, in which the chlorine content of the activated carbon is kept between said limits by periodically contacting the carbon with a chlorine-containing gas.



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SUBSTITUTE

REMPLACEMENT

SECTION is not Present

Cette Section est Absente

OPIC
Office de la propriété intellectuelle du Canada

CIPO
Canadian Intellectual Property Office

Ottawa Hull K1A 0C9

(21) (A1) 2,150,529

(22) 1995/05/30

(43) 1995/12/29

(51) Int.Cl.[6] B01D 53/64

(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Method and Apparatus for Continuously Separating Mercury from Flowing Gases

(72) Scherer, Volker - Germany (Federal Republic of) ;
Greczmiel, Monika - Germany (Federal Republic of) ;

(71) Patent-Treuhand-Gesellschaft für elektrische Glühlampen mbH - Germany (Federal Republic of) ;

(30) (DE) P 44 22 661.6 1994/06/28

(57) 21 Claims

Notice: This application is as filed and may therefore contain an incomplete specification.

ABSTRACT OF THE DISCLOSURE.

A method and apparatus for the continuous separation of mercury from flowing gases, in particular from exhaust gases from thermal processes, e.g. melting of mercury containing glas shards from fluorescent lamps. At least one halogen, in particular iodine and/or bromine, is added to the gases when they flow into a reaction vessel. The halogen reacts with the mercury to form mercury halide, which is separated in the solid state from the gases prior to their outflow from the reaction vessel, for example by deposition on a cooled metal surface or by filtration. Excess halogen is separated by means of adsorption. A regulating device is optionally provided which readjusts the feed rate of the halogen in such a way that a predetermined small mercury concentration is set in the outflowing gases, e.g. less than 0.2 mg per m^3 of gas.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

"METHOD AND APPARATUS FOR CONTINUOUSLY SEPARATING MERCURY FROM FLOWING GASES"

Reference to related patent and application, the disclosures of which are hereby incorporated by reference:

U.S. 4,729,882, Ide et al.;

International Application PCT/EP 92/01557, published WO 93/02773, U.S. designated, Kürzinger et al.

Reference to related patents:

European 0 289 810 A1, Vogg;

German 41 40 969 C1, Körner et al.

* * * * * * *

FIELD OF THE INVENTION.

The present invention relates to an apparatus and method for continuously separating mercury from flowing gases, in particular from exhaust gases of thermal processes. Such gases arise during operation of a glass melting installation for fragmented mercury-containing lightbulbs, e.g. fluorescent lamps or metal halide lamps.

BACKGROUND.

Conventionally, some mercury separation methods employ activated charcoal for binding the mercury. For example, the activated charcoal may be in the form of filters or screens, and

possibly used for pre-cleaning (for example WO 93/02773, Kürzinger et al.). Since activated charcoal is highly flammable, its employment is limited to cleaning gases at an appropriately low temperature.

The following methods are suitable for higher gas temperatures. Lime, to which green coke has been added, is used as the reaction agent for binding mercury, see EP 0 289 810. The mercury-green coke-adsorbate being generated is separated in a precipitator and stored. A large amount of special waste is generated, which is disadvantageous for this type of method.

Another method involves bringing the mercury- containing gases into contact with precious metal halides. In such a method, the precious metals are reduced and the corresponding mercury halide is separated. However, high costs are incurred because of the use of precious metals.

Some amalgam-forming methods are known. In the simplest case, a sheet metal plate forming an amalgam is disposed in the gas flow. The relatively small surface and the resultant short service times are disadvantageous. To avoid this problem, it is proposed in the German Patent Disclosure Document DE-OS 41 40 969 to apply amalgam-forming metals, for example gold, silver, copper, tin, zinc, palladium, iridium, or rhodium, on a substrate with a large inner specific surface (up to approximately 90 m^2/g). However, the cost of these metallized substrates is high.

A method for cleaning mercury-containing gases from municipal waste incineration plants is disclosed in US Patent No. 4,729,882, Ide et al. In a first method step the mercury is converted to water-soluble mercury chloride by the addition of chlorine gas. The mercury is washed out of the gas in a subsequent wet-chemical method step by means of a washing solution. However, the high chemical aggressiveness of chlorine is disadvantageous. Furthermore, wet washing causes an additional pressure loss in the gas flow which is equivalent to an increased energy outlay.

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THE INVENTION.

It is an object of the invention to provide an efficient method and apparatus for separating mercury (Hg) from gases on a large industrial scale and so that the threshold values for mercury concentrations in exhaust air fall below those prescribed in the relevant regulations, while overcoming the previously mentioned disadvantages.

Briefly, at least one halogen X, in particular iodine and/or bromine, is admixed directly and continuously at a controllable feed rate to mercury-containing gas in order to thereby trigger a quantitative reaction of $Hg + X_2 \longrightarrow HgX_2$. By means of this reaction the concentration of elementary mercury in the gas flow is directly reduced. The mercury halide(s) HgX_2 generated in the course of the reaction is or are subsequently separated in the solid state from the gas flow, possibly together with further mercury compounds present in the gas flow.

Iodine is a preferred reactant, because it reacts well with mercury to form mercury iodide. It is furthermore advantageous in that as compared to chlorine and fluorine, iodine is clearly less chemically aggressive. In addition, mercury iodide has a lesser water solubility (approximately 0.006%) than mercury bromide (approximately 0.62%), mercury chloride (approximately 6.9%) and mercury fluoride (dissociates), as well as a relatively high evaporation temperature (approximately 354°C). Because of this, the humidity and temperature of mercury-containing exhaust gases have a lesser effect on the separation of the mercury iodide than with the other mercury halides mentioned. In spite of this, however, it is possible in principle to employ halogens other than iodine as reactants, provided a reduced efficiency of the separation is acceptable. It is also possible to use two or more different types of halogens simultaneously as reactants.

In a first embodiment of the invention, the halogen is

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continuously supplied in manually preset amounts. Optionally, the feed rate of the halogen(s) is increased to such a degree that the gas flow shows an excess of halogen. In this manner, the elemental mercury can be completely converted to the greatest extent into mercury halide(s) and separated from the gas flow. The excess halogen contained in the gas flow after the reaction is separated in a further method step.

In a second embodiment of the method, the mercury concentration is selectively and continuously measured following the reaction. The feed rate of the halogen(s) is readjusted as a function of the measured value in such a way that a preselectable threshold value of the mercury concentration occurs, particularly less than 0.2 mg mercury per m^3 of exhaust gas. In a preferred embodiment of the method, the mercury concentration is adjusted to a value which, although lying below a prescribed threshold value, lies above zero. Overdosing with halogen is prevented in this manner, even with fluctuating mercury concentrations in the inflowing gas. Accordingly, in this embodiment it is possible to omit the additional method step for separating excess halogen, which is generally required with the uncontrolled method. A further advantage is the flexible adaptation of the supplied amount of halogen to fluctuating mercury concentrations. Halogen use is reduced to a minimum as well. This embodiment is particularly efficient.

A basic apparatus which carries out the method in accordance with the invention has a reaction vessel open on both ends, wherein the mercury-containing gases flow in through its first open end and flow out through its second open end. The flow can be created by thermal convection or by means of a blower. The reaction vessel is preferably pipe-shaped and the cross section can be arbitrary, for example circular or polygonal, e.g. rectangular. The reaction vessel has a supply or feed device for supplying at least one halogen or for placing the halogen into

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the reaction vessel.

In addition, the apparatus provides a separating device, in which the mercury halide(s) can be separated from the gas flow in the solid state, possibly together with further mercury compounds present in the gas flow. In the process, the mercury halide either (a) cools to a temperature below the evaporation temperature in the separating device or (b) flows at an already appropriate temperature into the separating device. When employing two or more halogens, cooling is performed to below the lowest evaporation temperature of the mercury halides used. For example, for mercury iodide and for mercury bromide the evaporation temperatures are approximately 354°C and 319°C, respectively. Thus, if both halogens are used, the temperature must be lower than 319°C.

In a preferred form of the first embodiment, a heat exchanger is used as the separating device. The advantage here is that by this step the energy balance is improved at the same time and in this way the efficiency of the entire system increased. In conventional installations the heat exchanger is primarily used in a manner known per se for the partial return of the process heat contained in the exhaust gas. For this purpose the heat exchanger has a large effective surface cooled by a fluid. The mercury halide(s) is (are) deposited thereon. Because of this, the effective flow cross section of the heat exchanger is increasingly reduced and as a consequence the flow resistance is increased. If it exceeds a threshold value, the heat exchanger must be cleaned. The time when a change is due is determined by means of two pressure probes, one in the inflow and the other in the outflow of the heat exchanger. With the flow speed being constant, the pressure difference between the two probes, i.e., the pressure loss caused by the heat exchanger, is a direct measurement of the flow resistance.

In the second embodiment, a filter is used as the separating

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unit, for example an electrostatic filter (E-filter) or a mechanical one. The advantage of the E-filter is a reduced pressure loss and consequently a reduced additional energy outlay. However, a mechanical filter, for example a conventional fibrous or textile filter, is cheaper.

To assure intimate mixing and reaction of mercury and halogens, a minimum distance must be maintained between the region where the halogen(s) enter(s) and where the corresponding mercury halides are separated from the gas flow. In individual cases this depends on the respective flow conditions and the type of admixture of the halogen(s). In a conventional exhaust gas installation the minimum distance is six times the hydraulic diameter of the exhaust gas conduit. It may be advantageous to assist admixing by suitable elements for the generation of flow eddies disposed in the interior of the reaction vessel.

The apparatus may have a second separating device. By means of this second separating device, halogen, which may be in excess after the reaction, is separated from the gas chamber, for example by means of an adsorption agent.

Preliminary tests with iodine have shown that aluminum chips are well suited as an adsorption medium. With dry gases it was possible to achieve an iodine absorption of 60 percent by weight, and with moist gases, such as is the general case with fossil-fired thermal processes, an iodine absorption of 40 percent by weight, at least, related to the adsorption medium. In comparison therewith, a clearly lesser iodine absorption was measured in the case of zinc chips (with dry gases, only 15 percent by weight). Aluminum chips, such as occur as waste products in machining operations, for example, are suitable. However, prior to their use as an adsorption agent, it is necessary to remove adhering lubricants which are often present.

In contrast, aluminum needles have not proven themselves

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useful because of the high apparent weight. Also, the air resistance of a corresponding filter is too great and the needles tend to adhere together, particularly with moist gases.

An apparatus for realizing the method in accordance with the invention with controlled halogen metering additionally has an Hg-measuring device for measuring the concentration of elemental mercury, as well as a control and regulating unit connected with the Hg-measuring device and acting on the feed device for the halogen. The measuring sensor of the Hg-measuring device is disposed at a distance downstream from the place where the halogen is added; the distance corresponds to at least six times the hydraulic diameter of the reaction vessel. This assures that at the place of measuring, the previously metered and supplied halogen has reacted essentially completely with the mercury and that therefore the actual remaining concentration of elemental mercury is measured.

The second separating device for separating excess halogen in the controlled apparatus may be omitted. The control unit preferably is adjusted in such a way that although the remaining concentration of mercury in the exhaust gas lies below a prescribed threshold value, it still lies above zero. In this way overdosing with halogen is impossible, i.e., the outflowing gas is sufficiently free of halogen even without an appropriate separating device.

DRAWINGS:

The invention will be explained below by means of some exemplary embodiments.

Fig. 1 is a schematic flow diagram of the method for the continuous separation of mercury from flowing gases in accordance with the invention. The additional method steps required for a controlled operation (second embodiment) are those framed by dashed lines.

Fig. 2 is schematic representation of an apparatus for

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executing the directed embodiment of the method of Fig. 1.

Fig. 3 is a schematic representation of an apparatus for executing the controlled embodiment of the method of Fig.1.

Fig. 4 is a schematic fragmentary view illustrating the separating device in form of a heat exchanger.

DETAILED DESCRIPTION:

Fig. 2 shows an apparatus 8 for performing the method of the first embodiment of the invention. The apparatus uses iodine as the reactant for the mercury and comprises the following components a tube-shaped reaction vessel 2 that is open at both ends and has a circular cross section, and a feed device 3-4-5 for introducing the iodine into the reaction vessel. The feed device includes at least one reservoir 3, which contains at least one halogen such as solid iodine and which is connected to a halogen holder 4, e.g. an evaporation trough, for charging the holder 4 with the halogen. The holder is displaceable (e.g., in a direction transverse to that of the gas flow) via a displacement unit 5 driven by a motor M. The apparatus also includes within the reaction vessel 2 a separation device 6, such as a fibrous or textile filter or an electrostatic filter 6a (Fig. 3), and an adsorption agent 7.

The feed device introduces at least one halogen into the reaction vessel 2, so that a predetermined amount of the appropriate halogen vapour is admixed with the gas flow. The evaporation holder 4 is introduced into vessel 2 by driving

the displacement unit 5, e.g. a supply belt, with the motor M. The reservoir 3 is external to the reaction vessel 2; the temperature of the halogen within the reservoir 3 may be approximately 30°C which is less than the temperature of the gas flow within the reaction vessel 2.

The reaction vessel 2 is placed into an exhaust air conduit of a glass melting installation (not shown) for mercury-containing fragments of light bulbs. Mercury-containing gases flow through it in the direction of the arrow, wherein the gases flow in through the first open end of the reaction vessel 2 and, after having passed through the adjoining reaction area 8, flow out through the second open end of the reaction vessel, essentially free of mercury.

The evaporation holder 4 of the feed device is located in the area of the first end of the reaction vessel 2 and is charged with solid iodine from the reservoir 3. The feeding rate of gaseous iodine to supply the gas flow corresponds to the evaporation rate of the iodine and can therefore be affected by the temperature of the evaporation holder 4 and by the iodine surface exposed inside the reaction vessel, i.e., by the manually preselectable length of the partial area of the evaporation holder 4 introduced into the reaction vessel 2. A heat exchanger 25 can be located upstream of the feed device if the temperature of the Hg-laden gases entering vessel 2 is excessively high.

Because of the gas flow, the individual gas components are mixed with each other relatively quickly in the adjoining reaction region 8 and the iodine combines with the

mercury to form mercury iodide.

Within the reaction area 8, whose length L corresponds to approximately six times the diameter D of the reaction vessel 2, the reaction vessel 2 may have a simple and therefore cost-effective separation device 6 in the form of a fibrous or textile filter, which filters out the mercury iodide. The installation position of the apparatus 1 in relation to an exhaust gas conduit (not shown) and the connection position of the upstream heat exchanger 25, bring the mercury iodide flowing through the vessel 2 and then through the fibrous or textile filter 6 to a temperature below the evaporation temperature of the iodide (approximately 354°C). The downstream-connected adsorption agent 7 is made of aluminum chips at whose surfaces possible excess iodine is adsorbed.

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The particular advantage of this apparatus lies in its simple and cost-efficient design. However, the evaporation rate and therefore also the metering of the iodine is possibly affected by the temperature of the gas flowing around the evaporation trough 4. In that case it is not possible to use very small metered amounts and it may be necessary to accept overdosing.

In a particularly simply designed and therefore cost-effective embodiment, the supply or feed device consists of a wide-meshed metal net. It extends preferably over the entire cross section of the reaction vessel and is partially covered with solid iodine. The gases flow around the iodine through the uncovered mesh of the metal net, heat it and generate the desired vapor pressure. This embodiment is suitable for uses which do not require the exact control of the feed rate of halogen.

Fig. 3 schematically illustrates an apparatus 9 for carrying out the method in accordance with the second embodiment of the invention. The basic design is similar to that in Fig. 2. The flow direction has again been marked by arrows. The difference with respect to the embodiment of Fig. 2 lies in a changed feed device for the iodine, an additional regulating device and the omission of an adsorption agent.

The feed device uses a thermostat- controlled reservoir 11 of solid iodine 12, a suction line 13 provided with a blowback safety valve 14 and drying cartridge 15. The suction line 13 terminates in the reservoir 11 via a controllable pressure pump 16 and a continuous pressure line 17. A supply pipe 18 connects the reservoir 11 with the interior of the reaction vessel 10. The pressure pump 16 sucks ambient air through the drying cartridge 15 and the suction line 13 and introduces it via the pressure line 17 into the reservoir 11. The reservoir 11 is located inside a thermostat-controlled housing 19 which keeps the iodine 12 at a temperature of approximately 30°C. A suitably

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high vapor pressure of the iodine in the reservoir 11 is thereby created. The compressed air flows over the surface of the iodine 12 and is enriched with iodine vapor. The iodine-air mixture subsequently reaches the reaction vessel 10 through the supply pipe 18. The feed rate of the mixture can be controlled by means of controlling the flowing volume of the compressed air as well as the temperature and therefore the vapor pressure of the iodine 12.

The regulating device essentially includes an Hg-measuring device 20 for the selective measurement of the mercury concentration and a regulating device 21 connected therewith and controlling the controllable pressure pump 16. A measuring probe 22 of the Hg-measuring device 20 is disposed inside the reaction vessel 10 downstream of the supply pipe 18 at a distance A which approximately corresponds to six times the diameter D of the reaction vessel 10. A separation device 6 such as a fibrous or textile filter 6 (Fig. 2) or an electrostatic filter 6a (Fig. 3) is placed downstream of the measuring probe 22.

Preliminary tests have shown that this embodiment can react rapidly to fluctuations in the mercury content of the gas flow, so that with a suitable setting of the control 20, 21, no iodine overdosing occurs. For this reason an adsorption agent for iodine was omitted here, in contrast to Fig. 2.

Fig. 3 also shows, highly schematically, the separating device in form of an electrostatic precipitator 6a, connected to a voltage source 6b, the other terminal of which is connected to the vessel 10.

Fig. 4 shows, highly schematically, the separating device in form of a heat exchanger 26, located in the stream of gas flow, for use if the temperature of the gas and/or of the mercury halide goes above the evaporation temperature of the halogen being used. Heat recovered can be re-used. Cooling fluid is connected to couplings 27, 28.

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Various changes and modifications may be made, and any features described herein in connection with any one of the embodiments may be used with any of the others, within the scope of the inventive concept.

Example of an operative embodiment:

Inside diameter D of the reaction vessel 2, 10: 1.10 m temperature of gases at inlet end of reaction vessel 2, 10: 350°C gas flow rate through the reaction vessel: about 4.2 m^3/sec temperature of gases in region of introduction of halogen (Fig. 2: 4; Fig. 3: 18): 150°C rate of supply of halogen vapour from conduit 18 (Fig. 3) is such that the remaining concentration of mercury will be about 10 $\mu g/m^3$ temperature of gases with mercury halides at separator 6, 6a, 26: 140°C.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method for continuously separating mercury from a gas flow, comprising the steps of:

adding a reactant to the gas flow to form a reaction product with the mercury and thereby separate the mercury from the gas flow,

wherein, in accordance with the invention,

the reactant is at least one halogen, reacting with the mercury in the gas to form a reaction product, the reaction product including at least one mercury halide;

converting the mercury halide into solid state; and

separating the mercury halide from the gas flow.

2. The method of claim 1, wherein the step of converting includes bringing the at least one mercury halide into contact with a surface having a temperature below the evaporation temperature of the at least one mercury halide so that the at least one mercury halide deposits on this surface.

3. The method of claim 1, wherein the reaction product includes a plurality of mercury halides; and

the step of converting includes cooling the mercury halides to a temperature below a temperature which is lower than the lowest one of the evaporation temperatures of the mercury halides.

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4. The method of claim 1, wherein the separation of the mercury halide from the gas flow comprises electrostatic filtering.

5. The method of claim 1, wherein the separation of the mercury halide from the gas flow comprises mechanical filtering.

6. The method of claim 1, further comprising the steps of selectively measuring the mercury concentration in the gas, and

readjusting the feed rate of the halogen as a function of the measured mercury concentration in such a way that a preselectable threshold value of the mercury concentration is set; and

wherein the steps of selectively measuring and readjusting are carried out after the reaction product is formed.

7. The method of claim 6, wherein the preselectable threshold value is less than 0.2 mg of mercury per m^3 of the gas.

8. The method of claim 1, further comprising the step of separating excess halogen from the gas flow.

9. The method of claim 8, wherein the step of separating excess halogen comprises an adsorption step.

10. The method of claim 1, wherein the at least one halogen includes an element selected from the group consisting of iodine and bromine.

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11. An apparatus for continuously separating mercury from a gas flow,

carrying out the method of claim 1,

comprising

a reaction vessel (2, 10) having a first open end through which the gas flows in and a second open end through which the gas flows out,

said reaction vessel (2, 10) having a feed device (3-4, 11-17) in the vicinity of said first open end, for supplying and placing at least one halogen into the reaction vessel, and

said reaction vessel further having a separating device (6, 6a, 26) in a vicinity of said second open end for separating mercury halide formed in the reaction vessel (2, 10) from the gas flow.

12. The apparatus of claim 11, wherein the separating device includes a heat exchanger (26).

13. The apparatus of claim 11, wherein the separating device includes an electrostatic filter (6a).

14. The apparatus of claim 11, wherein the separating device includes a mechanical filter (6), optionally a fibrous or textile filter.

15. The apparatus of claim 11, wherein the reaction vessel (2, 10) is substantially tubular in shape and the separating device and the feed device are disposed at a distance (A) from each other which corresponds to at least six times the hydraulic diameter (D) of the reaction vessel (2, 10).

16. The apparatus of claim 11, wherein said reaction vessel (2, 10) has an additional separating device (7) located in the

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vicinity of said second end, said additional separating device containing an adsorption agent for separating excess halogen from the gas flow.

17. The apparatus of claim 16, wherein the adsorption agent consists essentially of aluminum chips (7) when the halogen comprises essentially iodine.

18. The apparatus of claim 11, wherein the feed device includes

at least one halogen reservoir (3) containing the halogen, and means (4, 5) for receiving the halogen from said reservoir (3) and for controllable feeding said at least one halogen into the reaction vessel (2), so that a predetermined amount of the halogen vapor emitted from said at least one halogen is admixed with the gas flow, for reaction with the mercury within said gas flow.

19. The apparatus of claim 11, wherein the feed device has at least one reservoir (11) containing the at least one halogen (12);

means (13-17) for introducing pressurized gas into the reservoir (11); and

a halogen supply conduit (18) extending from the reservoir (11) into the reaction vessel (10) to provide a predetermined amount of the respective at least one halogen for admixture with the gas flow.

20. The apparatus of claim 19, wherein the pressurized gas introduction means includes a controlled element (16);

a halogen measuring device (20, 22) measuring the concentration of elemental mercury within the gas flow;

and a control circuit (21), responsive to the measuring

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device (20, 22) as a function of the concentration of elemental mercury, and controlling said controlled element (16) to thereby control the amount of halogen admixed to the gas flow.

21. The apparatus of claim 20, wherein the mercury measuring device (20, 22) has a measuring probe located in the the gas flow downstream of the supply conduit (18) where the at least one halogen is admixed into the gas, said probe being spaced from the conduit (18) by a distance (A) of at least six times the hydraulic diameter (D) of the reaction vessel (10).

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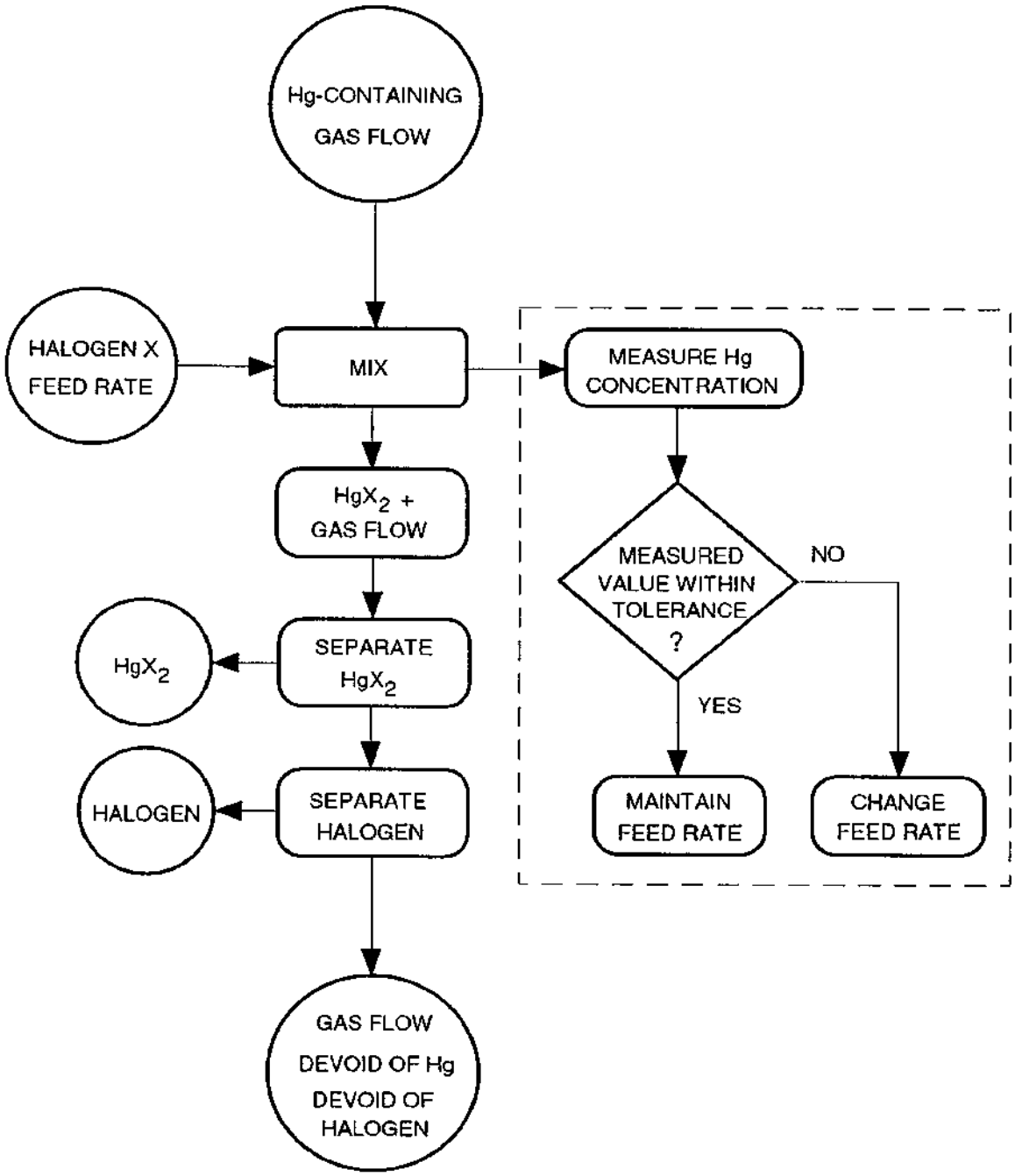


FIG. 1

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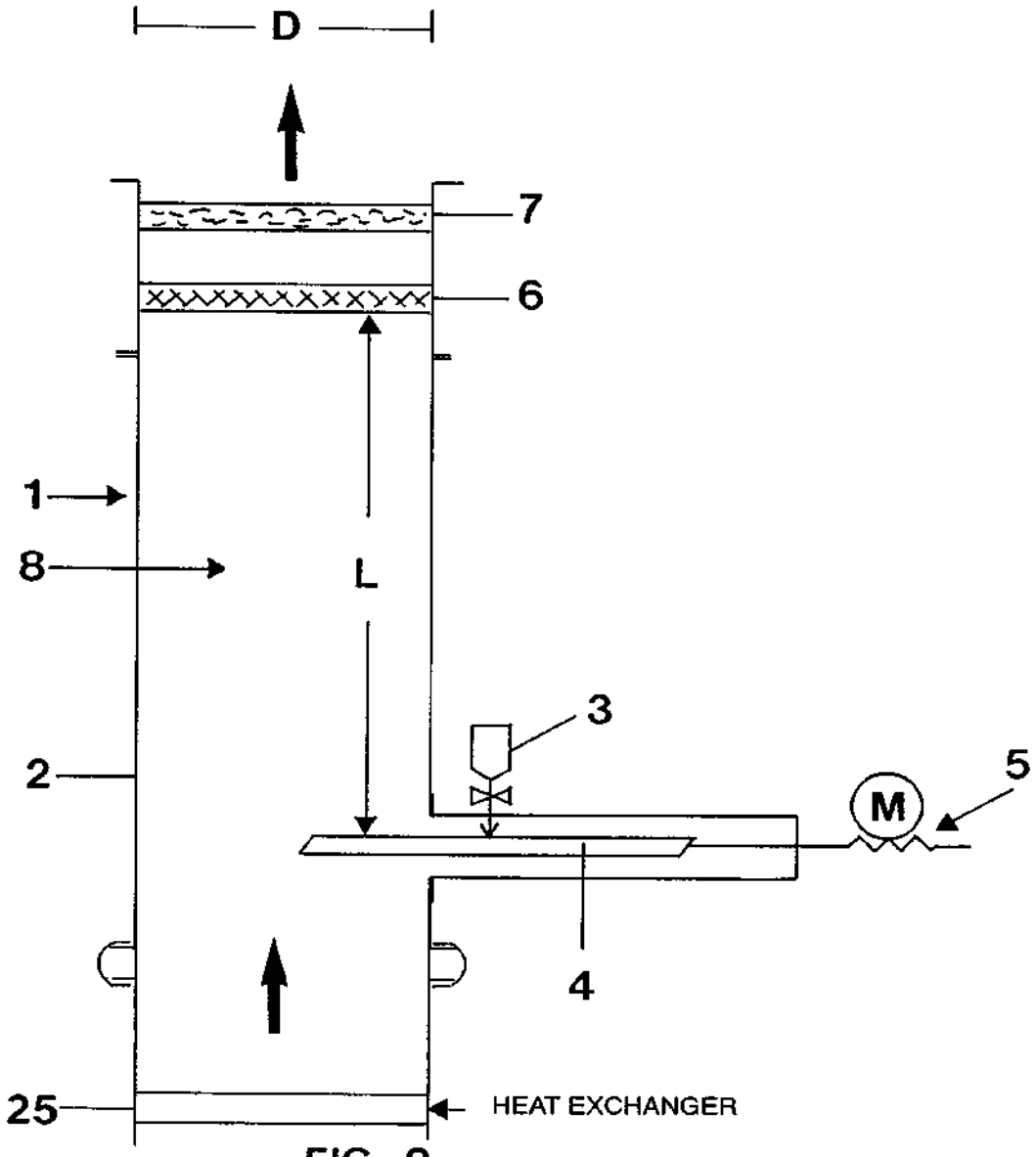


FIG. 2

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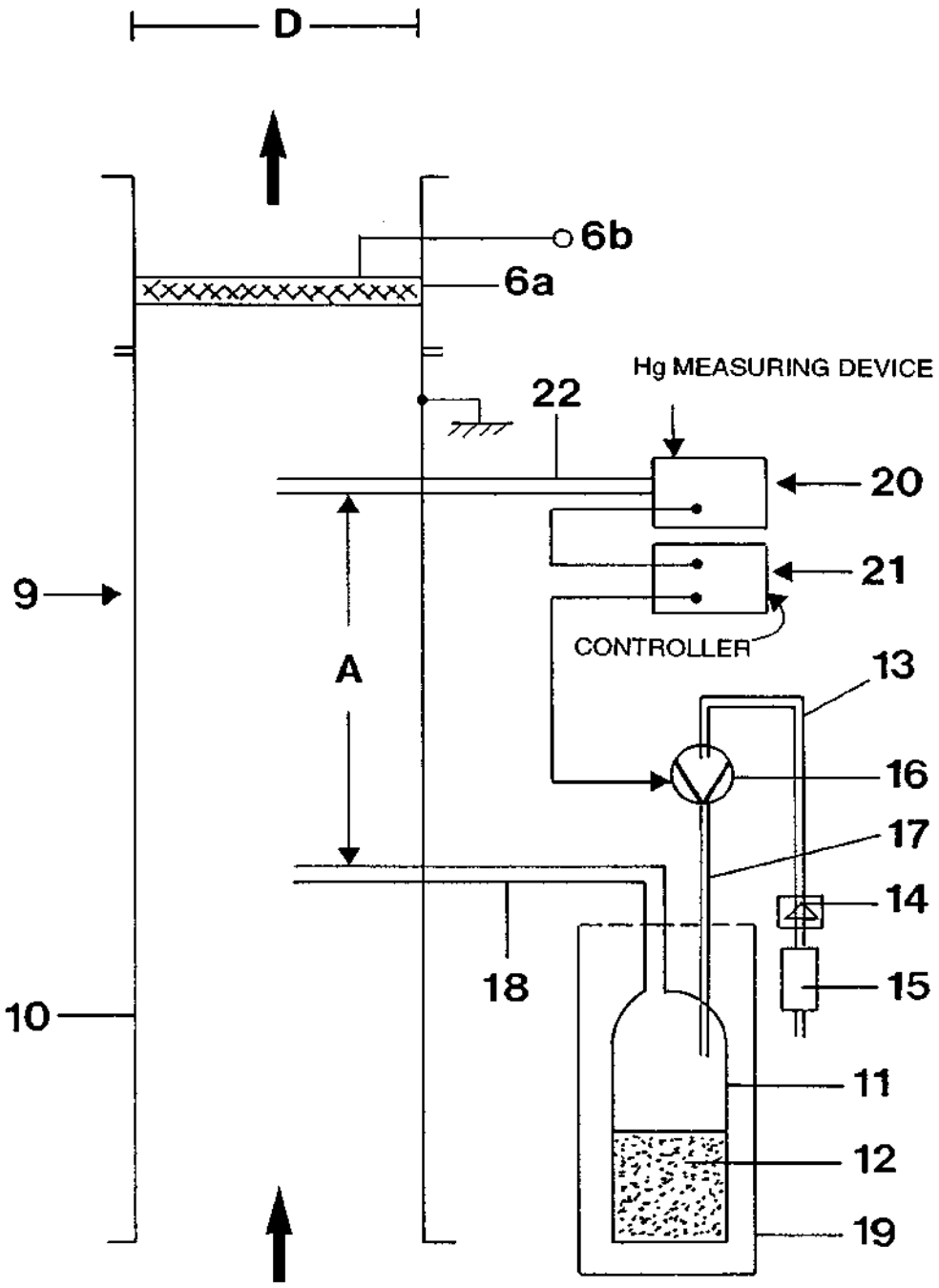


FIG. 3

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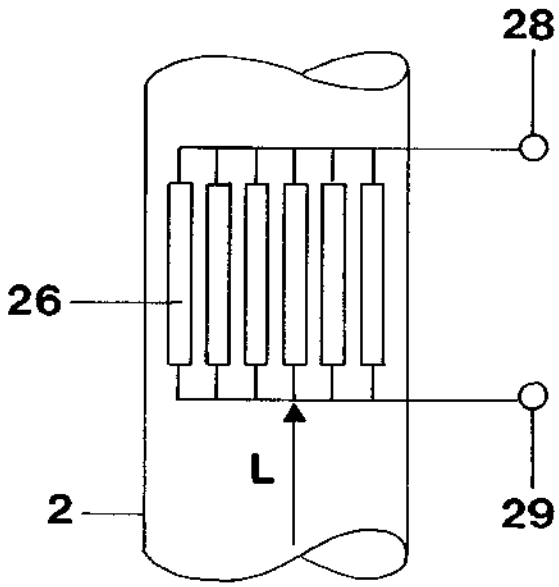


FIG. 4

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(54) POUDRE ADSORBANTE DESTINE A L'ELIMINATION DE MERCURE DANS DES COURANTS GAZEUX A TEMPERATURE ET HUMIDITE ELEVEES

(54) ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

(57)

There is disclosed an adsorption powder effective for capturing mercury from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon, and about 1-60% carbon impregnated with KI3. Additionally, a method of removing mercury from high temperature, high moisture gas streams is disclosed.

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(54) Title: ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

(57) Abrégé/Abstract:
There is disclosed an adsorption powder effective for capturing mercury from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon, and about 1-60% carbon impregnated with KI3. Additionally, a method of removing mercury from high temperature, high moisture gas streams is disclosed.

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(54) Title: ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

(57) Abstract: There is disclosed an adsorption powder effective for capturing mercury from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon, and about 1-60% carbon impregnated with KI3. Additionally, a method of removing mercury from high temperature, high moisture gas streams is disclosed.

ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

BACKGROUND OF THE INVENTION

The present invention relates generally to removal of pollutants from high temperature, high moisture gas streams such as those found in devices designed to treat contaminated soil and in hazardous material incinerators. More particularly, the invention relates to the capture of mercury and other metals, dioxins, furans and other organic compounds from high temperature, high moisture gas streams using an adsorption powder containing cupric chloride.

Strict standards exist for particulate and total mercury emissions by coal-fired power plants, petroleum refineries, chemical refineries, coal fired furnaces, trash burning facilities, incinerators, metallurgical operations, thermal treatment units and other particulate and mercury emitting facilities. These same restrictions apply to mercury vapor, which can enter the atmosphere as a result of low temperature thermal desorption (LTTD) treatment of contaminated soils.

These stringent standards exist in order to protect the environment and the community. When mercury-containing gases are released, the gases disperse and mercury is deposited over a wide area. The dispersed mercury can accumulate in the soil or water supplies, where it may be incorporated into the food chain. Mercury is extremely harmful to aquatic life and ultimately to the humans who consume mercury-contaminated plants and animals. It is necessary, therefore, to have a safe and effective method of eliminating mercury from the environment.

The problem of the capture and treatment of mercury vapor, typically in the context of coal-fired power plants and waste incinerators, has been previously considered. For example, U.S. Patent No. 3,193, 987 discloses passing mercury-containing vapor over activated carbon impregnated with a metal which forms an amalgam with mercury. U.S. Patent No. 4,094,777 discloses passing a mercury-containing vapor over an adsorption mass consisting essentially of a support, sulfided

copper and sulfided silver. U.S. Patent No. 3,876,393 discloses passing mercury-containing vapors over activated carbon that has been impregnated with sulfuric acid. Selenium has also been used in the removal of mercury from a vapor. U.S. Patent No. 3,786,619 discloses passing a mercury-containing gas over a mass containing as an active component, selenium, selenium sulfide or other selenium compounds. Electrostatic precipitators and various filters have traditionally been used for mercury removal, although complex apparatus have also been disclosed. (See e.g., U.S. Patent Nos. 5,409,522 and 5,607,496.)

The problem of recapturing mercury from power plant gas streams is analogous to the need for recapturing mercury from incinerators that treat contaminated soils. A process currently in use at soil treatment facilities is known as low temperature thermal desorption (LTTD). LTTD is the main process by which contaminated soils are treated to remove mercury and other contaminants. In this process, contaminated soils are fed into a heating furnace, most commonly a rotary kiln/drum, where the soil is heated by conduction. The heating volatizes the soil components and when a thermal oxidizer is added, the components are oxidized to manageable gases, such as CO_2, Cl_2, NO_x and SO_x, where x is 1-3.

The hot gas stream is subsequently cooled. The stream may be quenched with water, which cools the stream and concurrently increases the moisture content. Although water quenching is a highly effective cooling method, this treatment increases the difficulty of removing mercury from the gas stream. The gas stream is further treated to reduce and remove metals, HCl, NO_x and SO_x using acid scrubbers, carbon beds, condensation units and through the addition of adsorption powders.

When adsorption powders are injected into the gas stream, mercury and other metals bind to moieties present in the powder, precipitating them from the gas stream. The powder-bound mercury is ultimately collected in a bag house for appropriate disposal, while the clean gas stream is exhausted to the outside atmosphere. The problem with standard LTTD methods is that some metals, such as mercury, are not removed from the stream at high efficiency and will move with

the gas stream, ultimately into the environment. Other methods require the use of complex machinery and expensive adsorption beds. LTTD and other methods also suffer from the limitation that mercury removal from high moisture gas streams is much more difficult than mercury removal from dry streams.

Available adsorption powders remove organics, metals and other contaminants, but they do not effectively remove mercury. For example, one available powder (Sorbalite ™) consisting of carbon, calcium hydroxide and sulfur removes HCl from a gas stream, but removes only about 55-65% of the mercury. Another powder (WUELFRAsorb-C ™) consisting of alcohol saturated lime and activated carbon is also inefficient at removing mercury.

Some powders include sulfur or iodine impregnated carbon. At temperatures of 75°C or less, sulfur or iodine impregnated carbon based powders show a 95% mercury removal efficiency, however, powders formulated with sulfur impregnated carbon require a dry or low moisture gas stream to show this level of removal.

Finally, the mercury removal efficiency of the powders described and other available powders is known to be very temperature dependent, placing an additional limitation on powder formulations.

A pending application describing a process from the same inventors involved the use of solid fine cupric chloride that is not impregnated on carbon. This was found to be more difficult to handle because of the grinding process required to pulverize the cupric chloride which is generally provided in rock sizes. The grinding process requires a great amount of attention due to the dust production and associated heath hazards. Additionally, the powder is very corrosive and results in breakdown of the machinery used in the process.

Accordingly, there is a need in the industry for an adsorption powder that effectively removes metals and other organic compounds, in general, and mercury, in particular, from high temperature, high moisture gas streams generated by the incineration of contaminated soils, treatment of hazardous materials, combustion of coal and other mercury liberating sources. The powder must be inexpensive and

easy to use. Ideally, such an adsorption powder can be employed at treatment facilities already in place and can take advantage of equipment already in position, without requiring retooling or reconfiguring existing equipment.

SUMMARY OF THE INVENTION

There is disclosed an adsorption powder and method for removing mercury and other metals and contaminants from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon and about 1-60% KI_3 impregnated carbon. A method for removing mercury and other metals, dioxins, furans and other organic compounds from high temperature, high moisture gas streams using the claimed powder is also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

The instant invention will be more fully understood in the following detailed description, it being understood, however, that the invention is not confined to the precise disclosure. Changes and modifications may be made that do not affect the spirit of the invention, nor exceed the scope thereof, as expressed in the appended claims. Accordingly, the instant invention will now be described with particular reference to the accompanying drawings.

Figure 1 is a schematic diagram illustrating the design of an LTTD facility in which the claimed adsorption powder can be used to remove mercury from gas streams.

DETAILED DESCRIPTION OF THE INVENTION

There is disclosed an adsorption powder for removing mercury and other metals from a gas stream comprising:

a) about 1-97% carbon;

b) about 1-97% calcium hydroxide;

c) about 1-97% cupric chloride impregnated carbon; and

d) about 1-60% KI_3 impregnated carbon.

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The powder more particularly comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon and about 1-50% KI_3 impregnated carbon. A preferred adsorption powder comprises about 20-60% carbon, about 30-70% calcium hydroxide, about 1-30% cupric chloride impregnated carbon and about -30% KI_3 impregnated carbon.

In a more preferred embodiment, the adsorption powder comprises about 25-45% carbon, about 40-60% calcium hydroxide, about 1-15% cupric chloride impregnated carbon and about 1-15% KI_3 impregnated carbon. The most preferred embodiment comprises about 40% carbon, about 40% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

The use of the KI_3 impregnated carbon has been found to be optional as the powder lacking this component performed equally as well as one containing the KI_3 impregnated carbon.

Thus, in another embodiment of the invention, , the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide and about 1-50% cupric chloride impregnated carbon.

There is also disclosed a process for removing mercury from a gas stream using the adsorption powder of the invention comprising the steps of:

a) placing a solid phase mercury-containing contaminated soil feed into a rotary kiln/drum;

b) heating said kiln/drum containing said soil feed to form gaseous and solid components of the sample;

c) transferring the gaseous component of said soil feed to an exhaust cleaning unit/afterburner and the solid component of clean soil to a soil cooling unit;

d) heating the gaseous component of said contaminated soil feed in said exhaust cleaning unit/afterburner;

e) cooling the gaseous component of said contaminated soil feed;

f) adding the adsorption powder of Claim 1 to the gaseous component;

g) transferring the powder-containing gaseous component to a baghouse; and

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h) releasing the substantially mercury-free gaseous component of said sample to the atmosphere.

An adsorption powder for the removal of mercury and other metals, dioxins, furans and other organic compounds must be efficient under a range of conditions. Currently available powders do not function well at high temperatures and in high moisture environments, conditions that are favorable to mercury removal.

High temperatures are necessary for effective removal of contaminants from soil. Temperatures of about 1800°F are necessary to volatize organics, metals and other impurities from the contaminated soil. Mercury that is trapped in contaminated soil, however, is most efficiently adsorbed on carbon at about 300-500°F. The most practical method of cooling a gas stream exiting an 1800°F oven is to inject water into the gas stream. Water injection cools the gas stream to a temperature favorable to mercury removal, but also increases the moisture content of the sample, which decreases the efficiency of available mercury adsorption powders. The mercury absorbing properties of available powders suffer dramatically in a high moisture environment. The adsorption powder of the invention, however, operates effectively even in a higher moisture environment.

Experiments with carbon sources showed that coal carbon was superior to wood carbon for mercury adsorption. Many available adsorption powders use wood carbon as a component, rather than coal carbon. Cupric chloride was observed to significantly enhance the adsorption of mercury from a gas stream and is the key to the instant invention. Cupric chloride supplies chlorine and activated copper to the elemental mercury in the exhaust stream. Elemental mercury reacts with the chlorine to form mercury chloride and the activated copper to form a stable mercury amalgam. Both forms of mercury are easily captured from the exhaust gas stream. KI_3 impregnated carbon was also found to increase mercury adsorption when it was included in the powder.

Figure 1 shows a schematic diagram of the actual process and equipment used to carry out the invention. Prescreened contaminated feed soil ready to be processed **2** is placed within soil cleaning unit **4**. The contaminated soil is heated to about 900°F or a temperature that will completely volatize the contaminates from the soil and generate a gas stream, as well as a clean/remediated solid soil component. Preferably, soil cleaning unit **4** is a rotary kiln. The gas stream is then passed out

of soil cleaning unit **4** to dust remover **6**, while any solid fraction of the feed soil is transferred to clean soil cooling unit **8**, where the soil is cooled and prepared for reuse. Dust remover **6** is preferably a multi-tube dust collector.

After dust remover **6** removes any particulate matter from the gas stream sample, the gas stream is passed into the Exhaust Cleaning Unit **10.** The Exhaust Cleaning Unit heats the volatilized contaminates to a temperature of about 1800°F for a minimum of two seconds retention time, which assures complete destruction of any remaining organic or other contaminants. From the Exhaust Cleaning Unit **10**, the gas stream then passes through cooling chamber **12** wherein a water pump (not shown) injects water into the cooling chamber **12** to lower the temperature of the sample to about 360°F. This cooling process consequentially increases the moisture content of the sample.

The high temperature, high moisture gas stream is then contacted to the adsorption powder of the invention, which is stored in adsorbent storage silo **14** and injected into the gas stream. This powder formulation is effective in removing metals, particularly mercury, and other contaminants.

After the gas stream has been contacted to the adsorption powder, the powder/gas stream mixture continues on to baghouse **16**. The carbon component of the adsorption powder collects on the walls of bags and acts as a particulate filter for the gases leaving the baghouse. Baghouse **16** collects the particulate mercury-containing fraction of the adsorption powder mixture, which is transported to a suitable bulk storage facility **20** and subsequently removed. The gaseous fraction is released to the outside atmosphere through vent **18**, while the remaining dust particulate fraction is handled in a similar manner to the particulate mercury fraction of the adsorption powder mixture **20**.

EXAMPLE 1

A series of field tests were performed employing a preferred adsorption powder formulation. Three soil samples containing about 4.2 mg/kg of mercury were prepared by screening to 1 inch. The coarse material was discarded, and the remaining soil was fed into a soil cleaning unit and heated to about 900°F. The cleaned soil was transferred to a soil cooling unit and prepared for reuse. The exhaust stream was sent to a dust remover and the precipitated material was sent to the soil cooling unit. The exhaust stream was then fed into an exhaust cleaning unit, which was heated to

about 1850°F. The exhaust gas was then cooled to about 360°F by quenching with water, and subsequently an adsorption powder comprising 40% coal carbon, 10% KI_3 impregnated carbon, 40% calcium hydroxide and 10% cupric chloride impregnated carbon was added. The exhaust stream/adsorption powder mixture was fed into a baghouse, where the mercury-bound particulate was separated from the mercury-free exhaust gas. The particulate material was removed from the baghouse for analysis and disposal, while gas analyzers on the exhaust stack recorded mercury emission levels. The results of the three, two hour runs are reported in the following table.

	Run 1	Run 2	Run 3	Average
LTTD Mercury Input (lbs/hr)	0.193	0.199	0.199	0.197
Clean Soil Mercury Output (lbs/hr)	0.0020	0.0020	0.0020	0.0020
Mercury Emission Rate (lbs/hr)	0.0012	0.0006	0.0007	0.0008
Mercury Removal Efficiency[1]	99.4%	99.7%	99.6%	99.6%

[1] *Removal Efficiency (%) = (Mass input - Stack Output- Clean Soil Output)/(Mass Input - Clean Soil Output)*

The average mercury removal efficiency of 99.6% exceeds the current mercury control efficiency specification of 96.5% efficiency, set by NJDEP air permit legislation. Mercury emissions were determined by EPA method 29-060.

Although the adsorption powder and method described and claimed are presented in the context of mercury removal from a gas stream, it should be appreciated that the powder and method are also useful for removing organics, metals and other contaminants from a gas stream.

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WHAT IS CLAIMED IS:

1. An adsorption powder for removing mercury and other metals, dioxins, furans and other organic compounds from a gas stream comprising:

a) about 1-97% carbon;

b) about 1-97% calcium hydroxide;

c) about 1-97% cupric chloride; and

d) about 1-60% KI_3 impregnated carbon.

2. The adsorption powder of claim 1 wherein the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon and about 1-50% KI_3 impregnated carbon.

3. The adsorption powder of claim 1 wherein the adsorption powder comprises about 20-60% carbon, about 30-70% calcium hydroxide, about 1-30% cupric chloride impregnated carbon and about -30% KI_3 impregnated carbon.

4. The adsorption powder of claim 1 wherein the adsorption powder comprises about 25-45% carbon, about 40-60% calcium hydroxide, about 1-15% cupric chloride impregnated carbon and about 1-15% KI_3 impregnated carbon.

5. The adsorption powder of claim 1 wherein the adsorption powder comprises about 30% carbon, about 50% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

6. The adsorption powder of claim 1 wherein the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon.

7. The adsorption powder of claim 1 wherein the carbon is coal carbon.

8. A method for removing mercury and other metals, dioxins, furans and other organic compounds from a gas stream using the adsorption powder of claim 1 comprising the steps of:

a) placing a solid phase mercury-containing contaminated soil feed into a rotary kiln/drum;

b) heating said kiln/drum containing said soil feed to form gaseous and solid components of the sample;

c) transferring the gaseous component of said soil feed to an exhaust cleaning unit/afterburner and the solid component of clean soil to a soil cooling unit;

d) heating the gaseous component of said contaminated soil feed in said exhaust cleaning unit/afterburner;

e) cooling the gaseous component of said contaminated soil feed;

f) adding the adsorption powder of Claim 1 to the gaseous component;

g) transferring the powder-containing gaseous component to a baghouse; and

h) releasing the substantially mercury-free gaseous component of said sample to the atmosphere.

9. The method of Claim 8 wherein the adsorption powder used in step f) comprises about 40% carbon, about 40% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

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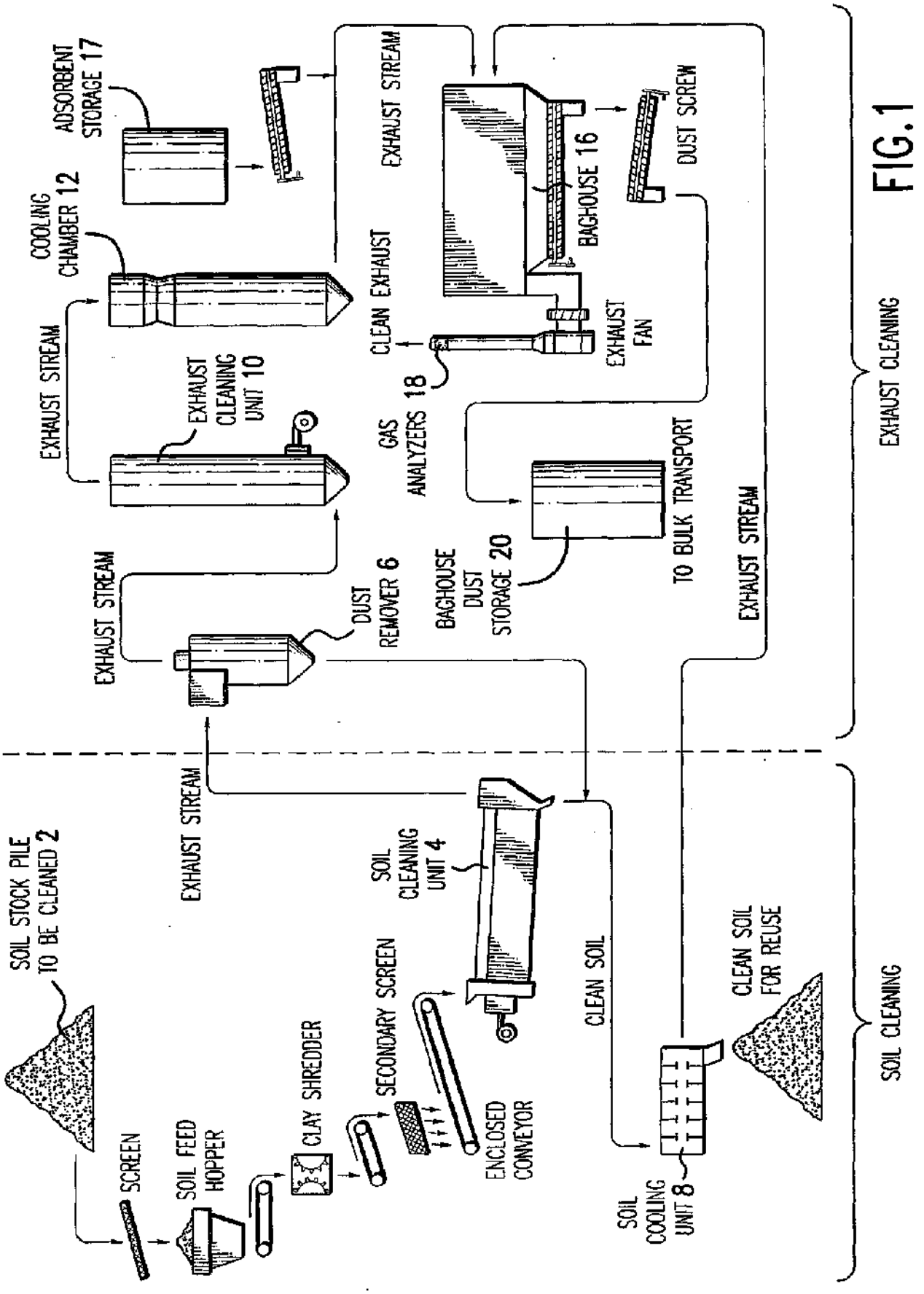

SOIL STOCK PILE TO BE CLEANED 2
SCREEN
SOIL FEED HOPPER
CLAY SHREDDER
SECONDARY SCREEN
ENCLOSED CONVEYOR
SOIL CLEANING UNIT 4
EXHAUST STREAM
DUST REMOVER 6
EXHAUST STREAM
EXHAUST CLEANING UNIT 10
EXHAUST STREAM
COOLING CHAMBER 12
ADSORBENT STORAGE 17
EXHAUST STREAM
CLEAN EXHAUST
GAS ANALYZERS 18
BAGHOUSE 16
DUST SCREW
EXHAUST FAN
BAGHOUSE DUST STORAGE 20
TO BULK TRANSPORT
EXHAUST STREAM
EXHAUST CLEANING
CLEAN SOIL
SOIL COOLING UNIT 8
CLEAN SOIL FOR REUSE
SOIL CLEANING

FIG. 1

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(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.

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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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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:

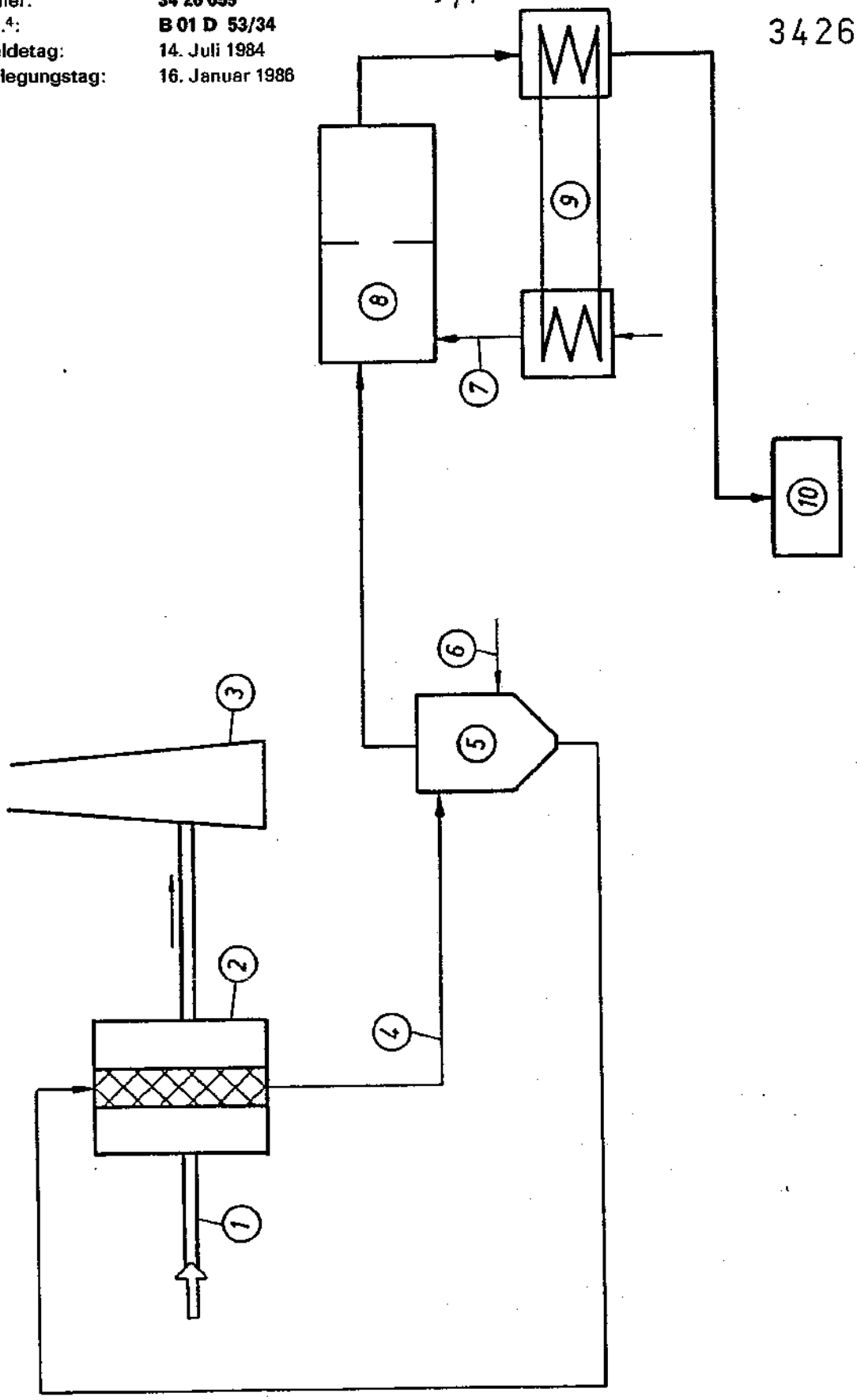
Das mit den organischen Schadstoffen beladene Rauchgas (1) tritt in den Adsorber (2) ein, der mit einem geeigneten Adsorptionsmittel wie Aktivkoks beschickt ist und wird dann über den Schornstein (3) abgeführt. Das mit den Schadstoffen beladene Adsorptionsmaterial wird über Leitung (4) in den Desorber (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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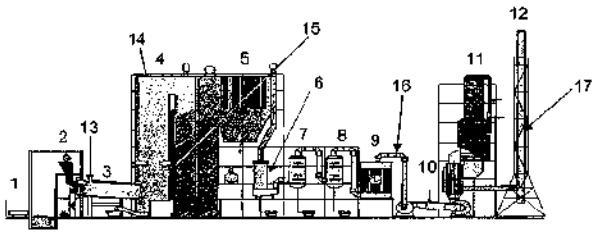
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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

(54) Bezeichnung: **Verfahren zur Abscheidung von Quecksilber aus Rauchgasen**

(57) Zusammenfassung: Die Erfindung beschreibt ein Verfahren zur Abscheidung von Quecksilber aus Rauchgasen von Hochtemperaturanlagen, insbesondere von Kraftwerken und Abfallverbrennungsanlagen, bei dem der, gegebenenfalls mehrstufigen, Feuerung und/oder dem Rauchgas in einem der Feuerung nachgeschalteten Anlagenteil eine bromhaltige Verbindung zugeführt wird, wobei die Temperatur beim Kontakt der bromhaltigen Verbindung mit dem Rauchgas mindestens 500°C, vorzugsweise mindestens 800°C, beträgt. Die Verbrennung erfolgt in Gegenwart einer schwefelhaltigen Verbindung, insbesondere Schwefeldioxid. Im Anschluss an die Feuerung wird das Rauchgas einer, gegebenenfalls mehrstufigen, Reinigung zur Abtrennung von Quecksilber aus dem Rauchgas unterzogen, welche eine Nasswäsche und/oder eine Trockenreinigung umfasst.



Beschreibung

[0001] Die Erfindung betrifft ein Verfahren zur Abscheidung von Quecksilber aus Rauchgasen von Hochtemperaturanlagen, insbesondere von Kraftwerken und Abfallverbrennungsanlagen.

Stand der Technik

[0002] Aufgrund der hohen Toxizität von Quecksilber, insbesondere von organisch gebundenem Quecksilber, das direkt oder indirekt über die Nahrungskette auch vom Menschen aufgenommen wird, existieren strenge Grenzwerte für die gesetzlich zulässige Emission von Quecksilber z.B. aus Verbrennungsanlagen und Kraftwerken. Trotz der heute bereits niedrigen Quecksilber-Reingaskonzentrationen – der derzeit in Deutschland zulässige Halbstundenmittelwert für Quecksilberemissionen aus Abfallverbrennungsanlagen beträgt 30 $\mu g/m^3$ i. N. tr. (i. N. tr.: im Normalzustand trocken) – werden aufgrund großer Volumenströme, beispielsweise aus Großkraftwerken, beachtliche Quecksilberfrachten erzielt, so dass eine weitere Minderung der derzeit zulässigen Grenzwerte angestrebt wird.

[0003] Diverse Verfahren zur Minderung von Quecksilberemissionen aus Kraftwerken, Abfallverbrennungsanlagen oder dgl. sind aus der Literatur bekannt. Welches der Verfahren für eine bestimmte Anwendung zweckmäßig ist, hängt stark von der eingebrachten Fracht und vom Chlorgehalt des Feuerungsgutes ab. Bei hohem Chlorgehalt ist der Anteil an ionischem Quecksilber im Rauchgas hoch. Ionisches Quecksilber lässt sich gut in Wäschern abscheiden. Das quasi-wasserunlösliche metallische Quecksilber kann beispielsweise durch den Zusatz von Oxidationsmitteln, wie Peroxide, Ozon oder Natriumchlorit, im Kesselrohgas vor der Rauchgasreinigung oder im entstaubten Kesselrohgas in ionisches Quecksilber überführt und anschließend in Wäschern abgeschieden werden. Weitere Verfahren zur Abscheidung des Quecksilbers sind: der Zusatz von Reaktionsmitteln, wie Natriumtetrasulfit, zur Bindung des Quecksilbers mittels Schwefel im Kesselrohgas vor Rauchgasreinigung oder im teilgereinigten Reingas; die verbesserte Auswaschung von ionischem Quecksilber durch pH- bzw. pCl-Absenkung in der sauren Wäsche oder durch Beaufschlagung mit 1,3,5-Triazin-2,4,6-trithiol (Trimercapto-S-triazin, TMT) in der schwach sauren oder schwach alkalischen Wäsche; die sorptive Abscheidung von ionischem und metallischem Quecksilber unter Zusatz von pulvrigen Sorbentien oder zerstäubten Suspensionen.

[0004] Bisherige Techniken zur Minderung sind nicht ausreichend effektiv und sind aufgrund ihrer z.T. hohen Zusatzinvestitionen und dem zusätzlichen Betriebsmittelverbrauch relativ teuer.

Aufgabenstellung

[0005] Aufgabe der Erfindung ist es, ein Verfahren zur Abscheidung von Quecksilber, insbesondere zur weitgehend vollständigen Abscheidung von Quecksilber (Hg), aus Rauchgasen von Hochtemperaturprozessen bereitzustellen. Das Verfahren soll breitestmögliche Anwendung finden, wie im Falle von im Wesentlichen konstanten niedrigen Hg-Konzentrationen, z.B. in Kohlekraftwerken, aber auch im Falle von relativ hohen Hg-Konzentrationen, z.B. in der Klärschlammverbrennung, oder sehr hohen Hg-Konzentrationen z.B. in der Hausmüll- oder Sondermüllverbrennung. Des Weiteren sollte das Verfahren keiner umfangreichen Nachrüstung der Hochtemperaturanlagen bedürfen sowie möglichst geringer zusätzlicher Betriebsmittel, so dass das Verfahren kostengünstig implementiert und betrieben werden kann.

[0006] Gegenstand der Erfindung ist ein Verfahren zur Abscheidung von Quecksilber aus Rauchgasen von Hochtemperaturanlagen, insbesondere von Kraftwerken und Abfallverbrennungsanlagen, welches darin besteht, dass der, gegebenenfalls mehrstufigen, Feuerung und/oder dem Rauchgas in einem der Feuerung nachgeschalteten Anlagenteil Brom und/oder eine bromhaltige Verbindung und/oder eine Mischung verschiedener bromhaltiger Verbindungen zugeführt wird, wobei die Temperatur beim Kontakt der bromhaltigen Verbindung mit dem Rauchgas mindestens 500°C, vorzugsweise mindestens 800°C, beträgt, die Verbrennung in Gegenwart einer schwefelhaltigen Verbindung, insbesondere Schwefeldioxid, gegebenenfalls unter Zusatz von Schwefel und/oder einer schwefelhaltigen Verbindung und/oder einer Mischung verschiedener schwefelhaltiger Verbindungen erfolgt und anschließend das Rauchgas einer, gegebenenfalls mehrstufigen, Reinigung zur Abtrennung von Quecksilber aus dem Rauchgas unterzogen wird, welche eine Nasswäsche und/oder eine Trockenreinigung umfasst.

[0007] Die Abscheidung von Quecksilber aus Rauchgasen in einer der Verbrennung oder einem ähnlichen Hochtemperaturprozess nachgeschalteten Rauchgasreinigung hängt entscheidend davon ab, in welcher Speziesform das Quecksilber vor Eintritt in die Rauchgasreinigung vorliegt. Ein möglichst hoher Anteil an ionischem Quecksilber ist von Vorteil, da das ionische Quecksilber gut wasserlöslich, also auswaschbar, sowie an diversen Adsorbentien gut adsorbierbar ist. Der Zusatz von Brom bzw. bromhaltigen Verbindungen zur Feuerung bewirkt unter den gegebenen Bedingungen eines Hochtemperaturprozesses oder dgl. in Gegenwart einer schwefelhaltigen Verbindung, insbesondere in Gegenwart von Schwefeldioxid, eine weitgehende, im Wesent-

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lichen vollständige, Oxidation des Quecksilbers und erlaubt daher eine starke Abscheidung des Quecksilbers aus Rauchgasen.

[0008] Unter Hochtemperaturanlagen werden im Sinne der vorliegenden Erfindung insbesondere Abfallverbrennungsanlagen, beispielsweise Hausmüll-, Sondermüll- und Klärschlammverbrennungsanlagen, sowie Kraftwerke, beispielsweise Steinkohle- oder Braunkohlekraftwerke, aber auch sonstige Anlagen für Prozesse hoher Temperatur, wie z.B. das Zementbrennen, sowie Abfall mitverbrennende Hochtemperaturanlagen oder kombinierte (mehrstufige) Hochtemperaturanlagen, wie z.B. Kraftwerke oder Zementdrehrohröfen mit vorgeschalteter Abfallpyrolyse oder Abfallvergasung, verstanden. Die Dimension der Hochtemperaturanlage spielt für das erfindungsgemäße Verfahren keine Rolle. Vorteilhaft an dem erfindungsgemäßen Verfahren ist gerade, dass es auf unterschiedliche Typen von Hochtemperaturanlagen und auf Hochtemperaturanlagen von unterschiedlicher Größenordnung anwendbar ist. Dies schließt Anlagen mit einem Rauchgasvolumenstrom von nur $15 \cdot 10^3$ m³ i. N. tr./h, beispielsweise zur Klärschlammverbrennung, oder von $50 \cdot 10^3$ m³ i. N. tr./h, z.B. in Sondermüllverbrennungsanlagen, oder von $150 \cdot 10^3$ m³ i. N. tr./h, z.B. in der Hausmüllverbrennung, ebenso ein wie Großkraftwerke mit z.B. $2–3 \cdot 10^6$ i. N. tr./h.

[0009] Für das erfindungsgemäße Verfahren ist es unerheblich, in welcher Form das zugeführte Brom vorliegt. Es ist möglich, freies oder organisch gebundenes oder anorganisch gebundenes Brom einzusetzen. Das Brom oder die bromhaltigen Verbindungen können einzeln oder im Gemisch zugeführt werden. Besonders bevorzugt wird eine wässrige Lösung von Bromwasserstoff oder ein Alkalibromid, insbesondere Natriumbromid, oder eine wässrige Lösung des Alkalibromids verwendet. Durch diese Ausführungsform ist das Verfahren wirtschaftlich besonders interessant, da die Kosten für zusätzliche Betriebsmittel niedrig gehalten werden können. Weiterhin bevorzugt ist eine Ausführungsform, in der die bromhaltige Verbindung bzw. das Gemisch verschiedener bromhaltiger Verbindungen aus bromreichen Abfallstoffen, wie z.B. niedrig- oder hochhalogenierte Flüssigabfälle, bestehen, welche Teil des Verbrennungsguts sind oder dem Verbrennungsgut, beispielsweise Sondermüll, beigemengt werden.

[0010] Das erfindungsgemäße Verfahren findet in Gegenwart einer schwefelhaltigen Verbindung statt. Die Zugabe einer bromhaltigen Verbindung nach dem erfindungsgemäßen Verfahren führt zu einer Gasphasenreaktion zwischen Quecksilber und Brom in Gegenwart von Schwefeldioxid. Da bei den im Sinne dieser Erfindung üblichen Verbrennungs- und sonstigen Hochtemperaturprozessen in der Regel Schwefeldioxid entsteht, ist für das erfindungsgemäße Verfahren in der Regel ein ausreichendes Angebot einer schwefelhaltigen Verbindung vorhanden. Ein ausreichendes Angebot im Sinne dieser Erfindung liegt vor, wenn unter Zugabe einer bromhaltigen Verbindung zu der Feuerung der Gehalt an Schwefeldioxid im Rauchgas vor der Rauchgasreinigung deutlich größer als Null ist. Wird bei einem Verbrennungsprozess jedoch kein oder nicht ausreichend Schwefeldioxid gebildet, muss dem Prozess eine schwefelhaltige Verbindung zugeführt werden. Dies kann in Form von freiem oder gebundenem Schwefel, beispielsweise Schwefelgranulat, Abfallschwefelsäure oder andere schwefelreiche Abfallstoffe, erfolgen. Darüber hinaus kann insbesondere auch zur Minderung eines zu hohen Gehalts an freien Halogenen im Rauchgas eine schwefelhaltige Verbindung zugesetzt werden, wenn z.B. mehr bromhaltige Verbindung zugeführt worden ist, als zur Oxidation des vorliegenden Quecksilbers notwendig ist. Die Zudosierung einer schwefelhaltigen Verbindung kann z.B. nach dem in der bisher unveröffentlichten Patentanmeldung DE 10131464 beschriebenen Verfahren zur korrosions- und emissionsarmen Mitverbrennung hochhalogenierter Abfälle in Abfallverbrennungsanlagen erfolgen. Nach diesem Verfahren wird in den primären und/oder sekundären Feuerraum Schwefel oder ein entsprechender Schwefelträger geregelt zudosiert. Die Regelung der Schwefelmenge erfolgt im Wesentlichen proportional zur mit den Abfällen eingetragenen aktuellen Halogengesamtfracht im Kesselrauchgas. Der zudosierte Schwefel verbrennt im Feuerraum zu Schwefeldioxid, was kesselintern zu einer weitgehenden Unterdrückung zwischenzeitlich gebildeter freier Halogene im Kesselrauchgas sowie nachfolgend zur stabilen Halogeneinbindung in der alkalischen Wäsche führt. Die Zudosierung von Schwefel wird so geregelt, dass der Soll-Schwefeldioxidgehalt im Rauchgas am Kesseleingang oder der Soll-Schwefeldioxidrestgehalt am Kesselende, d.h. im Kesselrohgas vor einer beispielsweise nassen Rauchgasreinigung, im stationären Betriebszustand über einen einfachen primären Regelkreis eingehalten werden.

[0011] Wird speziell Natriumbromid der Feuerung zugesetzt, so ist ein Mehrverbrauch an Schwefeldioxid zu beobachten, welcher auf die Sulfatierung des Natriumbromids im Hochtemperaturbereich zurückzuführen ist.

[0012] Andererseits stellt ein relativ hoher Gehalt einer schwefelhaltigen Verbindung, insbesondere an Schwefeldioxid, im Rauchgas keinen Nachteil für das erfindungsgemäße Verfahren dar. Ein hoher Gehalt an Schwefeldioxid kann beispielsweise bei der Verbrennung von Steinkohlen auftreten, welche üblicherweise zwischen 0,5 und 1 Gew.-% Schwefel enthalten, oder bei einer geregelten Zudosierung einer schwefelhaltigen Verbindung, welche zur Unterdrückung zwischenzeitlich gebildeter freier Halogene (s.o.) zugesetzt wird. Unter den gegebenen Bedingungen eines Hochtemperaturprozesses findet auch in Gegenwart von überschüssigem Schwefeldioxid die Oxidation des Quecksilbers statt, welche nach dem erfindungsgemäßen Verfahren durch den Zusatz einer oder mehrerer bromhaltiger Verbindungen erzielt wird. Darin liegt ein besonderer Vorteil des vorliegenden Verfahrens, denn die Oxidation des Quecksilbers durch den Zusatz von bromhaltigen Verbindun-

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gen zeigt sich – anders als durch den Zusatz von chlorhaltigen Verbindungen – weitgehend unempfindlich gegenüber einem Überschuss an Schwefeldioxid.

[0013] Die Zugabe einer bromhaltigen Verbindung sowie gegebenenfalls einer schwefelhaltigen Verbindung erfolgt erfindungsgemäß zur Feuerung und/oder zum Rauchgas in einem der Feuerung nachgeschalteten Anlagenteil, wobei die Temperatur beim Kontakt der bromhaltigen Verbindung mit dem Rauchgas mindestens 500°C, vorzugsweise mindestens 800°C, beträgt. Die bromhaltige Verbindung, z.B. Natriumbromid, kann entweder in fester, z.B. als Salz, oder flüssiger Form, z.B. als wässrige Lösung, dem zu verfeuernden Abfallgemisch, der Kohle oder dgl. vor der Feuerung beigemengt werden. Die Zugabe kann auch in einen der Feuerung vorgeschalteten Anlagenteil erfolgen, beispielsweise einer Pyrolysetrommel, welche z.B. dem thermischen Aufschluss mitverbrannter Abfallstoffe dient, oder einer Kohlemühle. Die Verbindung kann ebenso während des Verbrennungsprozesses zugeführt werden. Umfasst die Feuerung mehrere Stufen, z.B. eine primäre und eine sekundäre Feuerung, kann die bromhaltige Verbindung in eine oder beide Brennkammern, beispielsweise in den Drehrohrofen und/oder die Nachbrennkammer, ebenfalls in fester oder flüssiger Form eingeführt werden. Vorzugsweise wird eine wässrige Lösung der Verbindung in einer der Brennkammern eingedüst. Ferner kann die Zugabe auch nach der Verbrennung, z.B. in einem nachgeschalteten Abhitzekessel, erfolgen, sofern die Temperatur des Rauchgases ausreichend hoch ist, d.h. mindestens 500°C, insbesondere mindestens 800°C, beträgt. In anderen Hochtemperaturprozessen, wie z.B. dem Zementbrennen, wird beispielsweise der heiße Ofenkopf des Zementdrehrohrofens und/oder die befeuerte Entsäuerungsstufe des nachgeschalteten Zementrohmehlvorwärmers mit der bromhaltigen Verbindung bestückt.

[0014] In einer weiteren Ausführungsform des erfindungsgemäßen Verfahrens ist es auch möglich, die bromhaltige Verbindung, beispielsweise eine wässrige Lösung von Bromwasserstoff oder von Natriumbromid, fein dispergiert der Verbrennungsluft und/oder gegebenenfalls einem rückgeführten Teilstrom, insbesondere rückgeführtem Rauchgas, rückgeführter Asche und rückgeführten Flugstäuben, zuzuführen.

[0015] Um eine möglichst vollständige, insbesondere 100%ige, Oxidation des Quecksilbers durch die Zugabe einer bromhaltigen Verbindung zu erzielen, wird die bromhaltige Verbindung bevorzugt in einem Massenverhältnis von Brom zu Quecksilber im Bereich von 10^2 bis 10^4 zugegeben. Wird die bromhaltige Verbindung in großem Überschuss zugefügt, wirkt sich dies nicht nachteilig auf das erfindungsgemäße Verfahren aus. Ein zu großer Überschuss muss jedoch vermieden werden, nicht zuletzt aus Kostengründen. Gegebenenfalls müssen zwischenzeitlich gebildete freie Halogene, wie z.B. freies Brom, durch die Zugabe einer schwefelhaltigen Verbindung unterdrückt bzw. stabil eingebunden werden (s.o.), da auch Bromemissionen in der Regel gesetzlich festgelegten Grenzwerten unterliegen.

[0016] Die Oxidation von Quecksilber kann prinzipiell auch durch chlorhaltige oder jodhaltige Verbindungen erfolgen. Es zeigt sich jedoch, dass bromhaltige Verbindungen Quecksilber unter den gegebenen Bedingungen von Hochtemperaturprozessen, wie der Temperatur, und insbesondere auch bei einem hohen Gehalt an Schwefeldioxid (s.o.) wirksamer oxidieren als chlorhaltige Verbindungen. Jodhaltige Verbindungen oxidieren im Vergleich zu bromhaltigen Verbindungen Quecksilber wirksamer. Aus wirtschaftlichen Gesichtspunkten werden in dem erfindungsgemäßen Verfahren allerdings bromhaltige Verbindungen bevorzugt eingesetzt. Gegebenenfalls in den Abfallstoffen, z.B. in Sondermüll, vorliegende chlor- oder jodhaltige Verbindungen tragen demnach zur Oxidation des Quecksilbers bei. In einer bevorzugten Ausführungsform erfolgt das erfindungsgemäße Verfahren zusätzlich zu den bromhaltigen Verbindungen in Gegenwart von Chlor und/oder Jod und/oder einer chlorhaltigen Verbindung und/oder einer jodhaltigen Verbindung und/oder einem Gemisch solcher Verbindungen. Die chlorhaltige und/oder jodhaltige Verbindung kann beispielsweise in Form von chlor- oder jodreichen Abfallstoffen in Ergänzung zu oder unter teilweisem Ersatz der zugesetzten bromhaltigen Verbindung zugeführt werden.

[0017] Nach dem erfindungsgemäßen Verfahren folgt nach der Verbrennung oder einem ähnlichen Hochtemperaturprozess unter Zusatz einer bromhaltigen Verbindung eine Reinigung des Rauchgases, wodurch das oxidierte Quecksilber möglichst weitgehend aus dem Rauchgas abgeschieden wird. Verschiedene Rauchgasreinigungsverfahren zur Abscheidung von u.a. ionischem Quecksilber sind aus dem Stand der Technik bekannt. Sie basieren entweder auf einer Nasswäsche oder einer Trockenreinigung oder einer Kombination beider und kann ggf. mehrstufig sein. Die Nasswäsche umfasst z.B. eine saure Wäsche, welche beispielsweise in einer mit Kreislaufwaschwasser bedüsten Quenche, einem Druckdüsen- oder Rotationszerstäuberwäscher oder einem Füllkörperwäscher erfolgt. Eine Wäsche kann aber ggf. auch nur schwachsauer oder alkalisch ausgeführt sein, beispielsweise im Fall niedriger Chlorwasserstofffrachten, aber hoher Schwefeldioxidfrachten.

[0018] In einer bevorzugten Ausführungsform umfasst die Rauchgasreinigung eine mehrstufige nasse Rauchgaswäsche mit mindestens einer stark sauren (pH kleiner 1) und/oder mindestens einer schwach sauren (pH 3–4) und/oder mindestens einer alkalischen Waschstufe.

[0019] Die Rauchgasreinigung kann auch eine auf der Adsorption von ionischen Quecksilberverbindungen basierende Trockenreinigung umfassen. Eine solche Reinigung kann beispielsweise durch quasitrockene Entschwefelung in einem Sprühtrockner durchgeführt werden, welcher mit einer Kalkmilch-Kohle-Suspension beaufschlagt ist, oder mit Hilfe von Festbettadsorbern, z.B. auf Basis von körniger Aktivkohle oder von Herdofen-

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koks oder von Mischungen derartiger Adsorbentien mit gekörntem Kalk, oder mit Hilfe von Flugstromadsorbern, z.B. elektrostatischen Gasreinigungsfiltern (EGR-Filter), oder mit Hilfe von Gewebefiltern, welche mit einem eingeblasenen feinpulvrigen Kalkhydrat-Aktivkohle- oder Kalkhydrat-Herdofenkoks-Gemisch beaufschlagt sind. Auch Zeolithe eignen sich zur Abscheidung von quecksilberhaltigen Verbindungen. Im Bezug auf die trockene Rauchgasreinigung zeigt sich ein weiterer Vorteil des erfindungsgemäßen Verfahrens. Die Anwendung des Verfahrens ist insbesondere auch für jene Hochtemperaturanlagen interessant, welche über keine nasse Rauchgasreinigung, sondern ausschließlich über eine trockene Reinigung mit einer Quecksilbersorptionsstufe verfügen. Quecksilbercromid $HgBr_2$ adsorbiert stärker an Trockensorbentien als Quecksilberchlorid $HgCl_2$. Beispielsweise verstärkt sich die Adsorption von Quecksilber am Flugstaub von EGR-Filtern.

[0020] In einer bevorzugten Ausführungsform umfasst die Rauchgasreinigung daher mindestens eine trockene oder quasitrockene, auf Adsorption basierende Reinigungsstufe, insbesondere unter Verwendung von elektrostatischen oder filternden Staubabscheidern.

[0021] Des weiteren werden die mit Quecksilber beladenen Flugstäube aus gegebenenfalls vorhandenen Staubabscheidern zwecks Quecksilberentfrachtung vorzugsweise thermisch nachbehandelt, insbesondere in einer auf Temperaturen von mindestens 200°C beheizten Drehtrommel.

[0022] Bevorzugt wird in dem erfindungsgemäßen Verfahren der Quecksilbergehalt des Rauchgases, insbesondere der Gehalt an metallischem Quecksilber, nach der Rauchgasreinigung kontinuierlich gemessen und anhand des gemessenen Quecksilbergehalts die Menge an zugeführtem Brom und/oder bromhaltigen Verbindungen und/oder der Mischung bromhaltiger Verbindungen sowie gegebenenfalls Schwefel und/oder schwefelhaltigen Substanzen und/oder der Mischung schwefelhaltiger Substanzen geregelt. Ein relativ hoher Gehalt an metallischem Quecksilber im Rauchgas ist ein Indikator dafür, dass die Oxidation des Quecksilbers unvollständig verläuft und damit das Quecksilber in der Rauchgasreinigung unvollständig abgetrennt wird. Um Quecksilber möglichst vollständig zu oxidieren, muss in einem solchen Fall mehr bromhaltige Verbindung zugeführt werden. Zusätzlich kann der Gehalt an ionischem Quecksilber nach der Rauchgasreinigung gemessen werden und daraus der Abscheidegrad des ionischen Quecksilbers in der Rauchgasreinigung bestimmt werden. Der Gehalt an metallischem Quecksilber und ggf. an Quecksilber insgesamt im Kesselrohgas kann nach entsprechender Gasaufbereitung beispielsweise mit Hilfe eines Differenz-Absorptionsphotometers gemessen werden. Die kontinuierliche Messung von metallischem Quecksilber und ggf. auch von Quecksilber insgesamt im Reingas nach der nassen und/oder trockenen Rauchgasreinigung erfolgt vorzugsweise vor einer gegebenenfalls vorhandenen, nachgeschalteten SCR-Entstickungsanlage (SCR: selective catalytic reduction), da der metalloxidreiche Festbettkatalysator erhebliche Mengen an metallischem Quecksilber adsorbiert.

[0023] Nachfolgend wird die Erfindung anhand der Beispiele unter Bezugnahme auf die anliegenden Figuren näher erläutert. Es zeigen:

[0024] **Fig.** 1 ein Schema einer Sondermüllverbrennungsanlage

[0025] **Fig.** 2 ein Diagramm, welches den Gehalt von metallischem Quecksilber (Hg_{met}) im gewaschenen Kesselrauchgas, d.h. im Reingas, nach der Nasswäsche in $\mu g/m^3$ i. N. tr. (Kurve 21, linke Ordinate) sowie den Gesamtgehalt von Brom (Br_{ges}) im Kesselrauchgas in mg/m^3 i. N. tr. (Kurve **22**, rechte Ordinate) in Abhängigkeit von der Zeit darstellt,

[0026] **Fig.** 3 ein Diagramm, welches den Gesamtgehalt von Quecksilber (Hg_{ges}) im Kesselrauchgas, d.h. zugleich im Kesselrohgas, vor der Nasswäsche in $\mu g/m^3$ i. N. tr. (Kurve 31, linke Ordinate) sowie den Gehalt von metallischem Quecksilber (Hg_{met}) im Reingas nach der Nasswäsche in µg/m3 i. N. tr. (Kurve 32, rechte Ordinate) in Abhängigkeit von der Zeit darstellt,

[0027] **Fig. 4** ein Diagramm, welches den Gesamtgehalt von Brom (Br_{ges}) im Kesselrauchgas, d.h. zugleich im Kesselrohgas, vor der Nasswäsche in mg/m^3 i. N. tr. (Kurve 41, linke Ordinate) sowie den Gehalt von metallischem Quecksilber (Hg_{met}) im Reingas nach der Nasswäsche in $\mu g/m^3$ i. N. tr. (Kurve 42, rechte Ordinate) als Funktion der Zeit darstellt,

[0028] **Fig.** 5 ein Diagramm, welches das Massenverhältnis von Brom zu Quecksilber im Kesselrauchgas (Kurve 51, linke Ordinate) sowie den erzielten Gesamtabscheidegrad von Quecksilber in der mehrstufigen Nasswäsche in (Kurve 52, rechte Ordinate) als Funktion der Zeit darstellt,

[0029] **Fig.** 6 ein Diagramm, welches das Gewichtsverhältnis von metallischem Quecksilber zur Summe aus metallischem und ionischem Quecksilber (Hg_{met}/Hg_{ges}), d.h. den Hg_{met}-Speziesanteil im Kesselrohgas, in Gew.-% als Funktion des Gesamtgehaltes an Chlor (Kurve 61) bzw. an Brom (Kurve 62) im Kesselrohgas in mg/m^3 i. N. tr. darstellt,

[0030] **Fig.** 7 ein Diagramm, welches den Gesamtgehalt an Quecksilber (Hg_{ges}) im entstaubten Rohgas nach der elektrostatischen Gasreinigung (Kurve 71, linke Ordinate) bzw. den Gehalt an metallischem Quecksilber (Hg_{met}) nach der elektrostatischen Gasreinigung (Kurve 72, linke Ordinate) sowie die durch Quecksilberzudosierung herbeigeführte Anhebung des Gesamtgehalts an Quecksilber (Hg_{ges}) im Kesselrauchgas (Kurve 73, rechte Ordinate) als Funktion der Zeit darstellt,

[0031] **Fig.** 8 ein Diagramm, welches das Gewichtsverhältnis von metallischem Quecksilber (Hg_{met}) zu der Summe aus metallischem und ionischem Quecksilber (Hg_{ges}), d.h. den Hg_{met}-Speziesanteil (Hg_{met}/Hg_{ges}), im

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entstaubten Kesselrohgas nach der elektrostatischen Gasreinigung in Gew.-% (Kurve 82) sowie den Gesamtgehalt an Brom (Br_{ges}) im Kesselrauchgas in mg/m³ i. N. tr. (Kurve 81) als Funktion der Zeit darstellt.

[0032] **Fig.** 9 ein Schema eines Industriekraftwerks mit zwei Schmelzkammerkesseln.

Beispiele

[0033] Die Beispiele 1–4 wurden in einer dem Schema in **Fig.** 1 entsprechenden Sondermüllverbrennungsanlage der Bayer AG in Leverkusen durchgeführt. Der Drehrohrofen **3** als primärer Feuerraum wird mit Feststoffabfällen aus dem Bunker **1** über einen Krangreifer **2**, mit Flüssigabfällen aus einem Flüssigabfalltank sowie mit Abfallgebinden über eine Gebindeaufgabe befeuert. Auch die Nachbrennkammer **4** als sekundärer Feuerraum wird mit Flüssigabfällen befeuert. Das Rauchgas wird über den Abhitzekessel **5** abgekühlt und anschließend, als sogenanntes Kesselrohgas, der nassen Rauchgasreinigung (mehrstufige Wasche) zugeführt, welche eine Quenche **6**, einen sauren Rotationszerstäuberwäscher **7**, einen alkalischen Rotationszerstäuberwäscher **8** und eine elektrostatische Gasreinigung mit Wasserdampf-Teilkondensation **9** (KEGR) umfasst. Über Saugzüge **10** gelangt das gewaschene Rauchgas, als sogenanntes Reingas, in die nachgeschaltete katalytische Entstickungsanlage **11** (selektive katalytische Entstickung des Reingases mittels Ammoniak) und wird von dort über den Kamin **12** emittiert. Der Gehalt an metallischem Quecksilber (Hg_{met}) sowie gegebenenfalls der Gesamtgehalt an Quecksilber (Hg_{ges}) im gewaschenen Reingas nach KEGR wurde – nach entsprechender Aufbereitung – an der Messstelle **16** mit Hilfe eines Differenz-Absorptionsphotometers kontinuierlich bestimmt. Der Gehalt an Quecksilber insgesamt (Hgges) im emittierten Reingas wurde an der Messstelle **17**, d.h. in einer Kaminhöhe von 22 m, quasikontinuierlich bestimmt durch Amalgamierung an einer periodisch ausgeheizten Goldfolie mit nachfolgendem Differenz-Absorptionsphotometer.

[0034] Beispiel **5** beschreibt die Anwendung des erfindungsgemäßen Verfahrens in einem Kohlekraftwerk der Bayer AG in Uerdingen, welches im Wesentlichen einen Schmelzkammerkessel und eine kraftwerkstypische Rauchgasreinigung, bestehend aus einer trockenen elektrostatischen Gasreinigung (EGR), einem schwachsauren, auf Kalkstein basierten Nasswäscher zur Rauchgasentschwefelung sowie einer SCR-Entstickungsanlage (SCR: selective catalytic reduction), umfasst.

Ausführungsbeispiel

Beispiel 1

[0035] Über einen Zeitraum von 116 Minuten wurde dem sekundären Feuerraum (Nachbrennkammer **4**) über die Schauluke **15** eine Serie von Proben von metallischem Quecksilber in Kunststoffkapseln zugeführt (in Summe 3400 g, siehe Tabelle 1). Die Zugabe erfolgte in Abständen von ca. 5–10 Minuten mit zunehmender Quecksilbermenge. Das eingeworfene Quecksilber verdampft innerhalb von ca. 2–4 Minuten; demzufolge können die im Kesselrauchgas mit einem Volumenstrom von ca. 45·103 m³ i. N. tr./h aufgetretenen momentanen Spitzenkonzentrationen an Quecksilber abgeschätzt werden. Die Abschätzung liefert zum Versuchsende hin Spitzenkonzentrationen von mehr als $130 \cdot 10^3$ µg/m³ i. N. tr.

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Tabelle 1: Zugabe der Hg-Proben

Uhrzeit	Hg-Menge [g]	Uhrzeit	Hg-Menge [g]
9:24	5	10:32	180
9:32	10	10:37	200
9:38	15	10:43	220
9:49	20	10:48	240
9:54	40	10:53	260
9:59	60	10:58	280
10:04	80	11:03	300
10:09	100	11:08	310
10:15	120	11:13	320
10:20	140	11:20	340
10:26	160		
Versuchsdauer [min]		**Hg-Gesamtmenge [g]**	
116		**3400**	

[0036] Während des Versuchszeitraums wurde durch Mitverbrennung eines hochbromierten Flüssigabfalls (Zugabe zum Drehrohrofenkopf) im Kesselrauchgas von $45 \cdot 10^3$ m³ i.N. tr./h ein Bromgehalt von ca. $4 \cdot 10^3$ mg/m³ i. N. tr. aufrechterhalten, wie die Kurve 22 (rechte Ordinate) in **Fig.** 2 zeigt (Bestimmung anhand des Durchsatzes und Bromgehaltes des hochbromierten Flüssigabfalls). Der Rest-SO_2-Gehalt im Kesselrohgas vor der Quenche war dabei mittels Zudosierung von Schwefelgranulat zum Drehrohrofenkopf auf $5{,}5 \cdot 10^3$ mg/Nm³ i. N. tr. ungewöhnlich hoch eingestellt (direkte SO_2-Messung im Kesselrohgas vor der Quenche). Damit war sichergestellt, dass für das erfindungsgemäße Verfahren ein ausreichendes Angebot an Schwefeldioxid vorhanden war. Das sonstige Verbrennungsgut bestand aus Festabfällen und schwachchlorierten Lösemitteln. Vor, während und nach der Quecksilberzugabe wurde an der Messstelle **16**, d.h. nach der Rauchgasreinigung, der Gehalt an Quecksilber im Rauchgas gemessen. Wie die Kurve **21** (linke Ordinate) in **Fig.** 2 zeigt, steigt trotz der Zugabe von erheblichen Quecksilbermengen der Gehalt an metallischem Quecksilber, welches durch die Wäsche durchschlägt, praktisch nicht an.

[0037] Darüber hinaus sind in Tabelle 2 die momentanen Austragungsströme von Quecksilber um 11:30 Uhr, d.h. kurz nach der Zugabe der letzten Quecksilberprobe und damit zum Zeitpunkt der höchsten Quecksilberkonzentration, aufgeführt, welche mit den Wäscherabwässern der nassen Rauchgasreinigung ausgetragen wurden. Umfangreiche abwasserseitige Messungen belegen, dass ca. 99,93 % des insgesamt ausgetragenen Quecksilbers als ionisches Quecksilber mit dem Abwasser der stark sauren Quenche (pH-Wert kleiner 1) und ca. 0,066 % mit dem Abwasser des alkalischen Rotationszerstäuberwäschers (pH-Wert ca. 7,5) ausgetragen wurden. Der geringe, nicht ausgewaschene Rest von nur 0,004 % des insgesamt ausgetragenen Quecksilbers wurde mit dem gewaschenen Reingas als metallisches Quecksilber ausgetragen. Nachweislich war im gewaschenen Reingas praktisch kein Hg_{ion} zu finden (Hg_{ion} = Null, d.h. vollständige Auswaschung des ionischen Quecksilbers und somit $Hg_{ges} = Hg_{met}$).

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Tabelle 2: Momentane Quecksilber-Austragungsströme [g/h] um 11:30 Uhr

Quenche (einschließlich dem sauren Rotationszerstäuberwäscher)	1931
(Saurer Rotationszerstäuberwäscher, dessen Abwasser zur Quenche rückgeführt wird)	(468)
Alkalischer Rotationszerstäuberwäscher	1,32
Gewaschenes Reingas nach KEGR	0,069

Beispiel 2:

[0038] Über einen Zeitraum von 130 Minuten wurde dem sekundären Feuerraum (Nachbrennkammer **4**) über eine Düse in der Nachbrennkammerdecke kontinuierlich eine wässrige $HgCl_2$-Lösung zugeführt. Dabei wurde die zudosierte Menge in Zeitschritten von etwa 5 Minuten angehoben. **Fig.** 3 zeigt den so herbeigeführten Anstieg der Konzentration von Quecksilber im Kesselrauchgas in der Zeit zwischen ca. 10:45 und 13:00 Uhr. Das eindosierte Quecksilber wird in der Nachbrennkammer unverzüglich als metallisches Quecksilber Hg_{met} freigesetzt. Die Gesamtkonzentration von Quecksilber im Kesselrauchgas stieg auf diese Weise bis auf Werte von $18 \cdot 10^3$ µg/m³ i. N. tr. an (Kurve **31** und linke Ordinate). Die Hg-Konzentration im Kesselrauchgas wurde aus dem zugegebenen Quecksilbermengenstrom und dem betrieblich gemessenen Rauchgasvolumenstrom berechnet. Während des Versuchszeitraums wurde durch Mitverbrennung eines hochbromierten Flüssigabfalls (Zugabe über einen Brenner am Drehrohrofenkopf) im Kesselrauchgas von $45 \cdot 10^3$ m³ i.N. tr./h ein Bromgehalt von ca. $9 \cdot 10^3$ mg/m³ i. N. tr. aufrechterhalten (Bestimmung anhand des Durchsatzes und Bromgehalt des mitverbrannten hochbromierten Flüssigabfalls). Der Rest-SO_2-Gehalt im Kesselrohgas vor Quenche war dabei mittels Zudosierung von Schwefelgranulat zum Drehrohrofenkopf auf ca. $4 \cdot 10^3$ mg/Nm³ i. N. tr. eingestellt (direkte SO_2-Messung im Kesselrohgas vor der Quenche).

[0039] Im Zeitraum zwischen ca. 11:00 und 13:00 Uhr wurde im gewaschenen Reingas nach der KEGR eine Konzentration von metallischem Quecksilber von weniger als 10 µg/m³ i. N. tr. beobachtet. Nachweislich war im gewaschenen Reingas auch hier praktisch kein Hg_{ion} zu finden (Hg_{ion} = Null, d.h. vollständige Auswaschung des ionischen Quecksilbers und somit $Hg_{ges} = Hg_{met}$). Bei einem kurzzeitigen Ausfall der Bromzugabe gegen 13:05 Uhr stieg die Konzentration von Hg_{met} sprunghaft auf ca. 800 µg/m³ i. N. tr. an und kehrte aber unverzüglich auf ihren niedrigen Ausgangswert von weniger als 10 µg/m³ i. N. tr. zurück, als die Bromzugabe wieder einsetzte (Kurve **32** und rechte Ordinate).

Beispiel 3:

[0040] In der Zeit zwischen ca. 8:30 und 14:45 Uhr, d.h. über einen Zeitraum von 675 Minuten, wurde dem sekundären Feuerraum (Nachbrennkammer **4**) über eine Düse in der Nachbrennkammerdecke kontinuierlich eine wässrige $HgCl_2$-Lösung zugeführt. Dabei wurde nunmehr aber der zudosierte Hg-Mengenstrom konstant gehalten, entsprechend einer Konzentration von Quecksilber im Kesselrauchgas von ca. $9{,}6 \cdot 10^3$ µg/m³ i. N. tr.

[0041] In diesem Versuchszeitraum (vgl. **Fig.** 4 bzw. **Fig.** 5) wurde Brom in Form eines hochbromierten Flüssigabfalls über einen Brenner am Drehrohrofenkopf zugegeben, jedoch wurde die zugegebene Brommenge schrittweise verringert, womit der Bromgehalt im Kesselrauchgas stufenweise von ca. $9 \cdot 10^3$ auf ca. $3 \cdot 10^3$ mg/m³ i. N. tr. abgesenkt wurde (Kurve **41** in **Fig.** 4 und linke Ordinate). Der mittels Zudosierung von Schwefelgranulat herbeigeführte Rest-SO_2-Gehalt im Kesselrohgas war mit ca. $4{,}3 \cdot 10^3$ mg/m³ i. N. tr in diesem Versuchszeitraum wiederum sehr hoch gewählt worden. Neben dem hochbromierten Flüssigabfall wurde auch ein chlorierter Flüssigabfall mitverbrannt.

[0042] Wie **Fig.** 4 bzw. **Fig.** 5 zu entnehmen ist, war der Gehalt an metallischem Quecksilber im gewaschenen Reingas nach KEGR deutlich kleiner als 2 µg/m³ i. N.

[0043] tr. (Kurve **42** in **Fig.** 4 und rechte Ordinate). Nachweislich war im gewaschenen Reingas auch hier praktisch kein Hg_{ion} zu finden (Hg_{ion} = Null, d.h. vollständige Auswaschung des ionischen Quecksilbers und somit $Hg_{ges} = Hg_{met}$). Entsprechend war der Abscheidegrad von Quecksilber in der Nasswäsche deutlich größer als 99,98 % (Kurve **52** in **Fig.** 5 und rechte Ordinate), solange der Bromgehalt gößer als $3 \cdot 10^3$ mg/m³ i. N. tr.

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(Kurve **41** und linke Ordinate) bzw. das Brom-Quecksilber-Massenverhältnis größer als 500 µg Brom/µg Quecksilber betrug (Kurve **51** in **Fig.** 5 und linke Ordinate). Gegen 13:30 Uhr sinkt der Bromgehalt im Rauchgas auf $3 \cdot 10^3$ mg/m³ i. N. tr. bzw. das Brom-Quecksilber-Massenverhältnis auf ca. 335 µg Brom/µg Quecksilber. Dabei steigt die Konzentration von metallischem Quecksilber nach der Nasswäsche auf bis zu 20 µg/m³ i. N. tr. (Kurve **42** in **Fig.** 4 und linke Ordinate) bzw. nimmt der Hg-Abscheidegrad auf 99,8 % ab (Kurve **52** in **Fig.** 5 und rechte Ordinate). Darüber hinaus führt eine kurzzeitige Unterbrechung der Chlor-Zugabe kurz nach 14:30 Uhr zu einer Spitzenkonzentration von metallischem Quecksilber nach der Wäsche von ca. 117 µg/m³ i. N. tr. (Kurve **42** in **Fig.** 4 und linke Ordinate) bzw. zu einem kurzzeitigen Abfall des Abscheidegrades auf ca. 98,4 % (Kurve **51** in **Fig.** 5 und rechte Ordinate). Hieran wird die gegenüber Brom vergleichsweise geringe Wirkung von Chlor deutlich.

Beispiel 4:

[0044] **Fig.** 6 illustriert einen Versuch zum Vergleich der Wirkung von Brom und Chlor auf die Oxidation von Quecksilber im Kesselrauchgas der oben beschriebenen Sondermüllverbrennungsanlage. Dabei lagen ein durch Zudosierung von $HgCl_2$ eingestellter Hgges Gehalt von 130 µg/m³ i. N. tr. bei einem durch Mitverbrennung chlorarmer Lösemittel eingestellten Chlorgehalt (Cl_{ges}) im Kesselrauchgas von $1{,}35 \cdot 10^3$ mg/m³ i. N. tr. sowie einem durch Zudosierung von Schwefelgranulat eingestellten Restgehalt an Schwefeldioxid im Kesselrohgas von $1{,}5 \cdot 10^3$ mg/m³ i. N. tr. vor. Der Messpunkt **63** zeigt den zunächst ohne Bromzusatz, d.h. allein durch Chlor, erzielten Hg_{met}-Speziesanteil von ca. 63 Gew.-% im Kesselrohgas vor der Nasswäsche. Die anlagenspezifische Kurve **61**, welche auf ca. 20 Betriebsversuchen an einer Sondermüllverbrennungsanlage mit Verbrennung hochchlorierter Flüssigabfälle basiert, zeigt, wie der Hgmet-Speziesanteil (Hg_{met}/Hg_{ges}) mit wachsendem Chlorgehalt Cl_{ges} im Kesselrauchgas zurückgeht.

[0045] Ausgehend von einem Hgmet-Speziesanteil von ca. 63 Gew.-% im Kesselrohgas vor der Nasswäsche (Messpunkt **63** mit Cl_{ges}-Gehalt als Abszisse bzw. Messpunkt **63'** mit Brges Gehalt als Abszisse) wurde dann in drei Schritten eine zunehmende Menge einer bromhaltigen Verbindung zudosiert (vgl. Pfeil **64**, der den Übergang von der Darstellung des Hg_{met}-Speziesanteil in Abhängigkeit von dem Cl_{ges} Gehalt zu der Darstellung in Abhängigkeit von dem Br_{ges}-Gehalt markiert). Dabei wurde der Bromgehalt im Kesselrauchgas von zunächst 0 mg/m³ i. N. tr. (Messpunkt **63'** mit Br_{ges}-Gehalt als Abszisse) durch Zudosierung von wässriger Bromwasserstofflösung bzw. von wässriger Natriumbromidlösung (Eindüsung an der Nachbrennkammerdecke **14**, **Fig.** 1) in drei Schritten auf 50, 100 und 120 mg/m³ i. N. tr. (Messpunkte **62** mit Brges Gehalt als Abszisse) angehoben. Dabei ging der Hg_{met}-Speziesanteil (Hg_{met}/Hg_{ges}) im Kesselrohgas vor der Nasswäsche – ausgehend von ca. 63 Gew.-% – bis auf 30 Gew.-% zurück.

[0046] Der Vergleich weist die deutlich effektivere Oxidation des Quecksilbers durch bromhaltige Verbindungen im Vergleich zu chlorhaltigen Verbindungen am Beispiel einer Sondermüllverbrennungsanlage nach. Um allein mittels Chlor einen Hg_{met}-Speziesanteil von nur 30 Gew.-% zu erreichen, müsste man den Cl_{ges}-Gehalt gemäß der Chlorierungskurve **61** auf $4 \cdot 10^3$ mg/m³ i. N. tr. erhöhen. Statt dessen erreicht man dies mit nur 120 mg/m³ i. N. tr. an Brom. Brom erscheint daher etwa 25-fach wirksamer als Chlor. Die Hg-Bromierungskurve **65** (Br_{ges}-Gehalt als Abszisse) entspricht unter Berücksichtigung dieses Faktors der vollständig vermessenen Hg-Chlorierungskurve **61** (Cl_{ges}-Gehalt als Abszisse). Gleiches gilt für im Fall von Kraftwerksrauchgasen, wo allerdings die anlagenspezifische Hg-Chlorierungskurve und die entsprechende Hg-Bromierungskurve **65** zu wesentlich niedrigeren Halogengehalten hin verschoben sind.

Beispiel 5:

[0047] **Fig.** 7 und **Fig.** 8 illustrieren Versuche zum Nachweis der Wirkung von Brom auf die Quecksilberabscheidung in einem Kohlekraftwerk der Bayer AG in Uerdingen (vgl. **Fig.** 9). In dem Kohlekraftwerk erfolgte ein Versuch mit Zudosierung von wässriger $HgCl_2$-Lösung und von wässriger NaBr-Lösung in den Feuerraum zum Nachweis der Wirkung von Brom auf die Hg-Oxidation. Das Kraftwerk umfasst zwei parallele Schmelzkammerkessel **91**, **91'** mit Temperaturen im Feuerraum um 1450°C. Die Schmelzkammerkesssel **91**, **91'** werden mit Kohle **92**, **92'** bestückt. Über die jeweiligen Lufvorwärmer **93**, **93'** wird den Schmelzlkammerkesseln **91**, **91'** Frischluft **94**, **94'** zugeführt. Das Kesselrohgas **95**, **95'** wird über elektrostatische Gasreiniger (EGR) **96**, **96'** dem gemeinsamen schwachsauren (pH = 5,3) Nasswäscher als Rauchgasentschwefelungsanlage (REA-Wäscher) **97** zugeführt. Das gewaschene Kesselrauchgas (Reingas) wird anschließend in zwei parallele katalytisch wirkende Entstickungsanlagen (SCR-Entstickungsanlage) **98**, **98'** überführt, bevor es über Kamine **100**, **100'** emittiert wird. Der in den EGR abgeschiedene Flugstaub **99**, **99'** wird zu 100 % in die Feuerung des jeweiligen Schmelzkammerkessels zurückgeführt. An der Messstelle **101** nach der EGR **96** wurden die Gehalte an Hg_{met} und Hgges im entstaubten Kesselrohgas kontinuierlich erfasst.

[0048] Es wurde kein Schwefel zudosiert. Der Gehalt an Schwefeldioxid im Kesselrauchgas von $1{,}3 \cdot 10^3$ i. N. tr. resultierte ausschließlich aus dem verbrannten Kohleschwefel selbst. Der Gesamtquecksilbergehalt im ent-

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staubten Rohgas nach der EGR, d.h. vor der Nasswäsche, betrug zu Beginn bei reiner Kohleverbrennung (polnische Steinkohle) im Mittel nur 22,5 µg/m^3 i. N. tr., vgl. **Fig.** 7, Kurve **71** (Gesamtgehalt an Quecksilber Hg_{ges}) um 8:30 Uhr, der Gehalt an metallischem Quecksilber im Mittel nur 8,8 µg/m^3 i. N. tr., vgl. **Fig.** 7, Kurve **72** (Gehalt an metallischem Quecksilber Hg_{met}) um 8:30 Uhr. Die Zahnung beider Kurven **71**, **72** im 10-Minuten-Takt beruht auf der regelmäßigen Abklopfung der EGR; wodurch unmittelbar nach Abreinigung der Staubschichten im entstaubten Kesselrohgas hinter der EGR höhere Gehalte auftreten. Um 9:15 Uhr wurde mit der Zudosierung von Quecksilber (als wässrige $HgCl_2$-Löung) und um 10:30 dann auch mit der Zudosierung von Brom (als wässrige NaBr-Lösung) in den Feuerraum begonnen. Die Kurve **73** (**Fig.** 7, rechte Ordinate) stellt die durch Zudosierung von Quecksilber herbeigeführte Erhöhung des Hg_{ges}-Gehalts im Kesselrauchgas dar. Zwischen ca. 9:30 und 13:00 Uhr betrug die mittels $HgCl_2$-Zudosierung herbeigeführte Anhebung des Gesamtgehalts an Quecksilber im Rauchgas vor der EGR mindestens ca. 220 µg/m^3 i. N. tr. (Kurve **73**, rechte Ordinate). Die Kurve **81** in **Fig.** 8 stellt die durch Zudosierung von wässriger NaBr-Lösung herbeigeführte Erhöhung des Br-Gehalts im Kesselrauchgas dar. Um 10:30 Uhr wurde der Bromgehalt im Rauchgas vor der EGR zunächst um mindestens 75 mg/m^3 i. N. tr. angehoben und schrittweise wieder abgesenkt. Um 16:10 Uhr erfolgte eine neuerliche Anhebung des Bromgehalts um ca. 43 mg/m^3 i. N. tr. Wegen der Rückführung der Flugasche in die Schmelzkammerfeuerung und somit auch der Rückführung von an der Flugasche sorbiertem Quecksilber bzw. Brom handelt es sich hierbei um Mindestanhebungen, wie sie sich aus den zudosierten Mengenströmen und dem Rauchgasvolumenstrom (ca. $110 \cdot 10^3$ m^3 i. N. tr./h) ergeben. Die tatsächlichen Hg- und Br-Gehalte im Rohgas vor der EGR liegen demzufolge (Kreislauf zwischen Schmelzkammerfeuerung und EGR) etwas höher.

[0049] Die Kurven **71** bzw. **72** (linke Ordinate) in **Fig.** 7 zeigen, wie mit dem Zusatz der bromhaltigen Verbindung der Gehalt an Quecksilber im Rauchgas deutlich zurückgeht. Dies gilt einerseits für das ionische Quecksilber (Differenz zwischen Hg_{ges} und Hg_{met}), welches in Anwesenheit der bromhaltigen Verbindung vermehrt gebildet und offensichtlich am rückgeführten Flugstaub adsorbiert wird, und gilt andererseits aber stärker noch für das metallische Quecksilber, dessen Gehalt im entstaubten Rohgas nach EGR trotz des Zusatzes von Quecksilber annähernd auf den Ausgangsgehalt vor der Quecksilberzugabe zurückkehrt. Von 10:30 Uhr bis 13:00 Uhr (Ende der Br-Zudosierung) und weit darüber hinaus betrug der Gehalt an Hg_{met} weniger als 10 µg/m^3 i. N. tr. Erst mit dem Ende der neuerlichen Zugabe der Natriumbromidlösung gegen 19:00 Uhr steigt der Gehalt von Hg_{ges} deutlich an. Weiterhin zeigt die Kurve **82** in **Fig.** 8 den zunächst schlagartigen Rückgang des Speziesanteils an metallischem Quecksilber mit der Zugabe von Brom (Absenkung von ca. 40 Gew.-% auf ca. 10 Gew.-% gegen 10:30 Uhr). Entsprechendes zeigt sich nach ca. 17:00 Uhr bei der neuerlichen Quecksilber- und Bromzugabe an dem allmählichen Rückgang des Hg_{met}-Speziesanteils bis auf nur ca. 5 Gew.-% gegen 20:45 Uhr. Infolge der Hg-Zudosierung und der verstärkten Hg-Adsorption stieg der Hg-Gehalt im zur Schmelzkammer rückgeführten EGR-Flugstaub von anfänglich ca. 2–5 mg/kg im Laufe des Versuchs auf 55 mg/kg an.

Patentansprüche

1. Verfahren zur Abscheidung von Quecksilber aus Rauchgasen von Hochtemperaturanlagen, insbesondere von Kraftwerken und Abfallverbrennungsanlagen, **dadurch gekennzeichnet**, dass
– der, gegebenenfalls mehrstufigen, Feuerung und/oder dem Rauchgas in einem der Feuerung nachgeschalteten Anlagenteil Brom und/oder eine bromhaltige Verbindung und/oder eine Mischung verschiedener bromhaltiger Verbindungen zugeführt wird, wobei die Temperatur beim Kontakt der bromhaltigen Verbindung mit dem Rauchgas mindestens 500°C, vorzugsweise mindestens 800°C, beträgt,
– die Verbrennung in Gegenwart einer schwefelhaltigen Verbindung, insbesondere Schwefeldioxid, gegebenenfalls unter Zusatz von Schwefel und/oder einer schwefelhaltigen Verbindung und/oder einer Mischung verschiedener schwefelhaltiger Verbindungen erfolgt
– und anschließend das Rauchgas einer, gegebenenfalls mehrstufigen, Reinigung zur Abtrennung von Quecksilber aus dem Rauchgas unterzogen wird, welche eine Nasswäsche und/oder eine Trockenreinigung umfasst.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die bromhaltige Verbindung eine wässrige Lösung von Bromwasserstoff und/oder ein Alkalibromid, insbesondere Natriumbromid, und/oder eine wässrige Lösung von Alkalibromid ist.

3. Verfahren nach einem der Ansprüche 1 bis 2, dadurch gekennzeichnet, dass die bromhaltige Verbindung und/oder die Mischung bromhaltiger Verbindungen flüssige und/oder feste bromreiche Abfallstoffe sind.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass das Brom und/oder die bromhaltige Verbindung und/oder die Mischung bromhaltiger Verbindungen der Verbrennungsluft und/oder gegebenenfalls einem rückgeführten Teilstrom, insbesondere dem rückgeführtem Rauchgas und den rückgeführten Flugstäuben, zugesetzt wird.

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5. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, dass das Massenverhältnis von Brom zu Quecksilber im Bereich von 10^2 bis 10^4 liegt.

6. Verfahren nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, dass die Verbrennung zusätzlich in Gegenwart von Chlor und/oder einer chlorhaltigen Verbindung und/oder einer Mischung verschiedener chlorhaltiger Verbindungen und/oder Jod und/oder einer jodhaltigen Verbindung und/oder einer Mischung verschiedener jodhaltiger Verbindungen durchgeführt wird.

7. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, dass die Rauchgasreinigung eine mehrstufige nasse Rauchgaswäsche mit mindestens einer stark sauren und/oder mindestens einer schwach sauren und/oder alkalischen Waschstufe umfasst.

8. Verfahren nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass die Rauchgasreinigung mindestens eine trockene oder quasitrockene, auf Adsorption basierende Reinigungsstufe umfasst, insbesondere unter Verwendung von elektrostatischen oder filternden Staubabscheidern.

9. Verfahren nach Anspruch 8, dadurch gekennzeichnet, dass die mit Quecksilber beladenen Flugstäube aus gegebenenfalls vorhandenen Staubabscheidern zwecks Quecksilberentfrachtung thermisch nachbehandelt wird, insbesondere in einer auf Temperaturen von mindestens 200°C beheizten Drehtrommel.

10. Verfahren nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, dass der Quecksilbergehalt des Rauchgases, insbesondere der Gehalt an metallischem Quecksilber, nach der Rauchgasreinigung kontinuierlich gemessen wird und anhand des gemessenen Quecksilbergehalts die Menge an zugeführtem Brom und/oder bromhaltigen Verbindungen sowie gegebenenfalls Schwefel und/oder schwefelhaltigen Verbindungen geregelt wird.

Es folgen 9 Blatt Zeichnungen

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Anhängende Zeichnungen

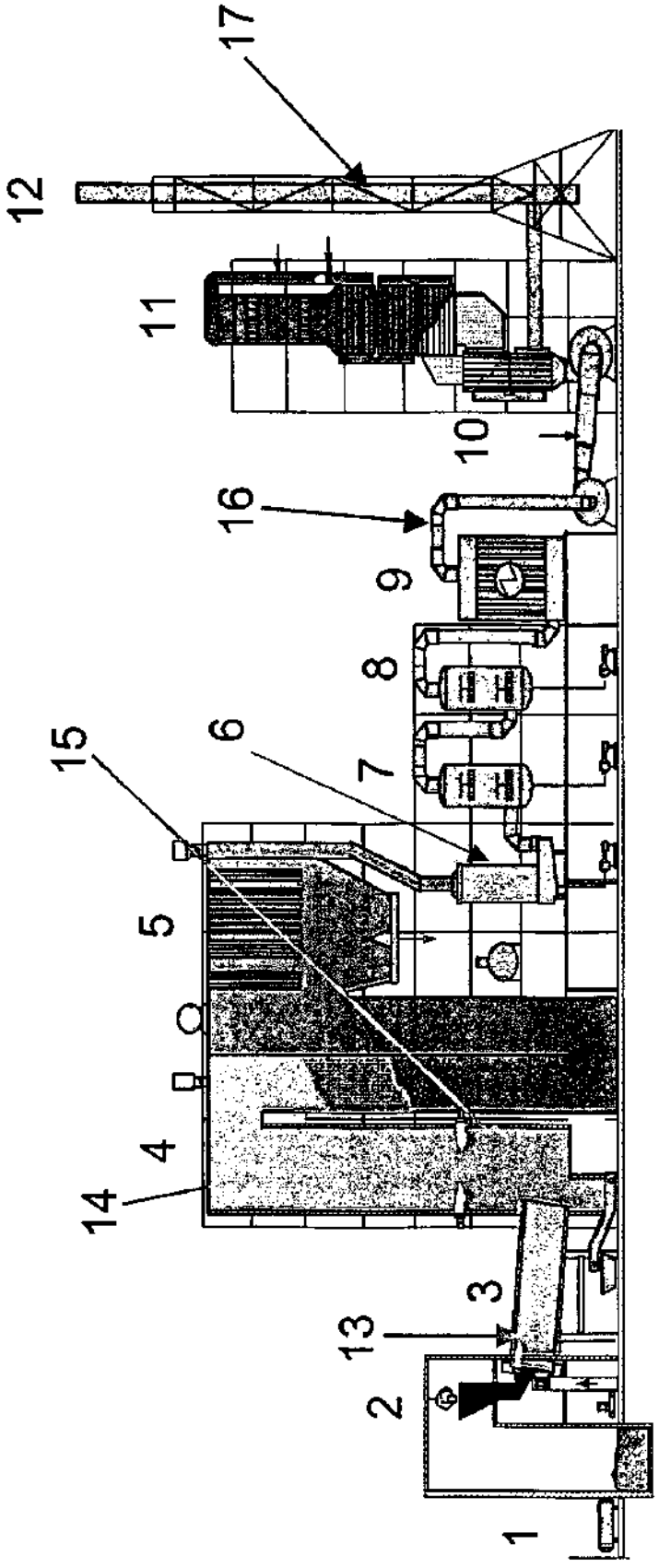


Fig. 1

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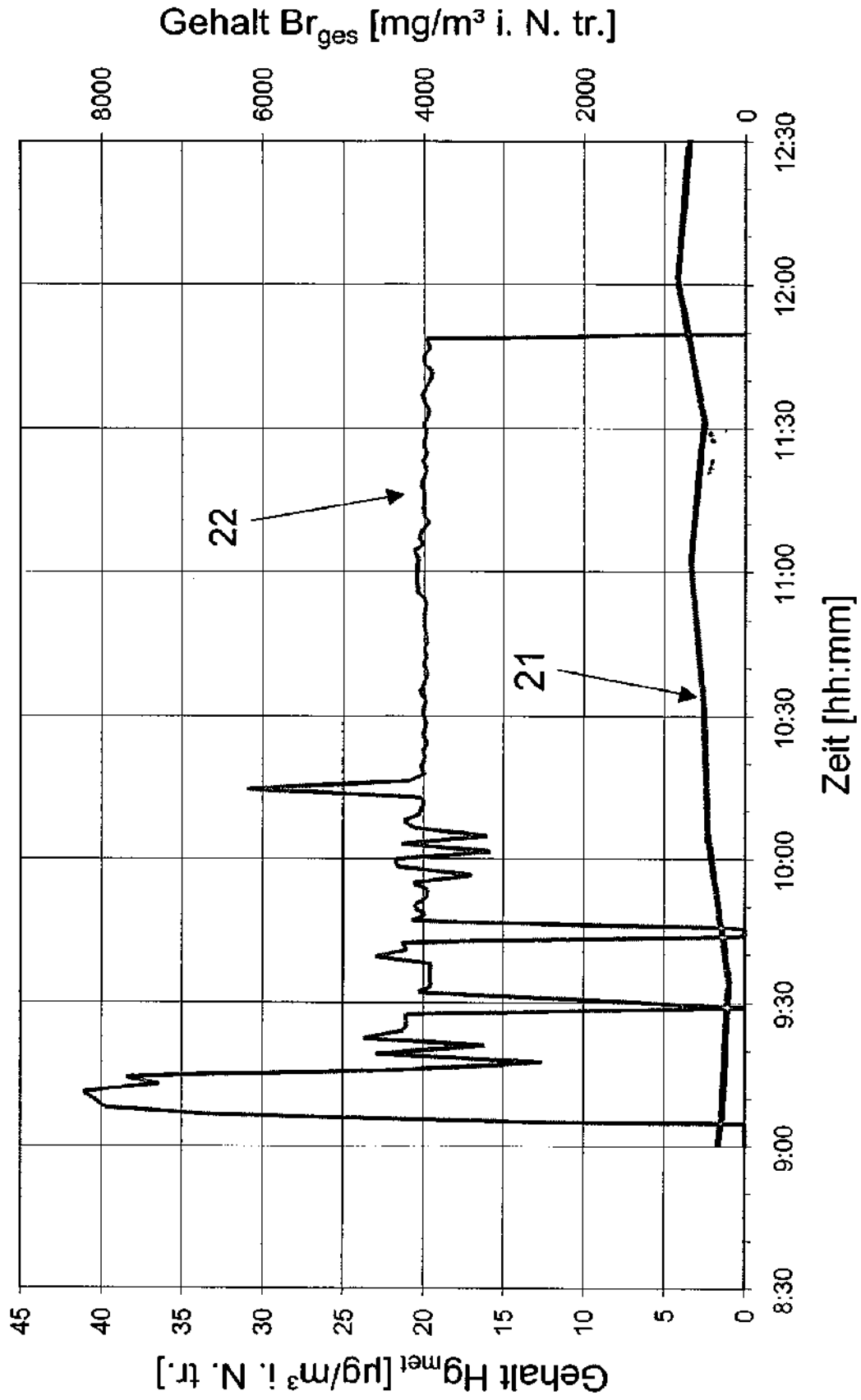

Gehalt Br_{ges} [mg/m³ i. N. tr.]
8000
6000
4000
2000
0
12:30
12:00
11:30
11:00
10:30
10:00
9:30
9:00
8:30
Zeit [hh:mm]
22
21
Gehalt Hg_{met} [µg/m³ i. N. tr.]
45
40
35
30
25
20
15
10
5
0

Fig. 2

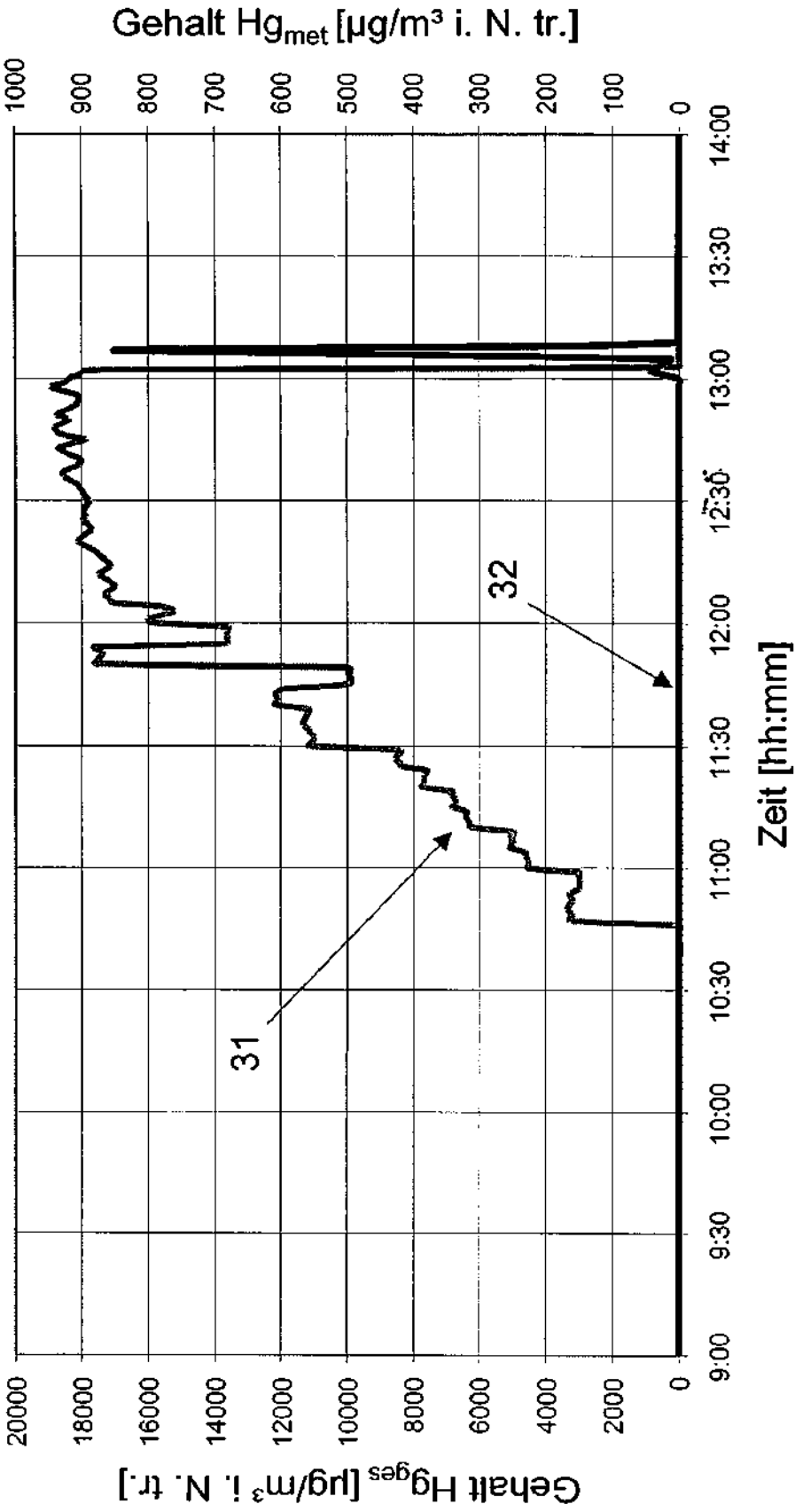


Fig. 3

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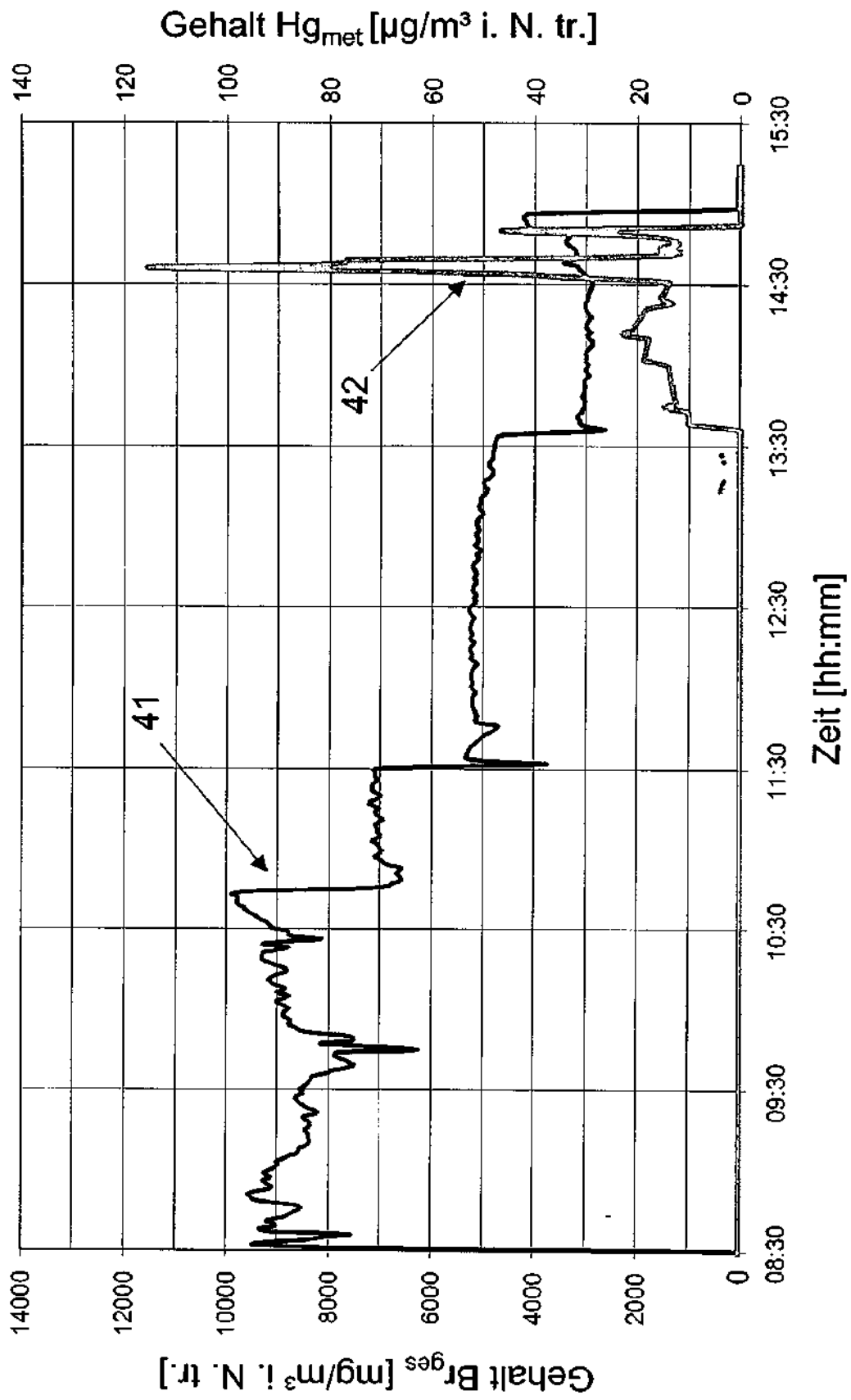

Gehalt Hg_{met} [µg/m³ i. N. tr.]
140
120
100
80
60
40
20
0
15:30
14:30
13:30
12:30
11:30
10:30
09:30
08:30
Zeit [hh:mm]
14000
12000
10000
8000
6000
4000
2000
0
Gehalt Br_{ges} [mg/m³ i. N. tr.]
41
42

Fig. 4

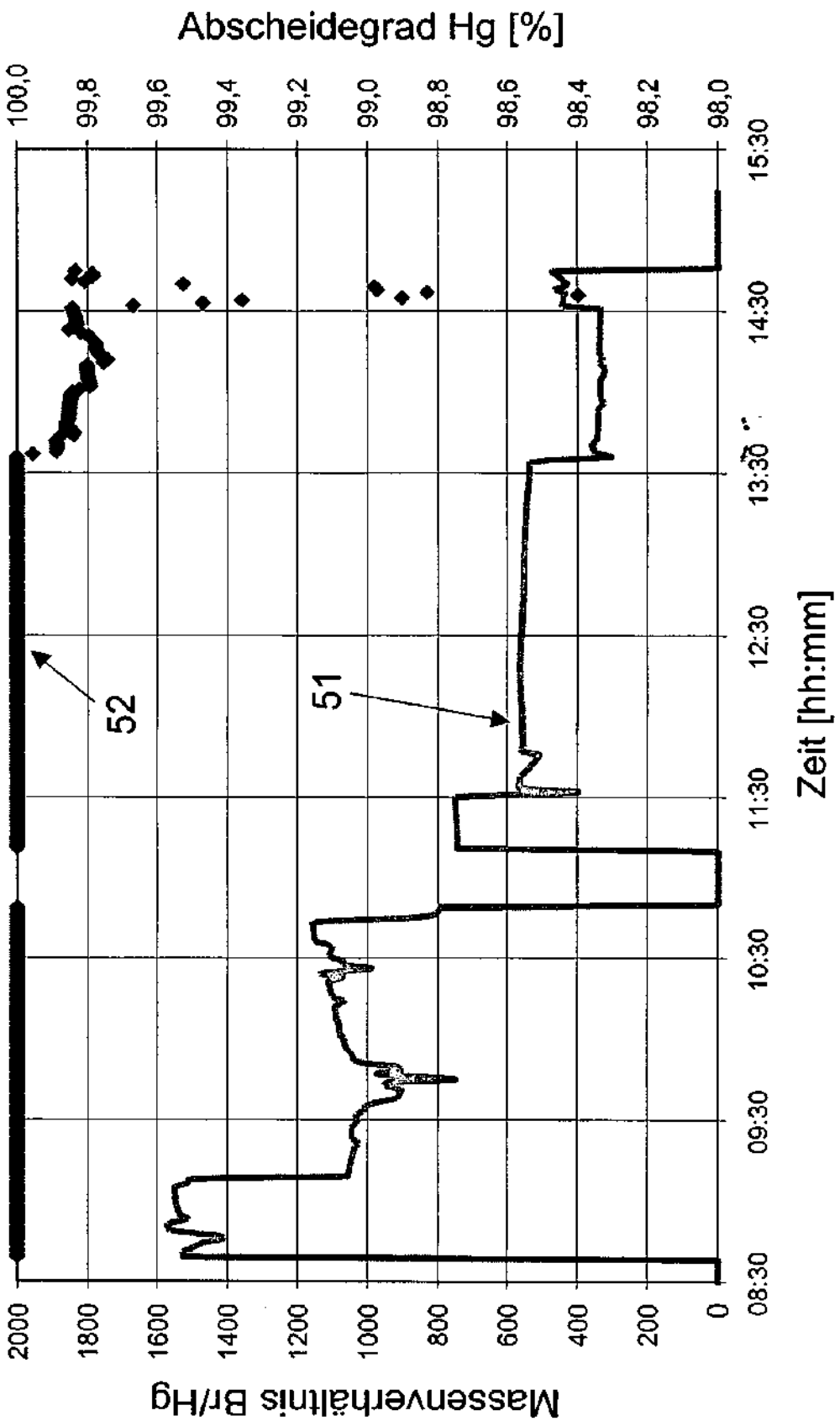


Fig. 5

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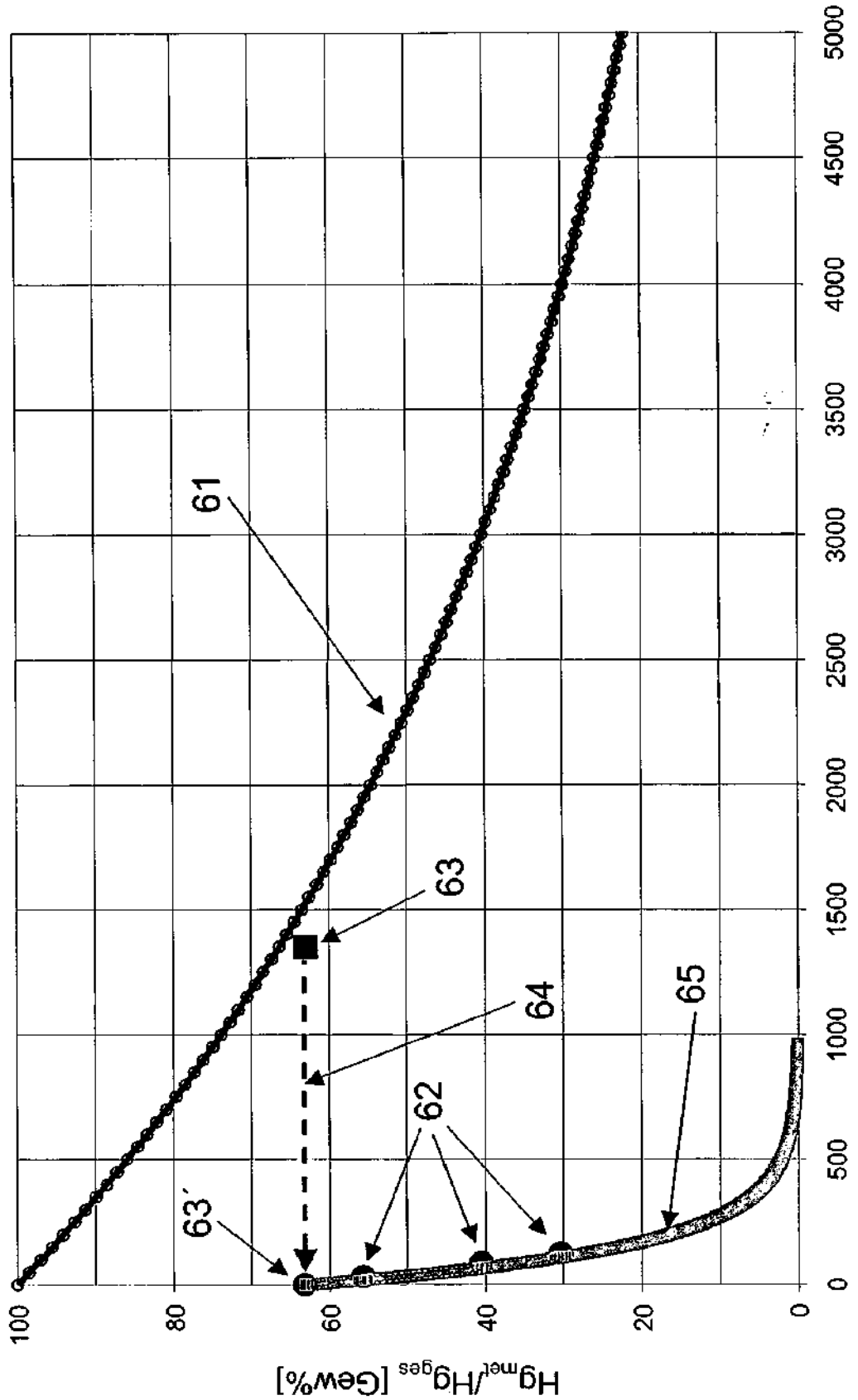


Fig. 6

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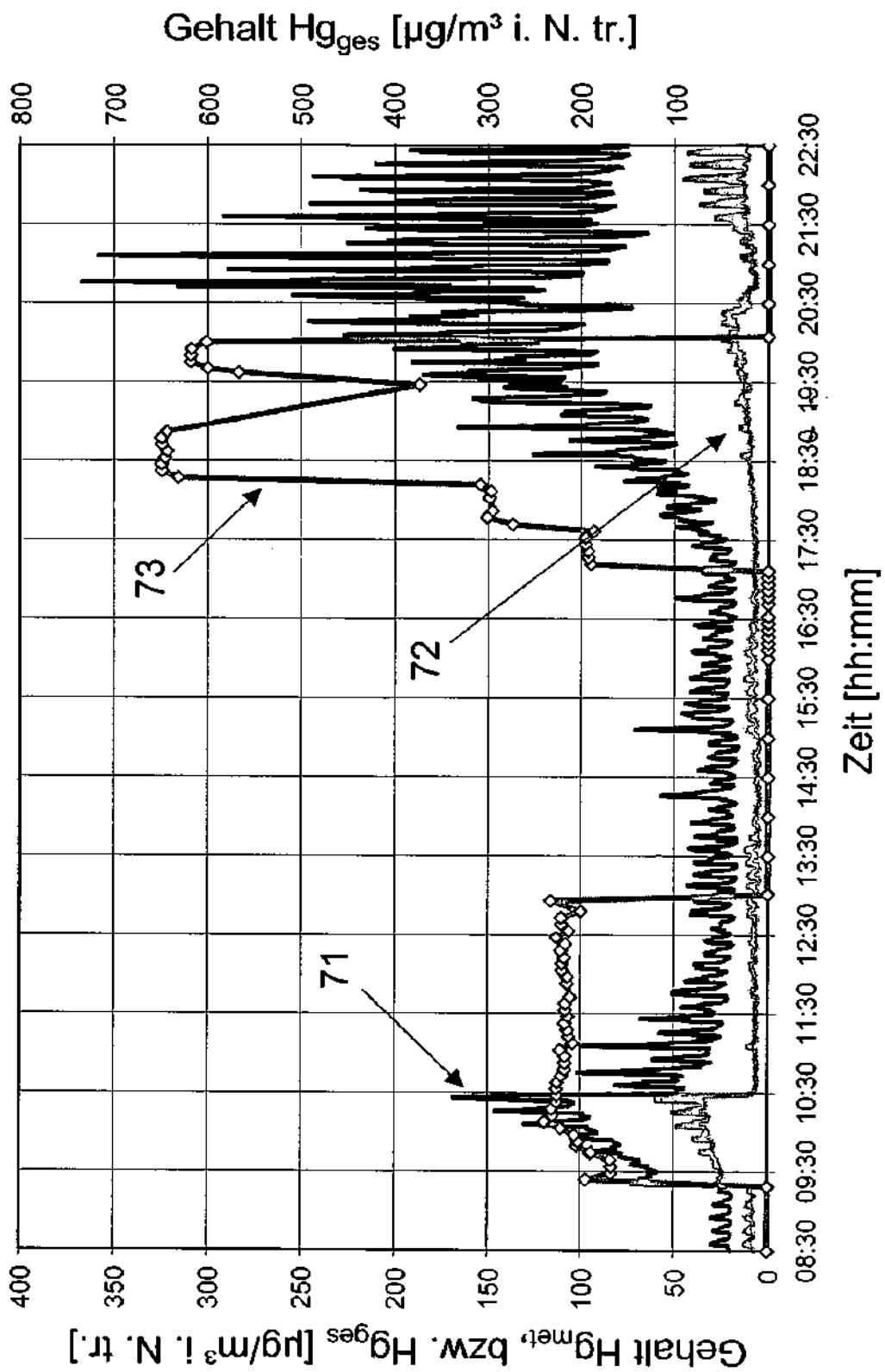

Gehalt Hg_{ges} [µg/m³ i. N. tr.]
800
700
600
500
400
300
200
100
08:30
09:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
18:30
19:30
20:30
21:30
22:30
Zeit [hh:mm]
Gehalt Hg_{mett} bzw. Hg_{ges} [µg/m³ i. N. tr.]
400
350
300
250
200
150
100
50
0
71
72
73

Fig. 7

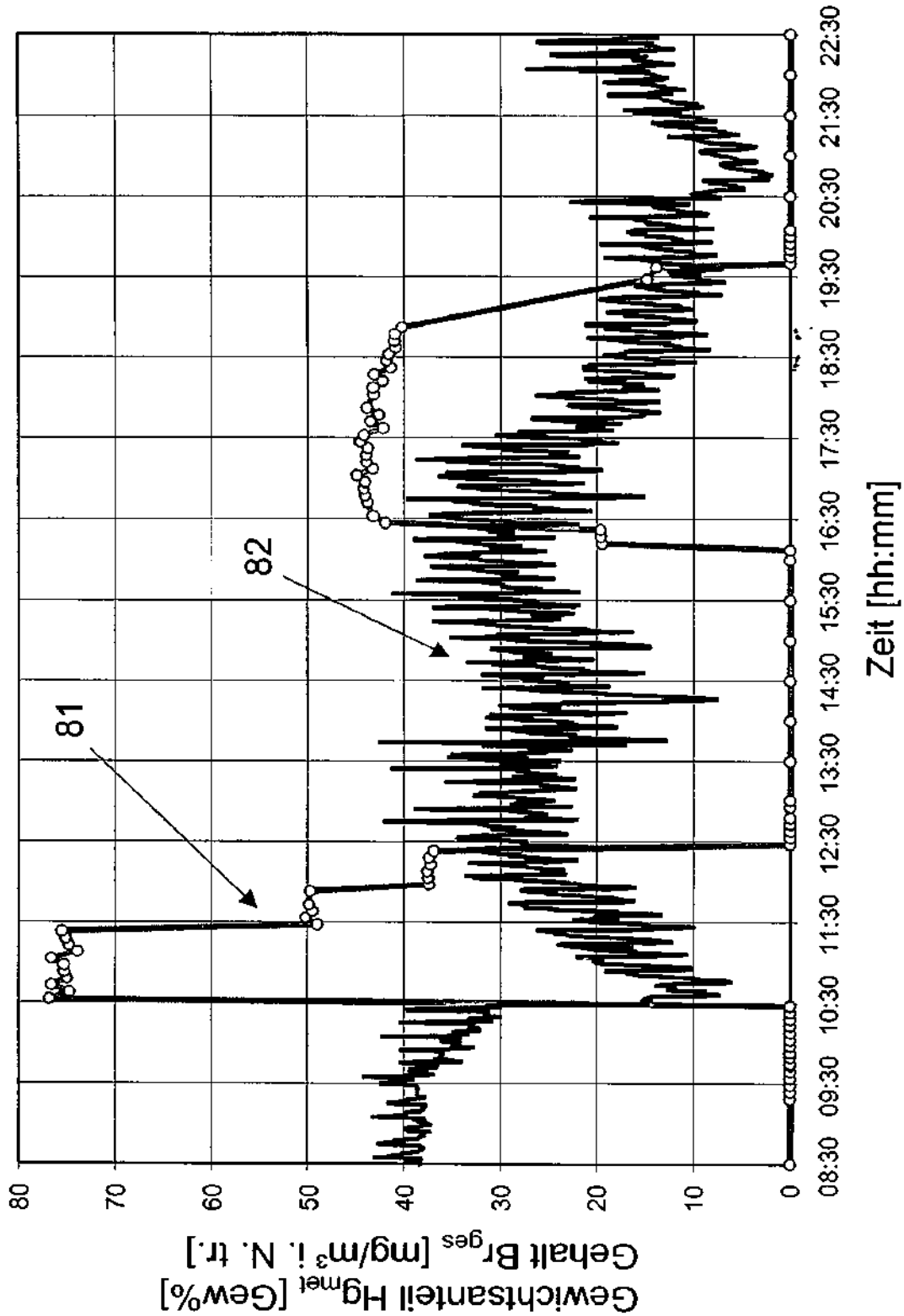

Gewichtsanteil Hg_{met} [Gew%]
Gehalt Br_{ges} [mg/m³ i. N. tr.]
0
10
20
30
40
50
60
70
80
08:30
09:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
18:30
19:30
20:30
21:30
22:30
Zeit [hh:mm]
81
82

Fig. 8

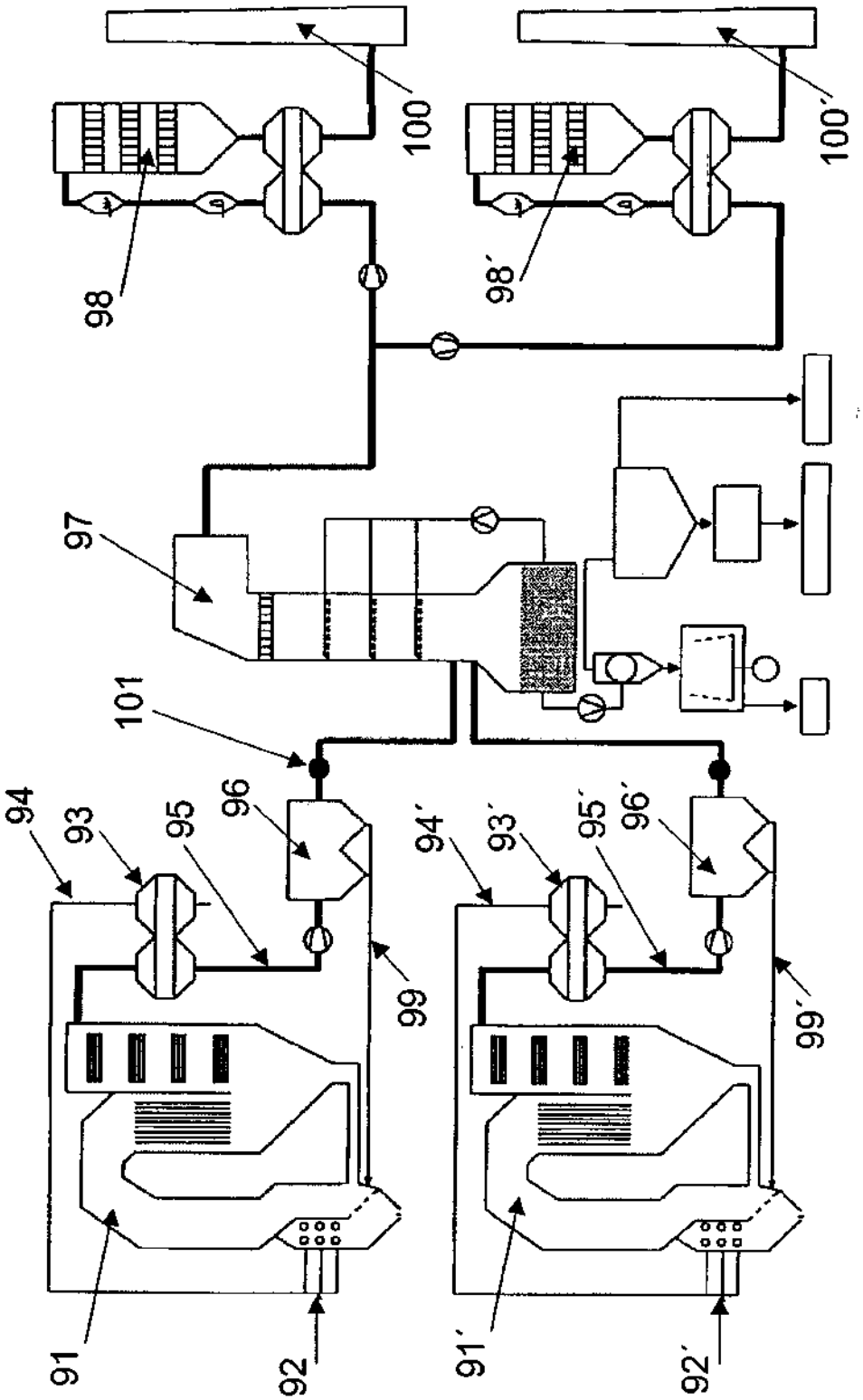


Fig. 9

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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.

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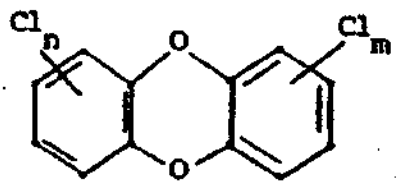
A process for removal of mercury vapor and vapor of chlorodibenzo-dioxins and -furans from a stream of hot flue gas.

FIELD OF THE INVENTION.

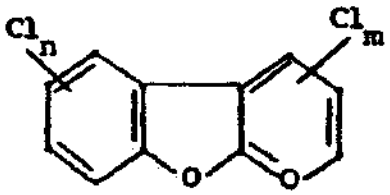
It is a well recognized fact that flue gases often contain mercury vapor in such amounts that their release into the atmosphere is regarded as being hazardous. This especially applies to flue gases from incineration plants where domestic refuse is incinerated but also flue gas formed by combustion of 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 integer 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 flue gases these compounds are primarily present in vapor phase and in the present specification the above abbreviations denote the 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 European application seems unsuitable for treating flue gas since 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 the 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 permanganate - 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, ^oC	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/Nm³	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/Nm³	not analysed	0.28
Downstream the baghouse		
PCDD[1] +PCDF, µg/Nm³	0.047	0.01
% removal	87.8	98.1

[1] The PCDD contents were approximately 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
EP 86 30 5054 0208490

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

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⑤1 Int.Cl.　　⑤2日本分類
B 01 d 53／02　13(9)F 2
B 01 d 53／04　13(7)B 62
B 01 d 53／34　13(7)A 11

⑲日本国特許庁

特許公報

⑪特許出願公告
昭49—43197
㊹公告　昭和49年(1974)11月19日
発明の数　1
（全3頁）

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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（公害防止関連技術）

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。

さらにモレキユ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銀分が完全には吸着されない欠点がある。

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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、ニツケル、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、ヨウ化ニツケル、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メツシユが適当である。

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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媒に吸着剤担体に加えて充分接触攪拌後、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10μg/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12000μg/m³の水素ガスを空間速度15001/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150μg/m³、20時間後で3200μg/m³、90時間後で11700μg/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10001/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9600μg/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150ml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50mlを流下せしめて硫酸第一錫を共存せしめた後、水銀含量250μg/m³の塩酸ガスを空間速度15001/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2μg/m³、90時間後で3μg/m³、250時間後で5μg/m³、500時間後で9μg/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	ヨウ素化合物	溶媒	担体			還元剤		対象ガス		ガス中の水銀濃度（μg／㎥）		
			種類	重量	ヨウ素化合物吸着量	種類	共存量	種類	流量空間速度	入口	出口	
				g	重量%		重量%		1／Hr		10時間後	250時間後	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＋硫酸第一錫	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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⑰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組体、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。

⑱引用文献

特　　公　昭４７－４４１５５

米国特許　３１９４６２９

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Page 510

WPI / Thomson

AN - 1974-86199V [50]

AP - JP19720097145 19720929

CPY - NIPS

DC - J01

DW - 197450

MC - J01-E01

PA - (NIPS) NIPPON SODA CO

PN - JP49053593 A 19740524 DW197450

XIC - B01D-053/46; B01D-053/64; B01J-020/20; C01B-031/00; C01B-031/08

AB - Activated carbon contg. >=1 of chlorides of Gp I and IIB metals is prepd. by immersing ordinary activated carbon in a soln. of the chlorides in water or an org. solvent. In an example, 50 pts activated carbon (20-50 mesh) was immersed in 200 pts aw. 10% ZnCl2 soln. for 30 min and dried at 105-110 degrees C for 10 hr after removing excess soln. Then, the activated carbon was packed in a glass tube and air contg. 10 mg Hg/m3 was passed through the tube at 1.1 l./min. Even after 10 hr, the activated carbon actively adsorbed Hg and the air thus treated contd. <0.005 mg Hg/m3.

ICAI- B01D53/64; B01J20/20; C01B31/08

ICCI- B01D53/46; B01J20/20; C01B31/00

IW - ACTIVATE CARBON CONTAIN MERCURY EXTRACT AIR GAS ADSORB

IWW - ACTIVATE CARBON CONTAIN MERCURY EXTRACT AIR GAS ADSORB

NC - 1

NPN - 1

PAW - (NIPS) NIPPON SODA CO

PD - 1974-05-24

TI - Activated carbon contg. chlorides for mercury extn. - from air or gases, with excellent adsorptivity

⑲ 日本国特許庁

公開特許公報

⑪特開昭 49-53593
㊸公開日 昭49.(1974)5.24
㉑特願昭 47-97145
㉒出願日 昭47.(1972)9.29
審査請求 未請求 (全3頁)

庁内整理番号	㊷日本分類
6646 41	14 E33
6415 4A	13(9)F2

(2,000円)

特許願(7)

昭和47年9月29日

特許庁長官 三宅幸夫 殿

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活性炭

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5. 添付書類の目録
~~(ア) 出願審査請求書 1通~~
(イ) 明細書 1通
~~(ウ) 図面 1通~~
(エ) 委任状 1通
(オ) 願書副本 1通

特許庁
47.9.29
出願第二課
北沢

明細書

1. 発明の名称
活性炭

2. 特許請求の範囲
周期律表の1族及び2族bの金属元素の塩化物から選ばれた1種又は2種以上の化合物を担持せしめることを特長とする活性炭。

3. 発明の詳細なる説明
本発明は、ガス中に存在する水銀に適用する新規な水銀吸着用活性炭及びその製造方法に係わるものである。

大気中に含まれる水銀は従来から労働衛生的立場より許容値(0.1 mg/m³)以下に管理することが必要であつたが、昨今の公害規制の強化に伴つて、環境衛生的立場からも次第に厳しい管理が必要とされるようになつてきている。同様に、又化学工業製品の原料となる各種の気体、例えば水素ガスなどに含まれる水銀に対しても厳しい規制と管理が必要になつている。

この様な大気中の水銀又は各種気体中の水銀の除去に関しては従来既にいくつかの方法が提案されている。例えば、高濃度の水銀に対しては、冷却して凝縮させる方法、又低濃度の水銀に対しては、酸化剤を含む溶液に吸収させる方法や活性炭などの吸着剤に吸着させる方法などが夫々提案されている。

これらの方法のうち、吸着剤を用いる方法は維持が簡単で、ある程度大容量のガスにも適用でき、又除去下限も割合い低いなどの利点を有しているようであるが、ただ吸着剤として吸着能力の高い優れたものを必要とする。しかし乍ら、現在この様な条件に適するものが見当らず、一部に使用されている活性炭もその性能持続期間(ライフ)が短かく工業的な使用に対しては不適当である。

本発明者らは大気中、あるいは各種の製品気体中の水銀を除去するために、上記の優れた特長をもつ吸着法を採用することとし、それに適する優れた吸着剤を得ることを目的として数多

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くの実験研究を行なつた結果、吸着剤として活性炭に、周期律表の1族及び2族bの金属元素の塩化物を含浸せしめたものが各種気体中の水銀の吸着除去に著しく優れた性能をもつことを見出し、種々検討の結果、本発明を完成したものである。

本発明に云う周期律表の1族及び2族bの金属元素の塩化物としては特にリチウム、ナトリウム、カリウム、銅、亜鉛、カドミウムなどの各金属の塩化物である。又、これらの金属元素の塩化物を担持させるための活性炭は、一般の活性炭でよいが、特にヤシガラ炭が適当であり、又その形状は普通粒状が用いられるが、勿論粉末も使用できる。

活性炭中の塩化物の担持量は0.01～40重量%、好ましくは0.1～20%であり、それらは活性炭に吸着され或は附着されている。

本発明の吸着剤である活性炭は種々の方法によつて製造することができるが、例えば上記の如き塩化物の1種又は2種以上の混合物を水溶液又はアルコール類、ケトン類、その他の極性有機溶媒の溶液とし、この溶液を浸漬或は噴霧して活性炭に含浸させる。この場合溶液中の金属元素の塩化物の濃度は活性炭にこれらの化合物が均一に含浸される程度のものであればよく、一般には0.1～40%、好ましくは1～30%が適当である。浸漬せしめる場合、浸漬する時間は均一含浸に必要な時間でよく、又、減圧下で含浸する場合には更に短時間ですむ。更に乾燥温度及びその時間は含浸した化合物が熱分解を起さない程度であればよく、一般には常圧下、50～110℃、3～10時間が適当であるが、減圧状態下では更に低温、短時間の乾燥が可能である。

本発明活性炭は、水銀の吸着剤の有効成分として使用され、一般のガス用吸着剤と同様に、各種の気－固接触による吸着方式の殆んどいずれをも使用することが可能である。例えば、固定床方式、移動床方式、流動床方式、気体輸送方式などの各種の方式により水銀或は水銀ガスを含有する気体と接触せしめることができる。勿論、本発明はこの使用法によつて制限されることはない。

本発明の吸着剤の性能を公知の吸着剤である活性炭と比較してみると表1の通りである。これより本発明の吸着剤は活性炭に比較して著しく高い吸着性能を有していることが認められる。又、Ⅱ族aの塩化物例えば塩化カルシウム、塩化ストロンチウム、塩化バリウム及び塩化亜鉛も吸着性能を有するが塩化亜鉛には及ばない。尚、この場合の試験方法は実施例1に示した或は準じた方法である。

表1

空気中水銀濃度	破過迄の時間	
	本発明の吸着剤 塩化亜鉛担持	活性炭
約10mg／m³	10時間以上	1秒以下
約250 〃	25分	〃

この様な本発明の吸着剤における驚異的な性能向上の機構は必らずしも明らかではないが、この様な効果は活性炭以外の多孔性吸着剤、例えば活性アルミナ、シリカ、ゼオライト、オイルコークス、パーライト、けいそう土などには見られないことであることから、活性炭独特のものとみられ、活性炭表面の水銀吸着のための活性点又はミクロやマクロな細孔が、これらの1族及び2族bの金属元素の塩化物によつて影響され、水銀吸着速度が増加すると共に、吸着量も増加したことによるものと考えられる。

本発明の方法を更に詳細な実施例で示すと以下の様になるが、本発明は以下の実施例により制限されることはない。

実施例1

ヤシガラ活性炭（20～50メッシュ）50部を秤取し、塩化亜鉛の10%溶液200部中に浸漬し、充分に攪拌含浸させ約30分後にとりだし、過剰の溶液を減圧濾過して乾燥器に入れ、105～110℃、10時間乾燥させた。

かくして得られた吸着剤を次にこのものを内径6mmのガラス管中に充填し（充填長さ20mm、充填重量350mg）約30mg/mの水銀

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を入れた二口の３００ｍℓの三角フラスコに取付け（他の口は解放）、カラムの他端を水銀蒸気計（ベックマン製、Ｋ－２３型）に連結したのち、先端にエアーポンプをとりつけて流量１．１ℓ／minで作動させた。従つてフラスコ内を通る空気は水銀蒸気（約１１ｍｇ／ｍ³）を伴つてカラムに入り、カラム内の吸着剤層を通る間に水銀は吸着され、水銀が減少したガスは水銀蒸気計を通して外に排出された。ここで蒸気計のフレはガス中の残存水銀量を示し、これをレコーダーで記録することにより、カラムに含まれる吸着剤の水銀吸着挙動を知り得た。この記録図よりその条件における吸着剤の破過時間を読みとり、これを吸着剤の性能の尺度とした。その結果、本実施例の吸着剤は１０時間の通気によつても破過に至らなかつた。そしてカラムを通過してでてきた空気中の水銀濃度は、カラムが破過に達する迄は０．００５ｍｇ／ｍ³（５μｇ／ｍ³）以下であつた。一方活性炭の場合は１秒以下の通気によつて破過に達した。そしてカラムを通過してでてきた空気中の水銀濃度は０．００５ｍｇ／ｍ³以上であつた。

実施例２

実施例１に準じヤシガラ活性炭（２０～５０メッシュ）に、表２に示す１族及び２族bの各種の金属元素の塩化物の溶液を含浸させ、乾燥させた。

かくして得られた吸着剤につき実施例１と同様な試験方法により吸着能力の測定を行なつた。又、水銀をいれたフラスコを熱湯で加熱して水銀濃度を約２５０ｍｇ／ｍ³に高め、その吸着能力を測定した。得られた結果は表２の通りである。

表２

担持物	破過迄の時間	
	Ⅰ通気中Hg 10mg/m³の場合	Ⅱ通気中Hg 250mg/m³の場合
塩化リチウム LiCl	１０時間以上	６０
塩化ナトリウム NaCl	〃	４５
塩化カリウム KCl	〃	４０
塩化銅 $CuCl_2$	〃	２０
塩化亜鉛 $ZnCl_2$	〃	２５
塩化カドミウム $CdCl_2$	〃	５０
なし（活性炭のみ）	１秒以内	１秒以内

実施例３

実施例１で作成した吸着剤を径６ｍｍのガラス管に２０ｍｍの長さに充填（約３５０ｍｇ）し、これに水素ガス（Ｈｇ約１２ｍｇ／ｍ³を含む）を流速１．１ℓ／minで通し、実施例１と同様な装置によりカラムを通つて出てきた水素ガス中の水銀の分析を行なつた。その結果、１０時間の通気によつても本実施例の吸着剤は破過に至らなかつたが、一方活性炭単独の場合は１秒以内に破過に達した。尚カラムを通過した水素ガス中の水銀の濃度は、本実施例の吸着剤の場合は約０．００５ｍｇ／ｍ³（５μｇ／ｍ³）であつたが、活性炭単独の場合は時間が短かく、不安定で、０．００５ｍｇ／ｍ³以下とはならなかつた。

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明細書

1 発明の名称

スキーバインデイング

2 特許請求の範囲

対称的に配置された、それぞれ1つの軸を中心として旋回可能である、ほぼアングルレバー状の2つの靴底保持体を有していて、これらの靴底保持体がそれぞれ一方のアームで靴底に接触しかつ他方のアームでばね力の作用下にある、共通の構成部分に作用している形式のスキーバインデイングにおいて、各アングルレバー状の靴底保持体1、2の一方のアームがほぼ垂直な軸4、5を中心として回転可能に支承された複数のローラ6、7で靴底8に接触していて、前記ローラ6、7の内一方のローラ6が靴底側面に近い範囲に、他方のローラ7が靴底端面に近い範囲に設けられていることを特徴とするスキーバインデイング。

3 発明の詳細な説明

本発明は、対称的に配置された、それぞれ1つの軸を中心として旋回可能である、ほぼアングルレバー状の2つの靴底保持体を有していて、これらの靴底保持体がそれぞれ一方のアームで靴底に接触しかつ他方のアームでばね力の作用下にある、共通の構成部分に作用している形式のスキーバインデイングに関する。

軸を中心として旋回可能な2つのアングルレバーを有するスキーバインデイングは公知である。この2つのアングルレバーの一方のアームはばねによつて負荷されており、これによつて他方のアームはスキー靴に向かつて圧着されかつスキー靴が保持されるようになつている。このばあい確実な保持を保証するためにはアームは所定の範囲にわたつてスキー靴に接触しなければならない。側方へ過負荷が生じると、一方のアングルレバーが旋回せしめられかつスキー靴はこのアングルレバーを擦過してアングルレバーから離反しなければならない。勿論このばあいには強い摩擦力が生じ、これによつて相当の摩滅がひき起される。さらにこのばあいに生

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じる摩擦力は表面の状態、例えば表面に水、氷、雪、汚泥が付着していることによつて大きく異なり、したがつてスキー靴の解放が同じ大きさの負荷で行なわれるように調節されていても、スキー靴がきわめて異なる強さの負荷で解放されるようになる。つまりスキー靴の解放は早すぎたりあるいは遅すぎたり、またはまつたく行なわれなくなり、この結果大きな事故が起ることがある。

さらに旋回可能なレバーが端部ならびにレバーの延長に設けられたローラでスキー靴に接触しているスキーバインデイングは既に公知である。この靴底保持体はアングルレバーではなく、ローラの軸に別のレバーが配置されて、このレバーの他方の共通の連接点がばねと結合されている。このばあいにも解放に際してレバーの端部に、外部からの影響を受けて大きく変化する滑り摩擦が生じる。さらにこのばあいの別の欠点は、レバーの基準位置を種々異なる靴底に適合させることができないことである。

本発明の課題は、スキー靴と靴底保持体部分との間の摩擦ができるだけ僅かでありかつ解放過程中にもほぼ一定に保たれるようなスキーバインデイングを提供することである。

この課題は本発明によれば、各アングルレバー状の靴底保持の一方のアームがほぼ垂直な軸を中心として回転可能に支承された複数のローラで靴底に接触していて、前記ローラの内一方のローラが靴底側面に近い範囲に、他方のローラが靴底端面に近い範囲に設けられていることによつて解決された。これによつて解放過程においては転動摩擦だけしか生じなくなる。この転動摩擦は滑り摩擦よりも僅かであるばかりではなく、外部の影響に左右されることも少ない。

さらに本発明の構成によれば、使用状態においては、靴底の端面側の範囲に設けられた両方のローラの軸の間隔は、アングルレバー状の靴底保持体が旋回可能に支承されている軸の間隔よりも小さくなつている。このばあいにはスキー靴によつてローラに押圧力がかけられることによつて、アングルレバー状の靴底保持体を内側に向かつて旋回させようとする回転モーメントが生ぜしめられる。これによつてアングルレバー状の靴底保持体の端部に設けられたローラは横方向にスキー靴底に圧着される。したがつてスキー靴は確実に保持されるだけではなく、自動的に必要な中央位置に保持される。

アングルレバー状の靴底保持体のローラを保持しているアームの間の間隔を選択的に調節するためには、他方のアームはばね力の作用下にある構成部材とバインデイングケーシングに配置された調節ねじとの間に設けられている。これによつて調節ねじを回動させてアングルレバー状の靴底保持体を適当に旋回させることによつて種々異なるスキー靴底にバインデイングを適合させることができるようになる。

次に図面について本発明を説明する：

第1図に略示されているように2つのアングルレバー状の靴底保持体1、2が軸3を中心として旋回可能に支承されている。各アングルレバー状の靴底保持体は一方のアームに2つのほぼ垂直な軸4、5を有している。これらの軸4、5にはローラ6、7が支承されている。スキー靴8は端面側の範囲で、靴底保持体1、2の軸3よりも相互間に僅かな間隔を有する軸5に支承されたローラ7に支えられている。これによつて靴底保持体1、2を軸3を中心として内側に向かつて旋回させようとするモーメントが生じる。したがつてアーム1の端部に設けられたローラ6、7はより強くスキー靴にあてつけられる。

種々異なるスキー靴底の形に適合させるためには靴底保持体1、2の基準位置を変化させることができる。このためには靴底保持体のアーム2はばね9の作用下にあるスライダ10と調節ねじ11との間に突入している。調節ねじ11をバインデイングケーシング12内で回動させることによつて回転方向に応じて靴底保持体は一点鎖線あるいは破線で示された位置に旋回せ

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しめられる。

第２図と第３図に示された構造においては、アングルレバー状の靴底保持体１、２は同様に軸４、５を中心として回転可能に支承されたローラ６、７を保持している。旋回軸３はバインディングケーシング１２に配置されている。このばあいには靴底保持体のアーム２だけが端部に設けられたスライダ１０の折曲げ部１３に接触しているのではなく、折曲げ部１３には靴底押え部材１５のアーム１４も作用している。靴底押え部材１５はバインディング部材１２に設けられた軸１６に旋回可能に支承されておりかつ種々異なる靴底厚さに適合させるためにねじ１７で高さ調節可能である。

ばね９は一方ではバインディングケーシング１２に、他方ではばね受け１８に支えられている。このばね受け１８はねじ１９によつてスライダ１０内で移動可能であるが回転不能に設けられている。ねじ１９自体はスライダ１０の折曲げ部２０の孔内に支えられている。ねじ１９を回動させることによつてばね受け１８が移動しかつばね９の張力を変化させる。解放力を表示するためにはばね受け１８はスライダ１０の窓２２内に突出する指針２１を形成する。

調節ねじ１１を回動させることによつてスライダ１０もばね９を緊縮しながら一方の方向にあるいはばね９を弛緩しながら他方の方向に移動する。

このばあいにも特にアングルレバー状の靴底保持体の位置に関する表示を行なうために、スライダ１０の窓２２はケーシング部分２４の別の窓２３の下に設けられている。したがつて窓２３内のマークは靴底保持体位置と調節された解放力とを表示する。

本発明は図示された実施例に限定されるものではなく、種々異なる態様で実施することができる。例えば規格化された靴底を使用するばあいにはアングルレバーの基準位置を変化させる必要はない。さらに必要なばあいには表示を別個に行なうこともできる。

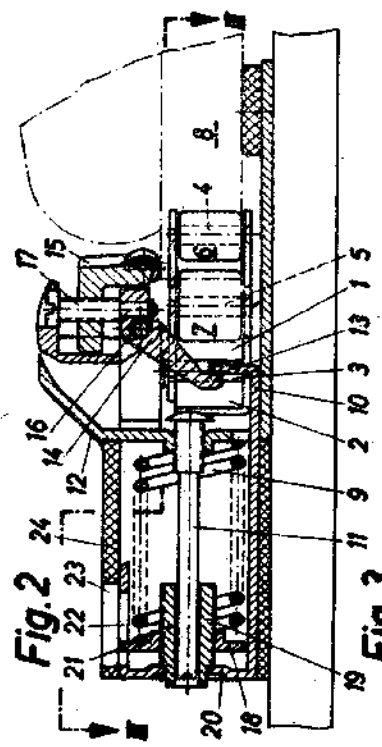
4　図面の簡単な説明

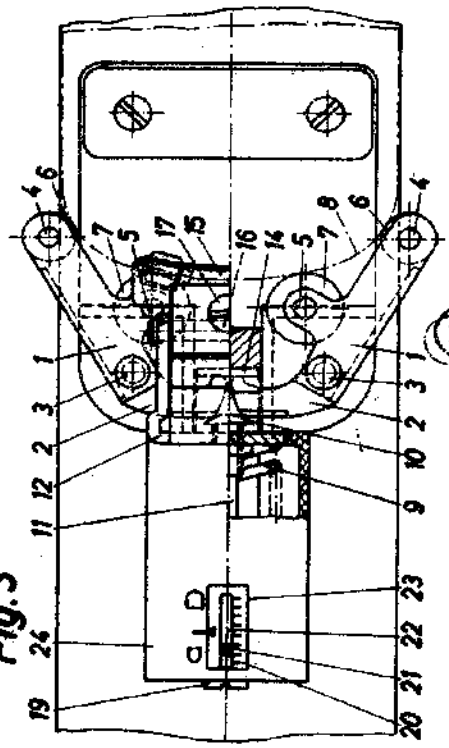
図面は本発明の１実施例を示すものであつて、第１図は本発明のバインディングの概略図、第２図は本発明のバインディングの中央縦断面図、第３図の上半分は第２図の平面図、第３図の下半分は第２図のⅡ－Ⅱ線に沿つた断面図である。

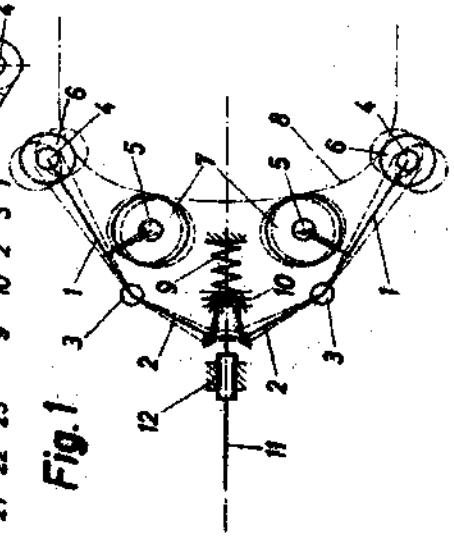
１、２・・靴底保持体、３・・軸、４、５・・軸、６、７・・ローラ、８・・スキー靴、９・・ばね、１０・・スライダ、１１・・調節ねじ、１２・・バインディングケーシング、１３・・折曲げ部、１４・・アーム、１５・・靴底押え部材、１６・・軸、１７・・ねじ、１８・・ばね受け、１９・・ねじ、２０・・折曲げ部、２１・・指針、２２・・窓、２３・・窓、24・・ケーシング部分。

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Fig.2


Fig.3


Fig.1

5. 添附書類の目録

(1)	明細書	1通
(2)	図面	1通
(3)	委任状	1通
(4)	優先権証明書	1通
( )	~~出願審査請求書~~	通

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昭和49年5月13日

特許庁長官殿

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3. 補正をする者
事件との関係：特許出願人
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6. 補正の対象
明細書(第9頁)

7. 補正の内容
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但し、明細書の浄書(内容に変更なし)

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4　図面の簡単な説明

図面は本発明の1実施例を示すものであつて、第1図は本発明のバインデイングの概略図、第2図は本発明のバインデイングの中央縦断面図、第3図の上半分は第2図の平面図、第3図の下半分は第2図のⅡ－Ⅱ線に沿つた断面図である。

1、2・・靴底保持体、3・・軸、4、5・・軸、6、7・・ローラ、8・・スキー靴、9・・ばね、10・・スライダ、11・・調節ねじ、12・・バインデイングケーシング、13・・折曲げ部、14・・アーム、15・・靴底押え部材、16・・軸、17・・ねじ、18・・ばね受け、19・・ねじ、20・・折曲げ部、21・・指針、22・・窓、23・・窓、24・・ケーシング部分。

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（ほか1名）

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(54) Title: ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

(57) Abstract: There is disclosed an adsorption powder effective for capturing mercury from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon, and about 1-60% carbon impregnated with KI3. Additionally, a method of removing mercury from high temperature, high moisture gas streams is disclosed.

ADSORPTION POWDER FOR REMOVING MERCURY FROM HIGH TEMPERATURE, HIGH MOISTURE GAS STREAMS

BACKGROUND OF THE INVENTION

The present invention relates generally to removal of pollutants from high temperature, high moisture gas streams such as those found in devices designed to treat contaminated soil and in hazardous material incinerators. More particularly, the invention relates to the capture of mercury and other metals, dioxins, furans and other organic compounds from high temperature, high moisture gas streams using an adsorption powder containing cupric chloride.

Strict standards exist for particulate and total mercury emissions by coal-fired power plants, petroleum refineries, chemical refineries, coal fired furnaces, trash burning facilities, incinerators, metallurgical operations, thermal treatment units and other particulate and mercury emitting facilities. These same restrictions apply to mercury vapor, which can enter the atmosphere as a result of low temperature thermal desorption (LTTD) treatment of contaminated soils.

These stringent standards exist in order to protect the environment and the community. When mercury-containing gases are released, the gases disperse and mercury is deposited over a wide area. The dispersed mercury can accumulate in the soil or water supplies, where it may be incorporated into the food chain. Mercury is extremely harmful to aquatic life and ultimately to the humans who consume mercury-contaminated plants and animals. It is necessary, therefore, to have a safe and effective method of eliminating mercury from the environment.

The problem of the capture and treatment of mercury vapor, typically in the context of coal-fired power plants and waste incinerators, has been previously considered. For example, U.S. Patent No. 3,193, 987 discloses passing mercury-containing vapor over activated carbon impregnated with a metal which forms an amalgam with mercury. U.S. Patent No. 4,094,777 discloses passing a mercury-containing vapor over an adsorption mass consisting essentially of a support, sulfided

copper and sulfided silver. U.S. Patent No. 3,876,393 discloses passing mercury-containing vapors over activated carbon that has been impregnated with sulfuric acid. Selenium has also been used in the removal of mercury from a vapor. U.S. Patent No. 3,786,619 discloses passing a mercury-containing gas over a mass containing as an active component, selenium, selenium sulfide or other selenium compounds. Electrostatic precipitators and various filters have traditionally been used for mercury removal, although complex apparatus have also been disclosed. (See e.g., U.S. Patent Nos. 5,409,522 and 5,607,496.)

The problem of recapturing mercury from power plant gas streams is analogous to the need for recapturing mercury from incinerators that treat contaminated soils. A process currently in use at soil treatment facilities is known as low temperature thermal desorption (LTTD). LTTD is the main process by which contaminated soils are treated to remove mercury and other contaminants. In this process, contaminated soils are fed into a heating furnace, most commonly a rotary kiln/drum, where the soil is heated by conduction. The heating volatizes the soil components and when a thermal oxidizer is added, the components are oxidized to manageable gases, such as CO_2, Cl_2, NO_x and SO_x, where x is 1-3.

The hot gas stream is subsequently cooled. The stream may be quenched with water, which cools the stream and concurrently increases the moisture content. Although water quenching is a highly effective cooling method, this treatment increases the difficulty of removing mercury from the gas stream. The gas stream is further treated to reduce and remove metals, HCl, NO_x and SO_x using acid scrubbers, carbon beds, condensation units and through the addition of adsorption powders.

When adsorption powders are injected into the gas stream, mercury and other metals bind to moieties present in the powder, precipitating them from the gas stream. The powder-bound mercury is ultimately collected in a bag house for appropriate disposal, while the clean gas stream is exhausted to the outside atmosphere. The problem with standard LTTD methods is that some metals, such as mercury, are not removed from the stream at high efficiency and will move with

the gas stream, ultimately into the environment. Other methods require the use of complex machinery and expensive adsorption beds. LTTD and other methods also suffer from the limitation that mercury removal from high moisture gas streams is much more difficult than mercury removal from dry streams.

Available adsorption powders remove organics, metals and other contaminants, but they do not effectively remove mercury. For example, one available powder (Sorbalite ™) consisting of carbon, calcium hydroxide and sulfur removes HCl from a gas stream, but removes only about 55-65% of the mercury. Another powder (WUELFRAsorb-C ™) consisting of alcohol saturated lime and activated carbon is also inefficient at removing mercury.

Some powders include sulfur or iodine impregnated carbon. At temperatures of 75°C or less, sulfur or iodine impregnated carbon based powders show a 95% mercury removal efficiency, however, powders formulated with sulfur impregnated carbon require a dry or low moisture gas stream to show this level of removal.

Finally, the mercury removal efficiency of the powders described and other available powders is known to be very temperature dependent, placing an additional limitation on powder formulations.

A pending application describing a process from the same inventors involved the use of solid fine cupric chloride that is not impregnated on carbon. This was found to be more difficult to handle because of the grinding process required to pulverize the cupric chloride which is generally provided in rock sizes. The grinding process requires a great amount of attention due to the dust production and associated heath hazards. Additionally, the powder is very corrosive and results in breakdown of the machinery used in the process.

Accordingly, there is a need in the industry for an adsorption powder that effectively removes metals and other organic compounds, in general, and mercury, in particular, from high temperature, high moisture gas streams generated by the incineration of contaminated soils, treatment of hazardous materials, combustion of coal and other mercury liberating sources. The powder must be inexpensive and

easy to use. Ideally, such an adsorption powder can be employed at treatment facilities already in place and can take advantage of equipment already in position, without requiring retooling or reconfiguring existing equipment.

SUMMARY OF THE INVENTION

There is disclosed an adsorption powder and method for removing mercury and other metals and contaminants from a high temperature, high moisture gas stream comprising: about 1-97% carbon; about 1-97% calcium hydroxide; about 1-97% cupric chloride impregnated carbon and about 1-60% KI_3 impregnated carbon. A method for removing mercury and other metals, dioxins, furans and other organic compounds from high temperature, high moisture gas streams using the claimed powder is also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

The instant invention will be more fully understood in the following detailed description, it being understood, however, that the invention is not confined to the precise disclosure. Changes and modifications may be made that do not affect the spirit of the invention, nor exceed the scope thereof, as expressed in the appended claims. Accordingly, the instant invention will now be described with particular reference to the accompanying drawings.

Figure 1 is a schematic diagram illustrating the design of an LTTD facility in which the claimed adsorption powder can be used to remove mercury from gas streams.

DETAILED DESCRIPTION OF THE INVENTION

There is disclosed an adsorption powder for removing mercury and other metals from a gas stream comprising:

a) about 1-97% carbon;

b) about 1-97% calcium hydroxide;

c) about 1-97% cupric chloride impregnated carbon; and

d) about 1-60% KI_3 impregnated carbon.

The powder more particularly comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon and about 1-50% KI_3 impregnated carbon. A preferred adsorption powder comprises about 20-60% carbon, about 30-70% calcium hydroxide, about 1-30% cupric chloride impregnated carbon and about -30% KI_3 impregnated carbon.

In a more preferred embodiment, the adsorption powder comprises about 25-45% carbon, about 40-60% calcium hydroxide, about 1-15% cupric chloride impregnated carbon and about 1-15% KI_3 impregnated carbon. The most preferred embodiment comprises about 40% carbon, about 40% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

The use of the KI_3 impregnated carbon has been found to be optional as the powder lacking this component performed equally as well as one containing the KI_3 impregnated carbon.

Thus, in another embodiment of the invention, , the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide and about 1-50% cupric chloride impregnated carbon.

There is also disclosed a process for removing mercury from a gas stream using the adsorption powder of the invention comprising the steps of:

a) placing a solid phase mercury-containing contaminated soil feed into a rotary kiln/drum;

b) heating said kiln/drum containing said soil feed to form gaseous and solid components of the sample;

c) transferring the gaseous component of said soil feed to an exhaust cleaning unit/afterburner and the solid component of clean soil to a soil cooling unit;

d) heating the gaseous component of said contaminated soil feed in said exhaust cleaning unit/afterburner;

e) cooling the gaseous component of said contaminated soil feed;

f) adding the adsorption powder of Claim 1 to the gaseous component;

g) transferring the powder-containing gaseous component to a baghouse; and

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h) releasing the substantially mercury-free gaseous component of said sample to the atmosphere.

An adsorption powder for the removal of mercury and other metals, dioxins, furans and other organic compounds must be efficient under a range of conditions. Currently available powders do not function well at high temperatures and in high moisture environments, conditions that are favorable to mercury removal.

High temperatures are necessary for effective removal of contaminants from soil. Temperatures of about 1800°F are necessary to volatize organics, metals and other impurities from the contaminated soil. Mercury that is trapped in contaminated soil, however, is most efficiently adsorbed on carbon at about 300-500°F. The most practical method of cooling a gas stream exiting an 1800°F oven is to inject water into the gas stream. Water injection cools the gas stream to a temperature favorable to mercury removal, but also increases the moisture content of the sample, which decreases the efficiency of available mercury adsorption powders. The mercury absorbing properties of available powders suffer dramatically in a high moisture environment. The adsorption powder of the invention, however, operates effectively even in a higher moisture environment.

Experiments with carbon sources showed that coal carbon was superior to wood carbon for mercury adsorption. Many available adsorption powders use wood carbon as a component, rather than coal carbon. Cupric chloride was observed to significantly enhance the adsorption of mercury from a gas stream and is the key to the instant invention. Cupric chloride supplies chlorine and activated copper to the elemental mercury in the exhaust stream. Elemental mercury reacts with the chlorine to form mercury chloride and the activated copper to form a stable mercury amalgam. Both forms of mercury are easily captured from the exhaust gas stream. KI_3 impregnated carbon was also found to increase mercury adsorption when it was included in the powder.

Figure 1 shows a schematic diagram of the actual process and equipment used to carry out the invention. Prescreened contaminated feed soil ready to be processed 2 is placed within soil cleaning unit 4. The contaminated soil is heated to about 900°F or a temperature that will completely volatize the contaminates from the soil and generate a gas stream, as well as a clean/remediated solid soil component. Preferably, soil cleaning unit 4 is a rotary kiln. The gas stream is then passed out

of soil cleaning unit **4** to dust remover **6**, while any solid fraction of the feed soil is transferred to clean soil cooling unit **8**, where the soil is cooled and prepared for reuse. Dust remover **6** is preferably a multi-tube dust collector.

After dust remover **6** removes any particulate matter from the gas stream sample, the gas stream is passed into the Exhaust Cleaning Unit **10.** The Exhaust Cleaning Unit heats the volatilized contaminates to a temperature of about 1800°F for a minimum of two seconds retention time, which assures complete destruction of any remaining organic or other contaminants. From the Exhaust Cleaning Unit **10,** the gas stream then passes through cooling chamber **12** wherein a water pump (not shown) injects water into the cooling chamber **12** to lower the temperature of the sample to about 360°F. This cooling process consequentially increases the moisture content of the sample.

The high temperature, high moisture gas stream is then contacted to the adsorption powder of the invention, which is stored in adsorbent storage silo **14** and injected into the gas stream. This powder formulation is effective in removing metals, particularly mercury, and other contaminants.

After the gas stream has been contacted to the adsorption powder, the powder/gas stream mixture continues on to baghouse **16**. The carbon component of the adsorption powder collects on the walls of bags and acts as a particulate filter for the gases leaving the baghouse. Baghouse **16** collects the particulate mercury-containing fraction of the adsorption powder mixture, which is transported to a suitable bulk storage facility **20** and subsequently removed. The gaseous fraction is released to the outside atmosphere through vent **18**, while the remaining dust particulate fraction is handled in a similar manner to the particulate mercury fraction of the adsorption powder mixture **20**.

EXAMPLE 1

A series of field tests were performed employing a preferred adsorption powder formulation. Three soil samples containing about 4.2 mg/kg of mercury were prepared by screening to 1 inch. The coarse material was discarded, and the remaining soil was fed into a soil cleaning unit and heated to about 900°F. The cleaned soil was transferred to a soil cooling unit and prepared for reuse. The exhaust stream was sent to a dust remover and the precipitated material was sent to the soil cooling unit. The exhaust stream was then fed into an exhaust cleaning unit, which was heated to

about 1850°F. The exhaust gas was then cooled to about 360°F by quenching with water, and subsequently an adsorption powder comprising 40% coal carbon, 10% KI_3 impregnated carbon, 40% calcium hydroxide and 10% cupric chloride impregnated carbon was added. The exhaust stream/adsorption powder mixture was fed into a baghouse, where the mercury-bound particulate was separated from the mercury-free exhaust gas. The particulate material was removed from the baghouse for analysis and disposal, while gas analyzers on the exhaust stack recorded mercury emission levels. The results of the three, two hour runs are reported in the following table.

	Run 1	Run 2	Run 3	Average
LTTD Mercury Input (lbs/hr)	0.193	0.199	0.199	0.197
Clean Soil Mercury Output (lbs/hr)	0.0020	0.0020	0.0020	0.0020
Mercury Emission Rate (lbs/hr)	0.0012	0.0006	0.0007	0.0008
Mercury Removal Efficiency[1]	99.4%	99.7%	99.6%	99.6%

[1] *Removal Efficiency (%) = (Mass input - Stack Output- Clean Soil Output)/(Mass Input - Clean Soil Output)*

The average mercury removal efficiency of 99.6% exceeds the current mercury control efficiency specification of 96.5% efficiency, set by NJDEP air permit legislation. Mercury emissions were determined by EPA method 29-060.

Although the adsorption powder and method described and claimed are presented in the context of mercury removal from a gas stream, it should be appreciated that the powder and method are also useful for removing organics, metals and other contaminants from a gas stream.

WHAT IS CLAIMED IS:

1. An adsorption powder for removing mercury and other metals, dioxins, furans and other organic compounds from a gas stream comprising:

a) about 1-97% carbon;

b) about 1-97% calcium hydroxide;

c) about 1-97% cupric chloride; and

d) about 1-60% KI_3 impregnated carbon.

2. The adsorption powder of claim 1 wherein the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon and about 1-50% KI_3 impregnated carbon.

3. The adsorption powder of claim 1 wherein the adsorption powder comprises about 20-60% carbon, about 30-70% calcium hydroxide, about 1-30% cupric chloride impregnated carbon and about -30% KI_3 impregnated carbon.

4. The adsorption powder of claim 1 wherein the adsorption powder comprises about 25-45% carbon, about 40-60% calcium hydroxide, about 1-15% cupric chloride impregnated carbon and about 1-15% KI_3 impregnated carbon.

5. The adsorption powder of claim 1 wherein the adsorption powder comprises about 30% carbon, about 50% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

6. The adsorption powder of claim 1 wherein the adsorption powder comprises about 10-70% carbon, about 20-80% calcium hydroxide, about 1-50% cupric chloride impregnated carbon.

7. The adsorption powder of claim 1 wherein the carbon is coal carbon.

8. A method for removing mercury and other metals, dioxins, furans and other organic compounds from a gas stream using the adsorption powder of claim 1 comprising the steps of:

a) placing a solid phase mercury-containing contaminated soil feed into a rotary kiln/drum;

b) heating said kiln/drum containing said soil feed to form gaseous and solid components of the sample;

c) transferring the gaseous component of said soil feed to an exhaust cleaning unit/afterburner and the solid component of clean soil to a soil cooling unit;

d) heating the gaseous component of said contaminated soil feed in said exhaust cleaning unit/afterburner;

e) cooling the gaseous component of said contaminated soil feed;

f) adding the adsorption powder of Claim 1 to the gaseous component;

g) transferring the powder-containing gaseous component to a baghouse; and

h) releasing the substantially mercury-free gaseous component of said sample to the atmosphere.

9. The method of Claim 8 wherein the adsorption powder used in step f) comprises about 40% carbon, about 40% calcium hydroxide, about 10% cupric chloride impregnated carbon and about 10% KI_3 impregnated carbon.

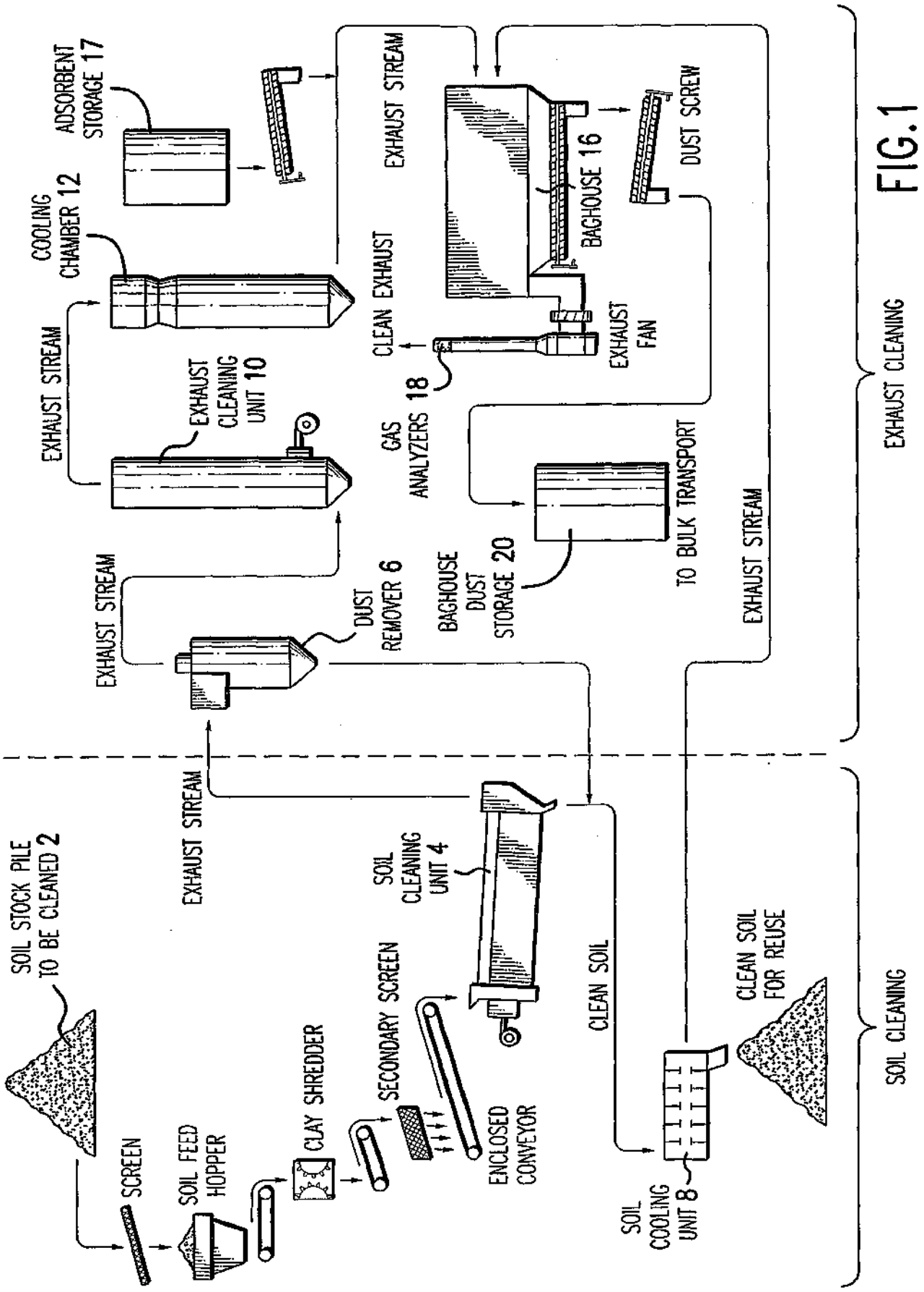

SOIL STOCK PILE TO BE CLEANED 2
SCREEN
SOIL FEED HOPPER
CLAY SHREDDER
SECONDARY SCREEN
ENCLOSED CONVEYOR
SOIL CLEANING UNIT 4
EXHAUST STREAM
DUST REMOVER 6
EXHAUST STREAM
EXHAUST CLEANING UNIT 10
EXHAUST STREAM
COOLING CHAMBER 12
ADSORBENT STORAGE 17
EXHAUST STREAM
CLEAN EXHAUST
GAS ANALYZERS 18
BAGHOUSE 16
DUST SCREW
EXHAUST FAN
BAGHOUSE DUST STORAGE 20
TO BULK TRANSPORT
EXHAUST STREAM
CLEAN SOIL
SOIL COOLING UNIT 8
CLEAN SOIL FOR REUSE
SOIL CLEANING
EXHAUST CLEANING

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/05259

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B01D 53/04

US CL :95/133, 134, 141, 900; 96/154; 423/210

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 95/133, 134, 141, 142, 900; 96/108, 132, 135, 154; 423/210

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,193,987 A (MANES et al.) 13 July 1965 (13.07.65).	1-9
A	US 3,194,629 A (DREIBELBIS et al.) 13 July 1965 (13.07.65).	1-9
A	US 3,876,393 A (KASAI et al.) 08 April 1975 (08.04.75).	1-9
A	US 4,094,777 A (SUGIER et al.) 13 June 1978 (13.06.78)	1-9
A	US 4,273,747 A (RASMUSSEN) 16 June 1981 (16.06.81)	1-9
A	US 5,409,522 A (DURHAM et al.) 25 April 1995 (25.04.95).	1-9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 09 APRIL 2001	Date of mailing of the international search report 07 MAY 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ROBERT H. SPITZER Telephone No. (703) 308-0651

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/05259

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,575,982 A (REISS et al.) 19 November 1996 (19.11.96).	1-9
A	US 5,607,496 A (BROOKS) 04 March 1997 (04.03.97).	1-9
A	US 5,659,110 A (HERDEN et al.) 19 August 1997 (19.08.97).	1-9

Electronic Acknowledgement Receipt

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Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
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First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Rebecca Krueger
Filer Authorized By:	Dennis Robert Daley
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	IDS.PDF	261616 ad12d9965a14b06a93231a0cb0e51624715a3dcc	no	5

Warnings:	
Information:	

This is not an USPTO supplied IDS fillable form					
2	NPL Documents	AttachmentA.PDF	6738855 254b7a456945483a347f701d70a1ff81f661 7b9e	no	106
Warnings:					
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3	NPL Documents	AttachmentB.PDF	251213 aa2ca50f1a876c19d2c2d591b288ba659d8 a307f	no	7
Warnings:					
Information:					
4	NPL Documents	AttachmentC.PDF	214193 fa2059c5daa14a888403fd959e3dd33c7a1c c2bb	no	4
Warnings:					
Information:					
5	Foreign Reference	CA1099490.PDF	402398 038586b2c52f04d3cbd50478bfdc40bc85d 38a1	no	11
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6	Foreign Reference	CA2150529.PDF	817971 bb4cfc4221f5695f674bf70ab4cdaa8d4829 79c4	no	25
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11	Foreign Reference	JP4943197.PDF	194669 e9da5e3f1999c525cdebbeee5b98132dabb e5658	no	3
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12	Foreign Reference	JP4953593-W-Abstract.PDF	185302 5d137d10e5ae4869a62220ffc0154b9991af dcc1	no	4
Warnings:					
Information:					
13	Foreign Reference	JP506438.PDF	285430 5af36f4af44be094ca6cf7846bd949d4a550 d180	no	5
Warnings:					
Information:					
14	Foreign Reference	WO01_62368.PDF	674867 0c77cc3a5e198f398288eac69222869705ec 4fca	no	14
Warnings:					
Information:					
15	NPL Documents	Dunham-Mercury-Capture.PDF	869729 2d2925312083e964103ba0aecf758a6534b 74562	no	6
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
16	NPL Documents	Felsvang-Mercury-Reduction.PDF	529923 ccb44a308180a9305f0a5328c87a1250f64c 69c9	no	19
Warnings:					
Information:					
17	NPL Documents	Ghorishi-Sorption-of-Mercury.PDF	1592606 14087653a3a6d23613c76ef4a1c7ae3f4fb7 41e0	no	12
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Information:					
18	NPL Documents	Lancia-Adsorption-of-Mercury.PDF	1694247 a4bcd819b433fddd596d13fbc1c2b9960afd 8b3a2	no	14
Warnings:					

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Information:					
19	NPL Documents	Olson-The-Reduction-of-Gas.PDF	131348 17676c623ca211e3eba3dac56b6b1c819ba5c560	no	13
Warnings:					
Information:					
20	NPL Documents	Vosteen-Chlor.PDF	1425947 67502e7f0c09e81dfae94ef092baa1368edcd5a3	no	31
Warnings:					
Information:					
			Total Files Size (in bytes):	18914430	

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/419,219	04/06/2009	1795	631	16291.0001USC1	24	1

CONFIRMATION NO. 1149

UPDATED FILING RECEIPT

23552
MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

OC000000038711048

Date Mailed: 11/16/2009

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

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

Assignment For Published Patent Application

Energy & Environmental Research Center Foundation, Grand Forks, ND

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 12/201,595 08/29/2008
which is a DIV of 11/209,163 08/22/2005 PAT 7,435,286
which claims benefit of 60/605,640 08/30/2004

Foreign Applications

If Required, Foreign Filing License Granted: 08/31/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/419,219**

Projected Publication Date: 02/25/2010

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****

Title

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Preliminary Class

430

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

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Olson et al.	Examiner:	Unknown
Serial No.:	12/419,219	Group Art Unit:	1795
Filed:	April 6, 2009	Docket No.:	16291.0003USC1
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

Filed via EFS-WEB

RESPONSE TO NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

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

Dear Sir:

In response to the Notice to File Missing Parts of Nonprovisional Application mailed September 4, 2009, Applicants submit the following:

- Replacement Drawings.

The undersigned hereby authorizes the U.S. Patent and Trademark Office to charge any additional fees due or credit any overpayment to Deposit Account No. 132725.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903



Dennis R. Daley
Reg. No. 34,994

Date: November 4, 2009

23552
PATENT TRADEMARK OFFICE

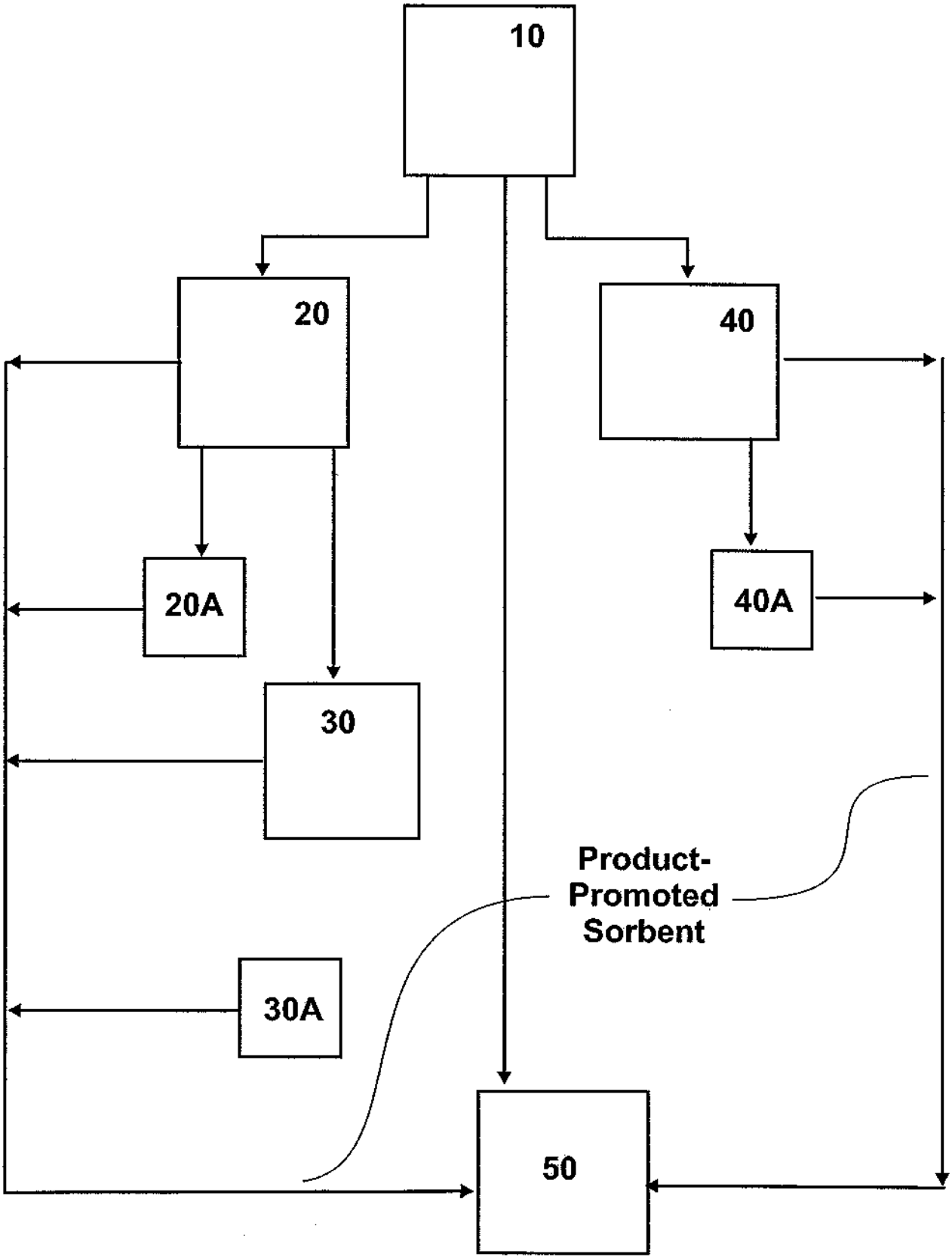


FIG. 1

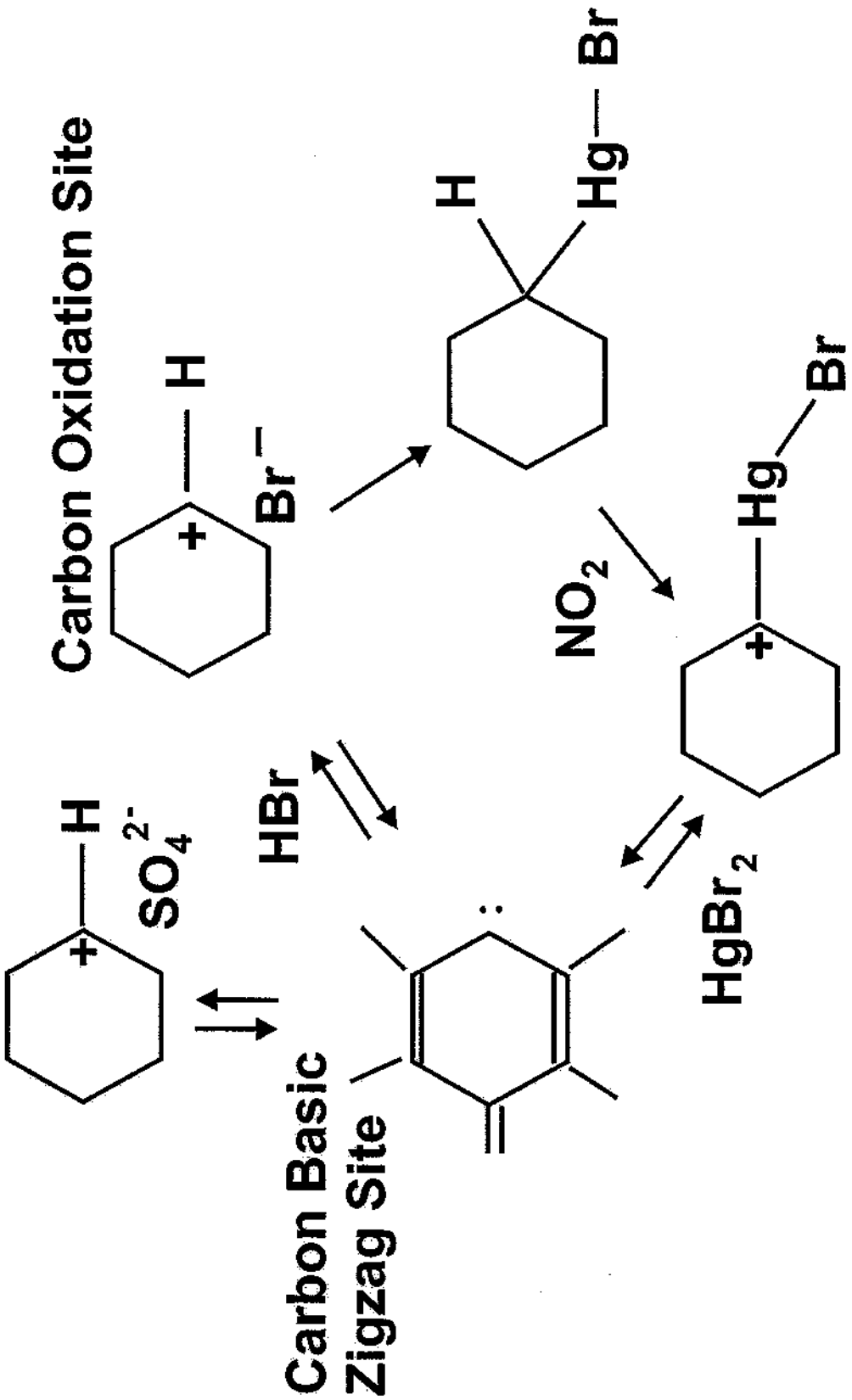

Carbon Oxidation Site
H
Br⁻
H
Hg— Br
NO2
Hg
Br
HBr
HgBr2
H
SO4 2-
Carbon Basic
Zigzag Site

FIG. 2

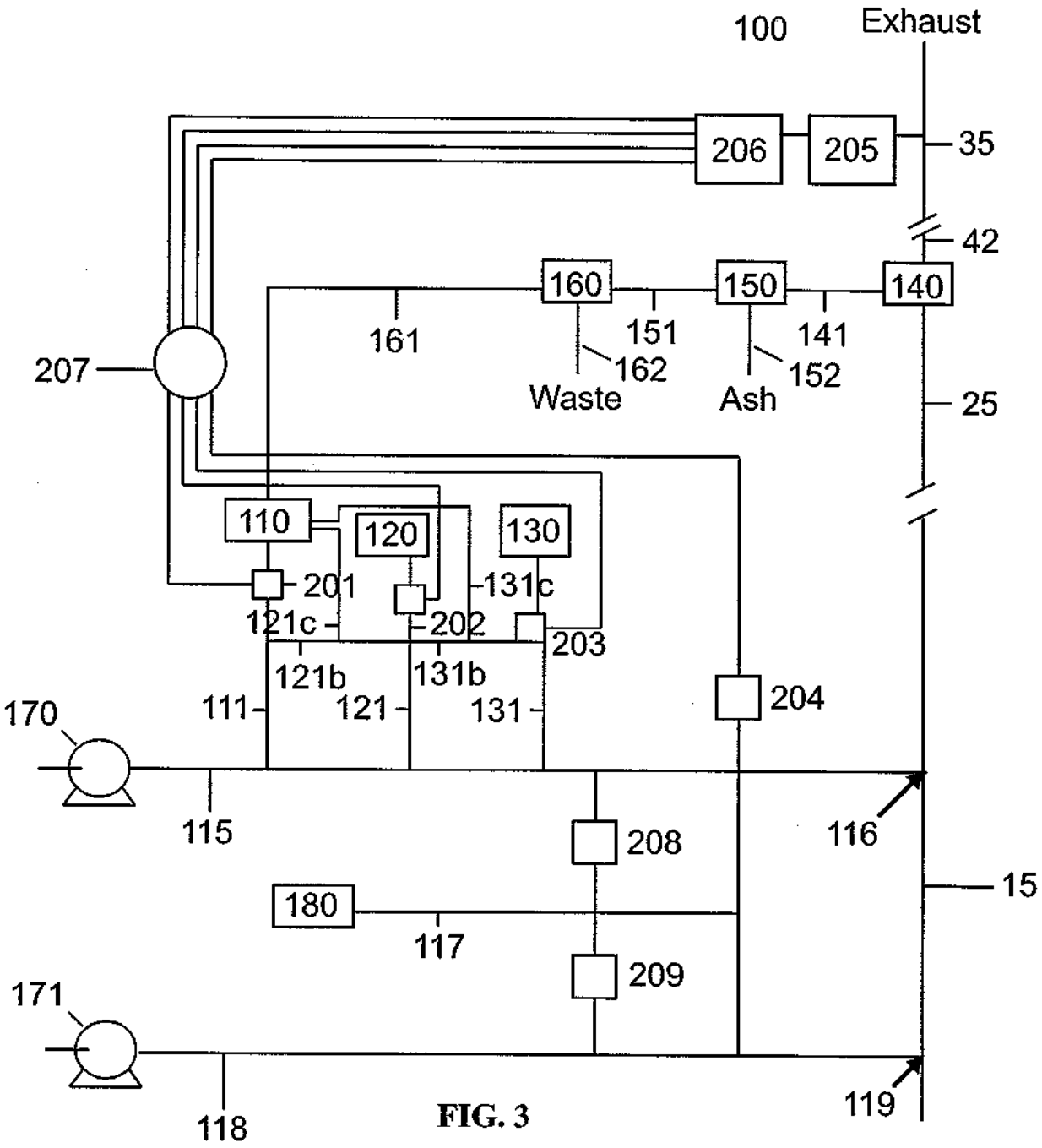

100
Exhaust
206
205
35
42
160
150
140
161
151
141
162
152
Waste
Ash
207
25
110
120
130
201
131c
121c
202
203
121b
131b
111
121
131
204
170
115
116
208
15
180
117
209
171
118
119

FIG. 3

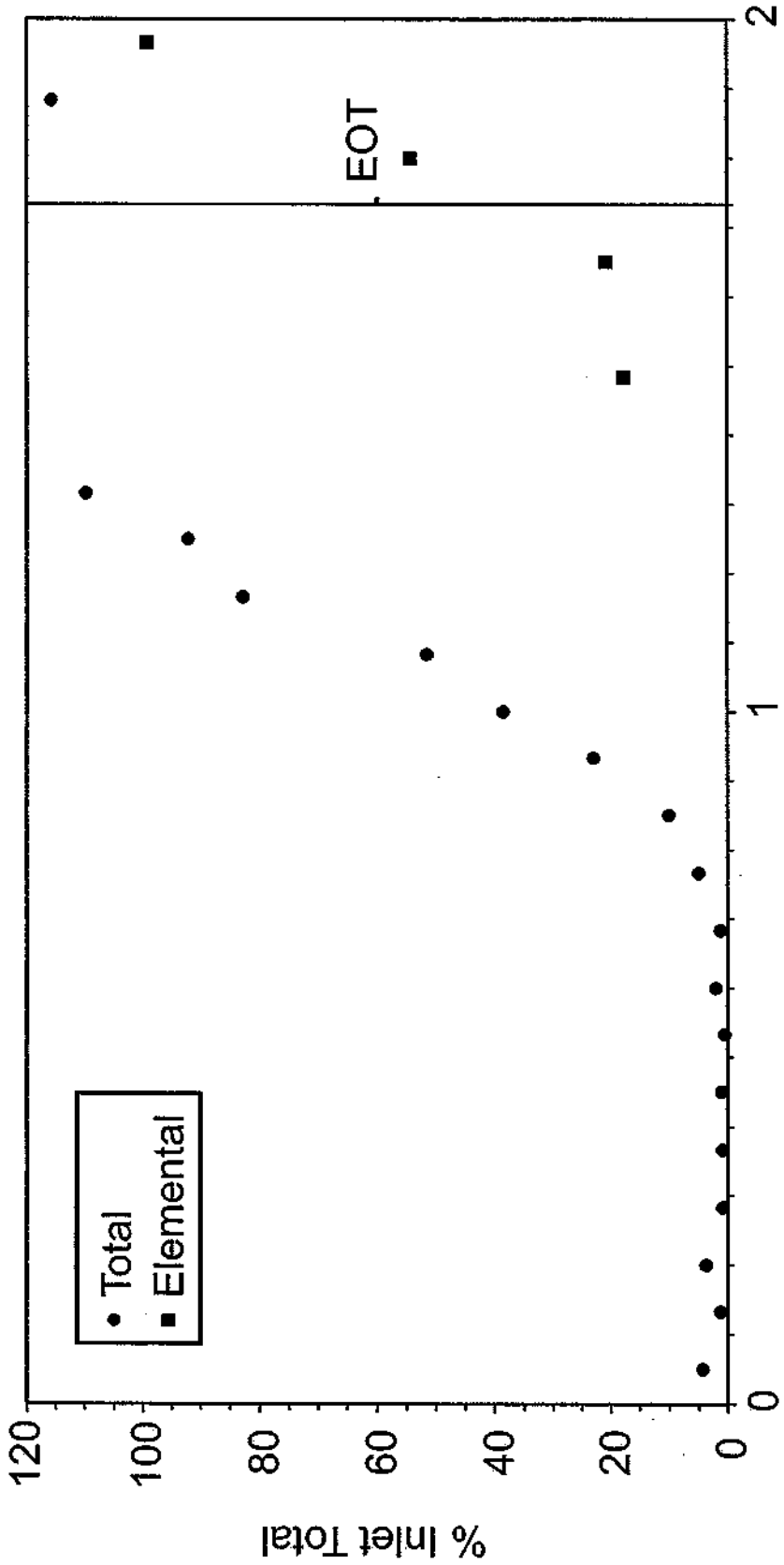

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 4

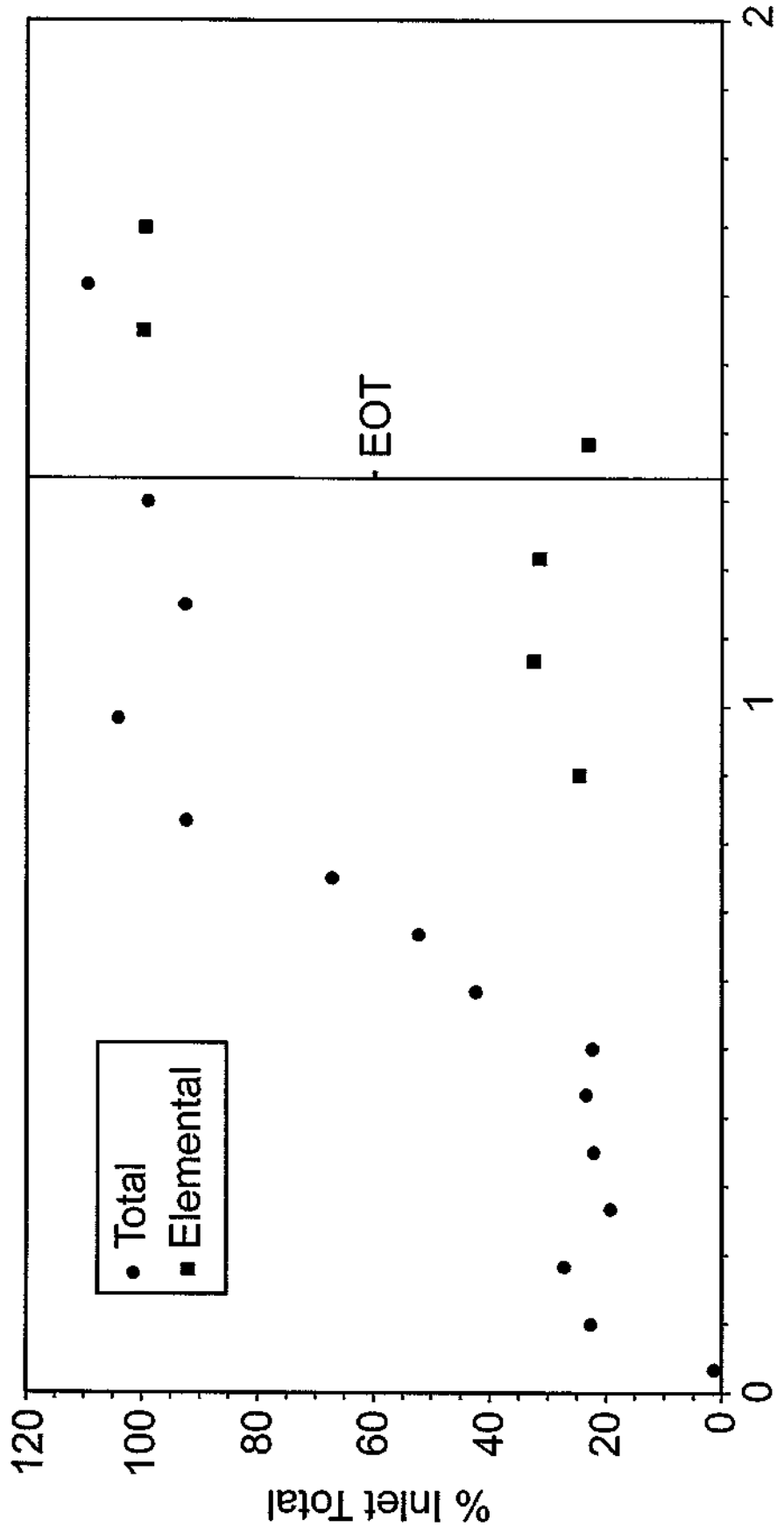

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 5

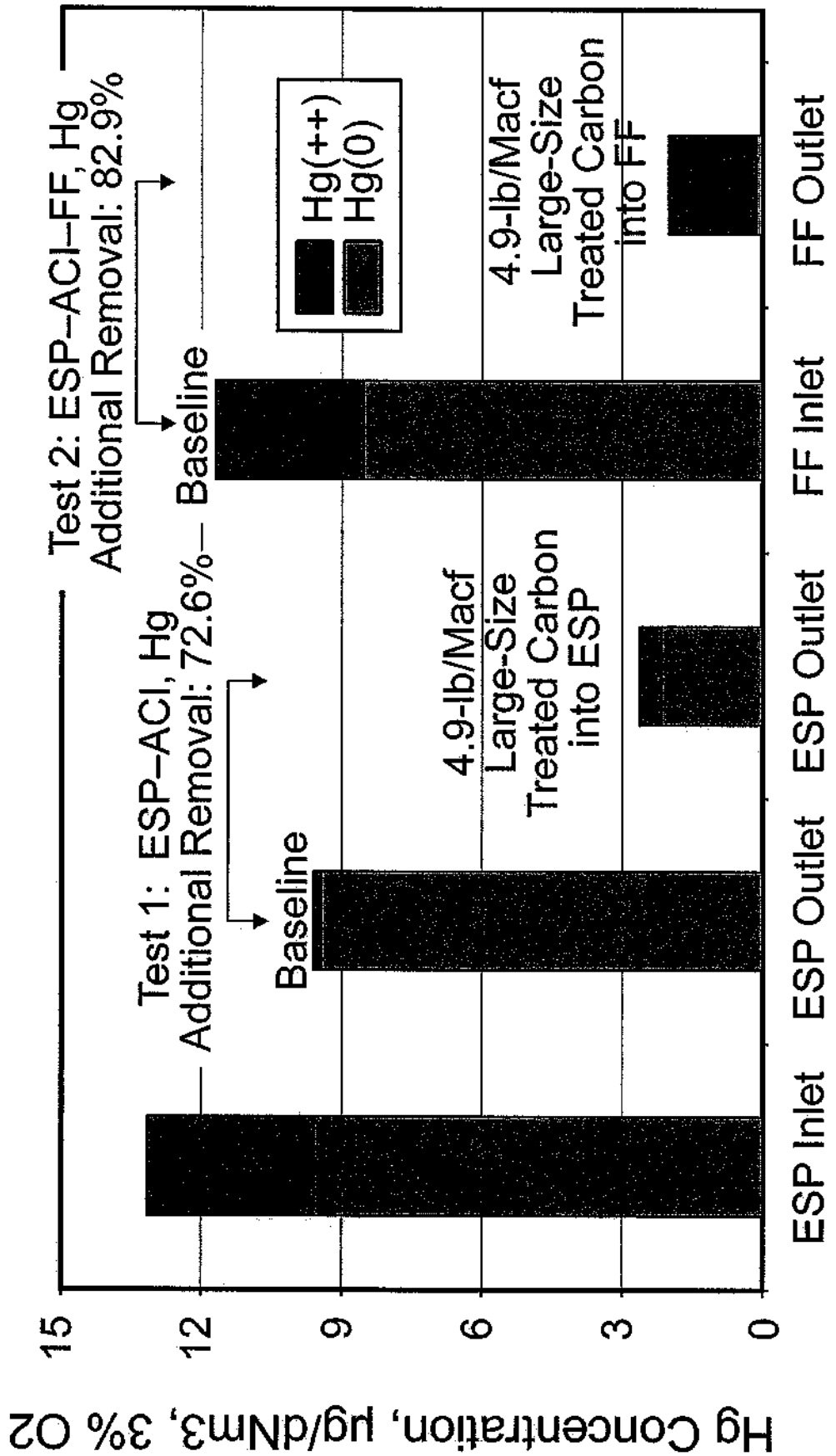

Hg Concentration, µg/dNm3, 3% O2
15
12
9
6
3
0
Test 2: ESP–ACI–FF, Hg
Additional Removal: 82.9%
Baseline
Test 1: ESP–ACI, Hg
Additional Removal: 72.6%
Baseline
4.9-lb/Macf
Large-Size
Treated Carbon
into ESP
4.9-lb/Macf
Large-Size
Treated Carbon
into FF
Hg(++)
Hg(0)
ESP Inlet
ESP Outlet
ESP Outlet
FF Inlet
FF Outlet

FIG. 6

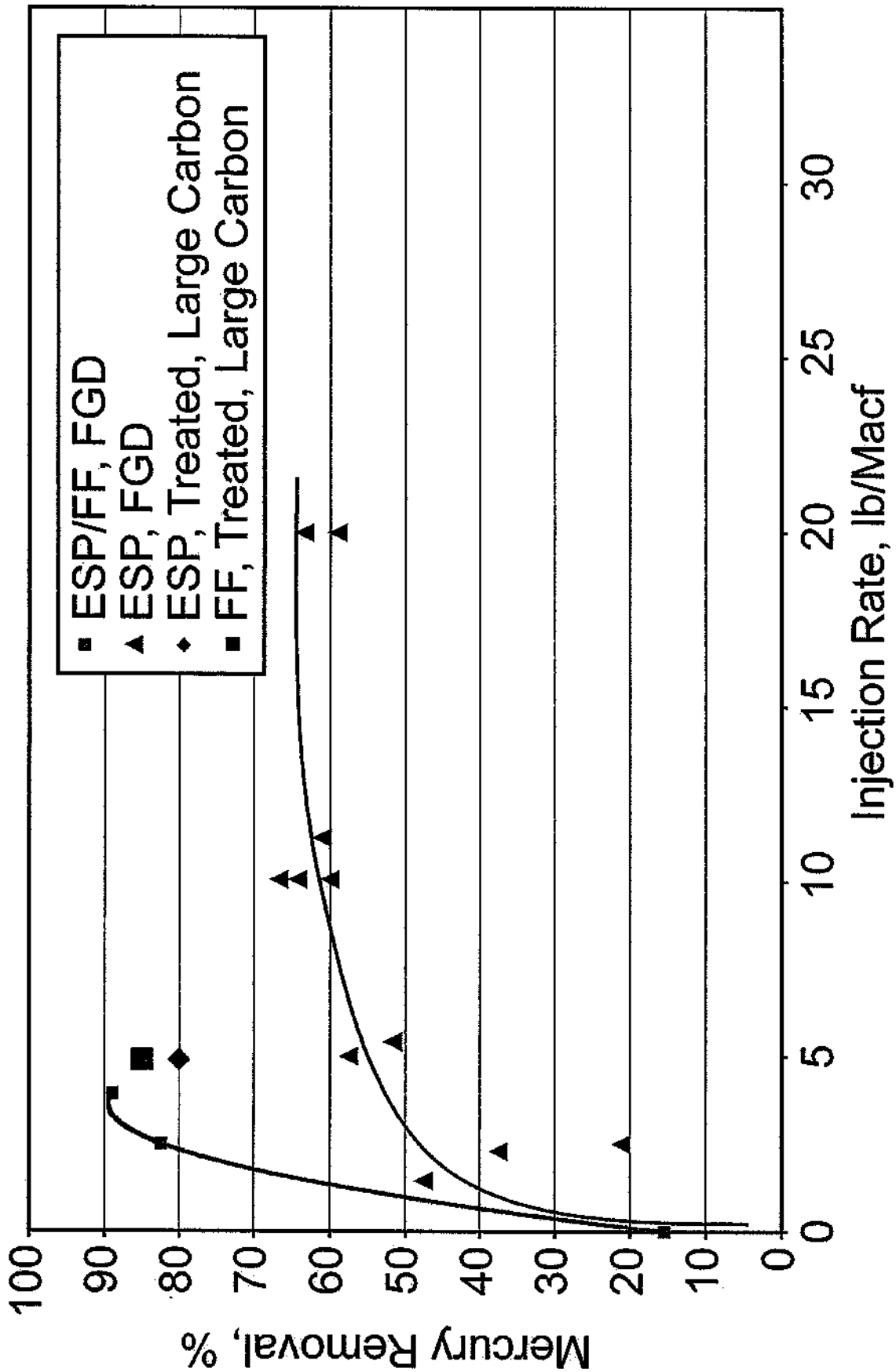

ESP/FF, FGD
ESP, FGD
ESP, Treated, Large Carbon
FF, Treated, Large Carbon
Mercury Removal, %
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Injection Rate, lb/Macf

FIG. 7

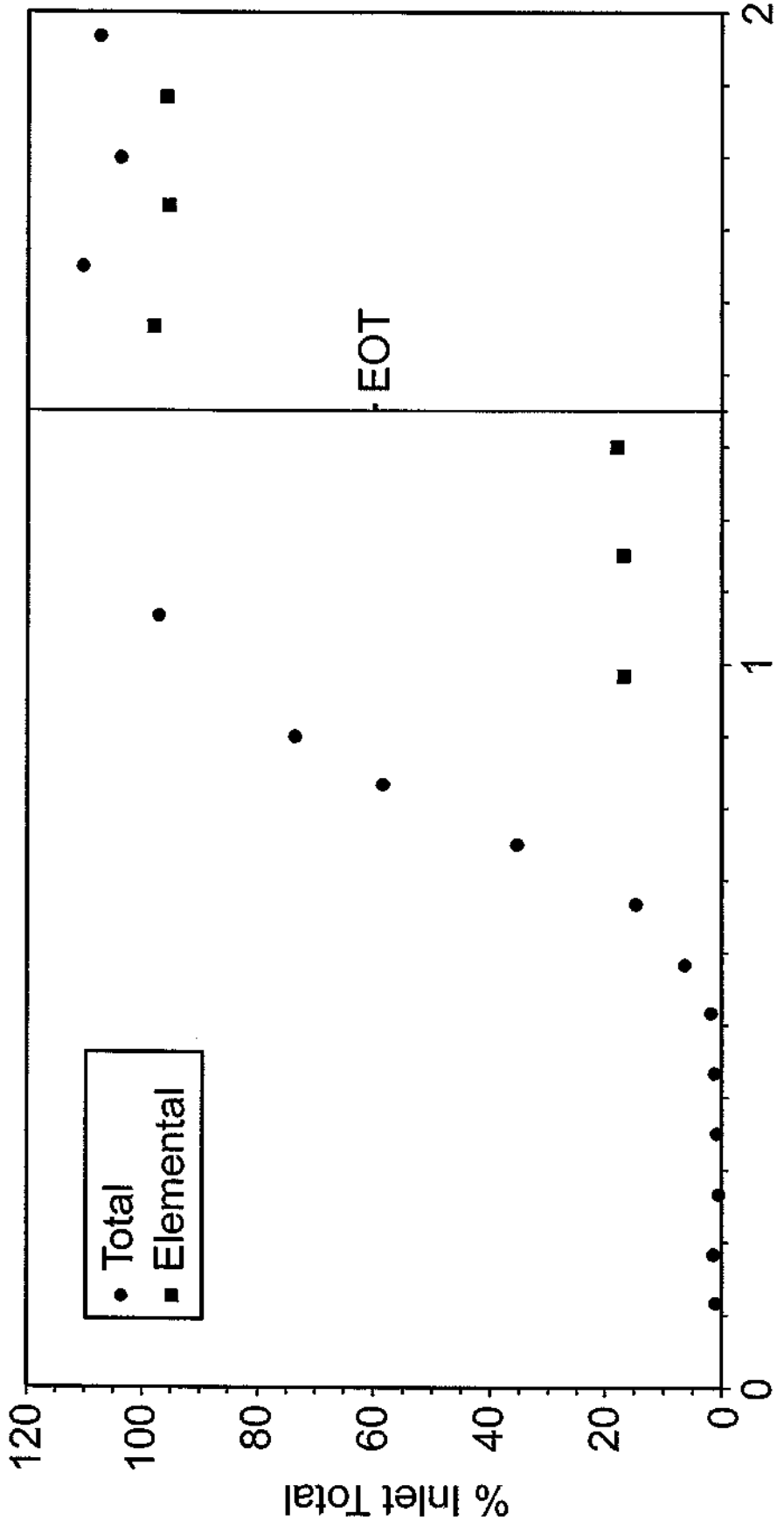

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 8

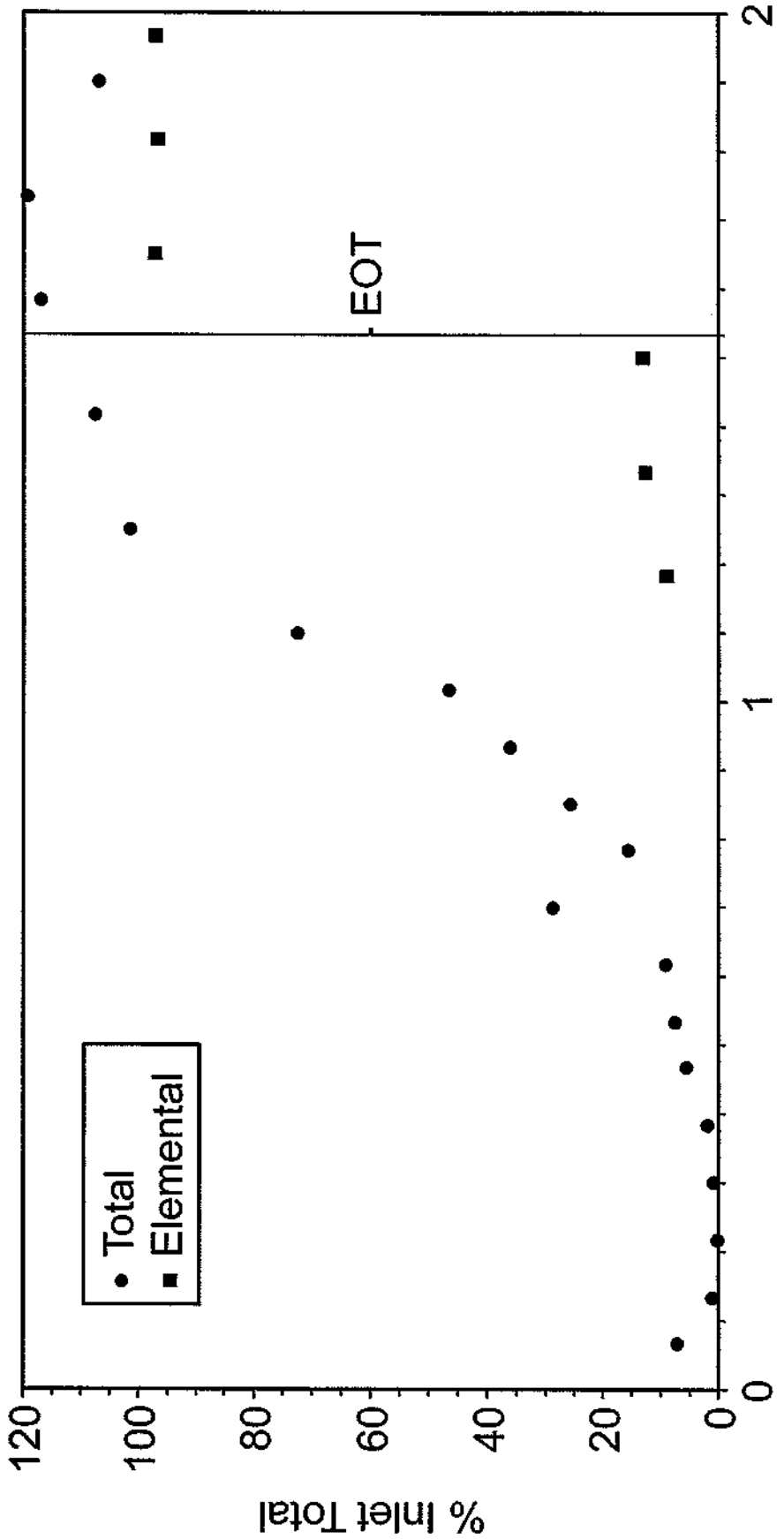

% Inlet Total
120
100
80
60
40
20
0
0
1
2
Time, hr
EOT
Total
Elemental

FIG. 9

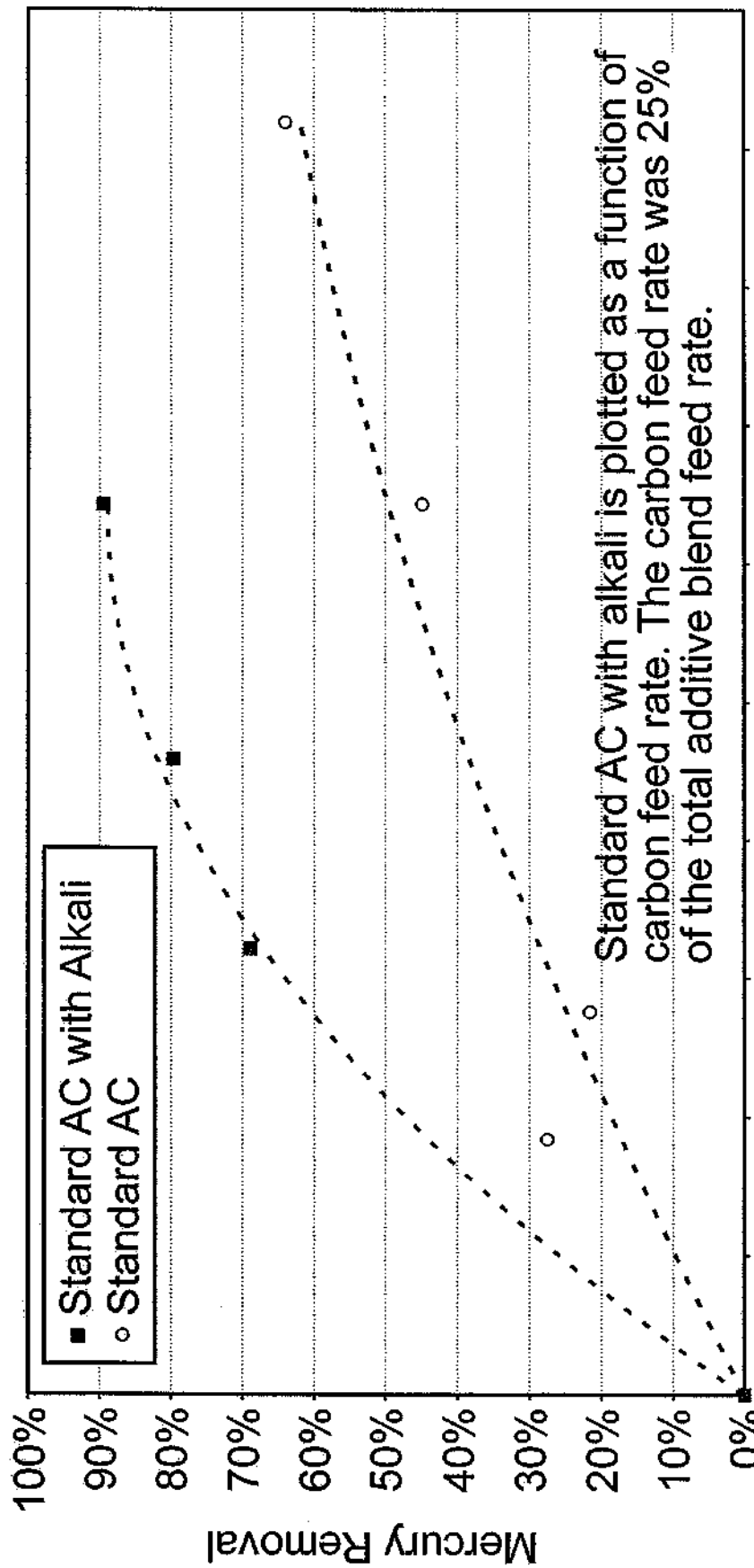

■ Standard AC with Alkali
○ Standard AC
Mercury Removal
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
Carbon Injection Rate, lb/Macf
Standard AC with alkali is plotted as a function of carbon feed rate. The carbon feed rate was 25% of the total additive blend feed rate.

FIG. 10

Electronic Acknowledgement Receipt

EFS ID:	6392353
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Rebecca Krueger
Filer Authorized By:	Dennis Robert Daley
Attorney Docket Number:	16291.0001USC1
Receipt Date:	04-NOV-2009
Filing Date:	06-APR-2009
Time Stamp:	16:15:09
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	Resp-MParts.PDF	32222 calab7a258aa7eaf7d56e538396f2b358899c9c96	no	1

Warnings:	
Information:	

2	Drawings-only black and white line drawings	Replacement-Figs.PDF	457852 04c4477cf0a99782ae3f42b5c396cf1752fc32c6	no	10

Warnings:	
Information:	
Total Files Size (in bytes):	490074

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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/419,219	04/06/2009	1795	631	16291.0001USC1	24	1

CONFIRMATION NO. 1149

23552
MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

FILING RECEIPT

OC000000037606560

Date Mailed: 09/04/2009

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Applicant(s)

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

Assignment For Published Patent Application

Energy & Environmental Research Center Foundation, Grand Forks, ND

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 12/201,595 08/29/2008
which is a DIV of 11/209,163 08/22/2005 PAT 7,435,286
which claims benefit of 60/605,640 08/30/2004

Foreign Applications

If Required, Foreign Filing License Granted: 08/31/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/419,219**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****

Title

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

Preliminary Class

430

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/419,219	04/06/2009	Edwin S. Olson	16291.0001USC1

CONFIRMATION NO. 1149

23552
MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

FORMALITIES LETTER

OC000000037606561

Date Mailed: 09/04/2009

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. 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 required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings have a line quality that is too light to be reproduced (weight of all lines and letters must be heavy enough to permit adequate reproduction) or text that is illegible (reference characters, sheet numbers, and view numbers must be plain and legible) see 37 CFR 1.84(l) and (p)(1)); See Figure(s) 2, 4-10.
  - Numbers, letters, and reference characters on the drawings must measure at least 0.32 cm (1/8 inch) in height. See Figure(s) 3-10.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/atesfaye/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Electronic Patent Application Fee Transmittal

Application Number:	12419219
Filing Date:	
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Filer:	Dennis Robert Daley/Carla Catalano
Attorney Docket Number:	16291.0001USC1

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	82	82
Utility Search Fee	2111	1	270	270
Utility Examination Fee	2311	1	110	110
Pages:				
Claims:				
Claims in excess of 20	2202	4	26	104
Miscellaneous-Filing:				
Late filing fee for oath or declaration	2051	1	65	65

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**631**

Electronic Acknowledgement Receipt

EFS ID:	5204844
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Carla Catalano
Filer Authorized By:	Dennis Robert Daley
Attorney Docket Number:	16291.0001USC1
Receipt Date:	23-APR-2009
Filing Date:	
Time Stamp:	13:52:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$631
RAM confirmation Number	187
Deposit Account	132725
Authorized User	DALEY,DENNIS R.

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 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (PTO-875)	fee-info.pdf	38213 e68446a2295a369119fd1da5feb2b8672004ef15	no	2

Warnings:

Information:

Total Files Size (in bytes):	38213

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

DOCKET NUMBER	ANTICIPATED CLASSIFICATION OF THIS APPLICATION:		PRIOR APPLICATION	
	CLASS	SUBCLASS	EXAMINER	ART UNIT
16291.0001USC1				1797

EFS Filing

CONTINUATION APPLICATION UNDER 37 C.F.R. § 1.53(b)

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

Dear Sir:

This is a request for filing a continuation application under 37 CFR § 1.53(b) of Serial No. 12/201,595, filed on August 29, 2008 entitled SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY by the following inventor(s):

Full Name Of Inventor	**Family Name** Edwin	**First Given Name** S.	**Second Given Name** Olson
Residence & Citizenship	**City** Grand Forks	**State or Foreign Country** North Dakota	**Country of Citizenship** U.S.A.
Post Office Address	**Post Office Address** 223 Circle Hills Drive	**City** Grand Forks	**State & Zip Code/Country** North Dakota 58201 U.S.A.
Full Name Of Inventor	**Family Name** Michael	**First Given Name** J.	**Second Given Name** Holmes
Residence & Citizenship	**City** Thompson	**State or Foreign Country** North Dakota	**Country of Citizenship** U.S.A.
Post Office Address	**Post Office Address** 614 - 6th Avenue	**City** Thompson	**State & Zip Code/Country** North Dakota 58278 U.S.A.
Full Name Of Inventor	**Family Name** John	**First Given Name** H.	**Second Given Name** Pavlish
Residence & Citizenship	**City** East Grand Forks	**State or Foreign Country** Minnesota	**Country of Citizenship** U.S.A.
Post Office Address	**Post Office Address** 42204 - 210th Street S.W.	**City** East Grand Forks	**State & Zip Code/Country** Minnesota 56721 U.S.A.

1. ☒ Enclosed is a copy of the prior application; including the specification, claims, drawings, a signed oath or declaration, and any amendments referred to in the oath or declaration filed to complete the prior application. (It is noted that no amendments referred to in the oath or declaration filed to complete the prior application introduced new matter therein.) The prior application is as follows: 29 pages of specification, 33 claims, 1 page of abstract, 7 sheets of drawings, and 1 pages of oath or declaration.

☒ The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

2. ☒ The filing fee is calculated below:

☒ Small entity status is claimed pursuant to 37 CFR 1.27.

3. ☒ Payment of fees:

☒ **PAYMENT OF THE FILING FEE IS BEING DEFERRED.**

4. ☒ The Commissioner is hereby authorized to charge any additional fees as set forth in 37 CFR §§ 1.16 to 1.18 which may be required by this paper or credit any overpayment to Account No. 13-2725.

5. ☐ A set of formal drawings (sheets) is enclosed.

6. ☒ Priority of application Serial No. 60/605,640, filed on August 30, 2004 in the U.S.A., is claimed under 35 U.S.C. 119.

☐ The certified copy has been filed in prior application Serial No.

7. ☒ The prior application is assigned of record to Energy & Environmental Research Center Foundation, 15 North 23rd Street, Grand Forks, North Dakota 58202-9018.

8. ☒ The Power of Attorney in the prior application is to:

Conley Rose, P.C., P.O. Box 3267, Houston, Texas 77253-3267

9. ☒ A preliminary amendment is enclosed. (Claims added by this amendment have been properly numbered consecutively beginning with the number next following the highest numbered original claim in the prior application.)

☐ Fee for excess claims is attached.

10. ☐ A petition and fee has been filed to extend the term in the prior application until . A copy of the petition for extension of time in the prior application is attached.

11. ☐ The inventor(s) in this application are less than those named in the prior application and it is requested that the following inventors identified above for the prior application be deleted:

12. ☐ A Non-publication Request under 37 CFR 1.213(a) is enclosed.

13. ☐ Information Disclosure Statement, Form 1449 and reference(s).

14. ☒ Application Data Sheet, 4 pages.

15. ☐ Also Enclosed:

16. ☒ Address all future communications to the **Attention of Dennis R. Daley** associated with the customer number below (may only be completed by attorney or agent of record)

17. ☒ A return postcard is enclosed.

23552
PATENT TRADEMARK

Respectfully submitted,

MERCHANT & GOULD P.C.

Dated: April 6, 2009

By: Dennis R. Daley
Reg. No. 34,994
GAS/TPJ/krn

PTO/SB/01A (08-03)
Approved for use through 06/30/2006. 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.

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 inventors, we declare that:

This Declaration is directed to:

☐ The attached application, or

☒ Application No. 12/201,595, filed on August 29, 2008.

☐ as amended on (if applicable);

We believe that we are the original and first inventors of the subject matter which is claimed and for which a patent is sought;

We have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

We acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to 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 our 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: 10-14, 2008	
Signature: Edwin S Olson	Citizen of: US	
Inventor two: Michael J. Holmes	Date: 9/25, 2008	
Signature: Michael J Holmes	Citizen of: US	
Inventor three: John H. Pavlish	Date: 9/26/, 2008	
Signature: John Pavlish	Citizen of: US	
Inventor four:	Date: _____, 2008	
Signature:	Citizen of:	
Inventor five:	Date: _____, 2008	
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.

Application Data Sheet

Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested Classification::	
Suggested Group Art Unit::	
CD-ROM or CD_R?::	None
Number of CD disks::	
Number of copies of CDs::	
Sequence Submission::	No
Computer Readable Form (CRF)?::	No
Title::	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
Attorney Docket Number::	16291.0001USC1
Request For Early Publication::	No
Request For Non-Publication::	No
Suggested Drawing Figure::	1
Total Drawing Sheets::	7
Small Entity::	Yes
Latin Name::	
Variety Denomination Name::	
Petition Included::	No
Petition Type::	
Licensed US Govt. Agency::	
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	No

Initial 04/06/09

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	U.S.A.
Status::	Full Capacity
Given Name::	Edwin
Middle Name::	S.
Family Name::	Olson
Name Suffix::	
City of Residence::	Grand Forks
State or Province of Residence::	North Dakota
Country of Residence::	U.S.A.
Street of mailing address::	223 Circle Hills Drive
City of mailing address::	Grand Forks
State or Province of mailing address::	North Dakota
Country of mailing address::	U.S.A.
Postal or Zip Code of mailing address::	58201

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	U.S.A.
Status::	Full Capacity
Given Name::	Michael
Middle Name::	J.
Family Name::	Holmes
Name Suffix::	
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State or Province of Residence::	North Dakota
Country of Residence::	U.S.A.
Street of mailing address::	614 - 6th Avenue

Initial 04/06/09

City of mailing address::	Thompson
State or Province of mailing address::	North Dakota
Country of mailing address::	U.S.A.
Postal or Zip Code of mailing address::	58278

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	U.S.A.
Status::	Full Capacity
Given Name::	John
Middle Name::	H.
Family Name::	Pavlish
Name Suffix::	
City of Residence::	East Grand Forks
State or Province of Residence::	Minnesota
Country of Residence::	U.S.A.
Street of mailing address::	42204 - 210th Street S.W.
City of mailing address::	East Grand Forks
State or Province of mailing address::	Minnesota
Country of mailing address::	U.S.A.
Postal or Zip Code of mailing address::	56721

Correspondence Information

Correspondence Customer Number::	23552

Initial 04/06/09

Representative Information

Representative Customer Number::	23552

Domestic Priority Information

Application::	Continuation Type::	Parent Application::	Parent Filing Date::
This application	Continuation	12/201,595	08/29/2008
which is a	Division of	11/209,163	08/22/05
which is a	Utility based on Provisional	60/605,640	08/30/04

Assignee Information

Assignee Name::	Energy & Environmental Research Center Foundation
Street of mailing address::	15 North 23rd Street
City of mailing address::	Grand Forks
State or Province of mailing address::	North Dakota
Country of mailing address::	U.S.A.
Postal or Zip Code of mailing address::	58202-9018

Initial 04/06/09

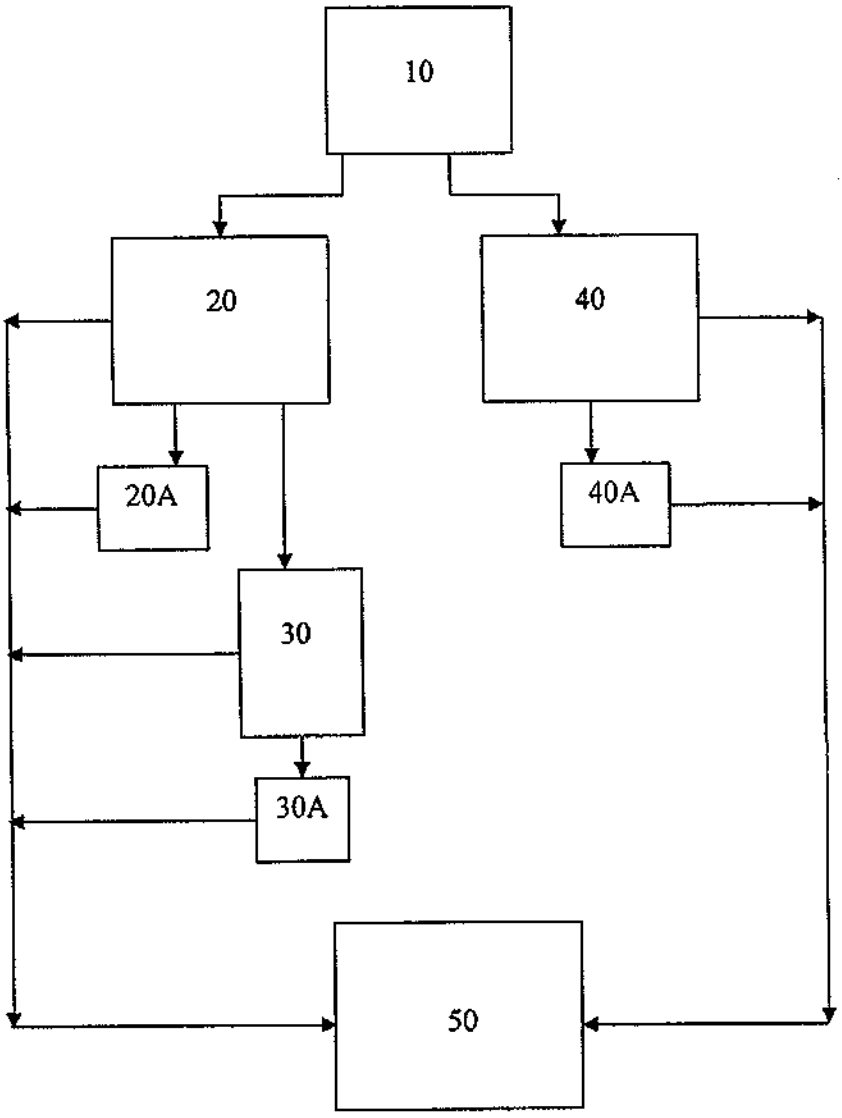


FIG. 1

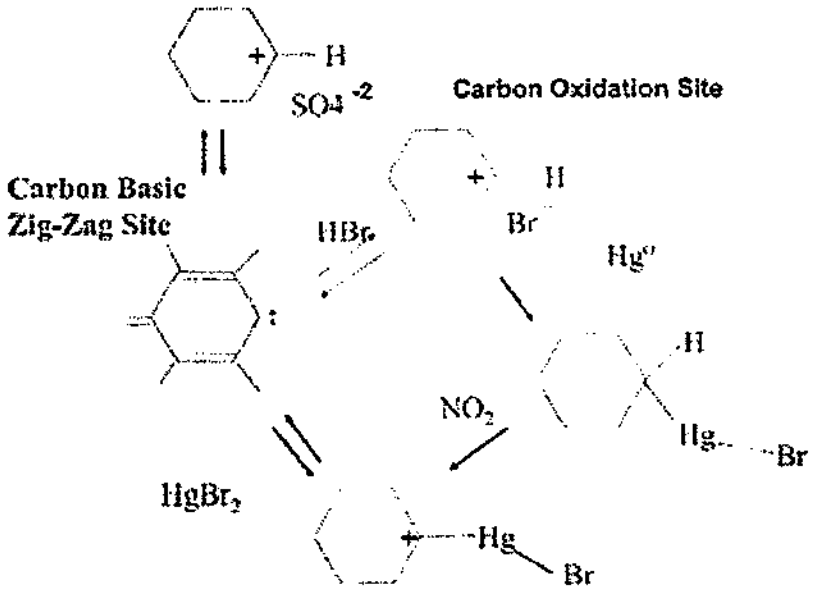

Carbon Basic
Zig-Zag Site
Carbon Oxidation Site
SO4 -2
HBr
Br
Hg"
H
NO2
Hg
Br
HgBr2
Hg
Br

FIG. 2

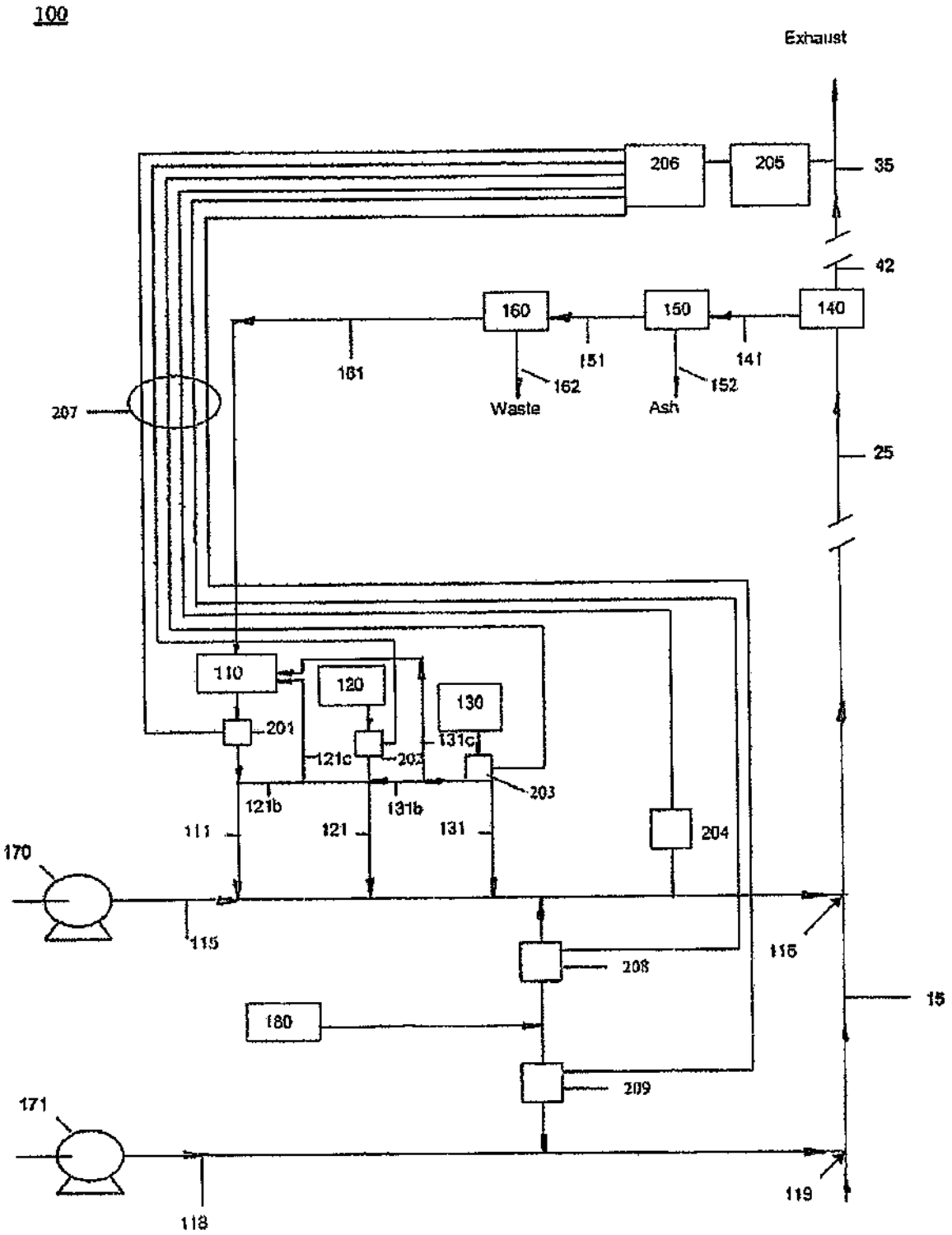

100
Exhaust
206
205
35
42
160
150
140
161
151
141
162
152
Waste
Ash
207
25
110
120
130
201
131c
121c
202
203
121b
131b
111
121
131
204
170
115
116
208
15
180
209
171
119
118

FIG. 3

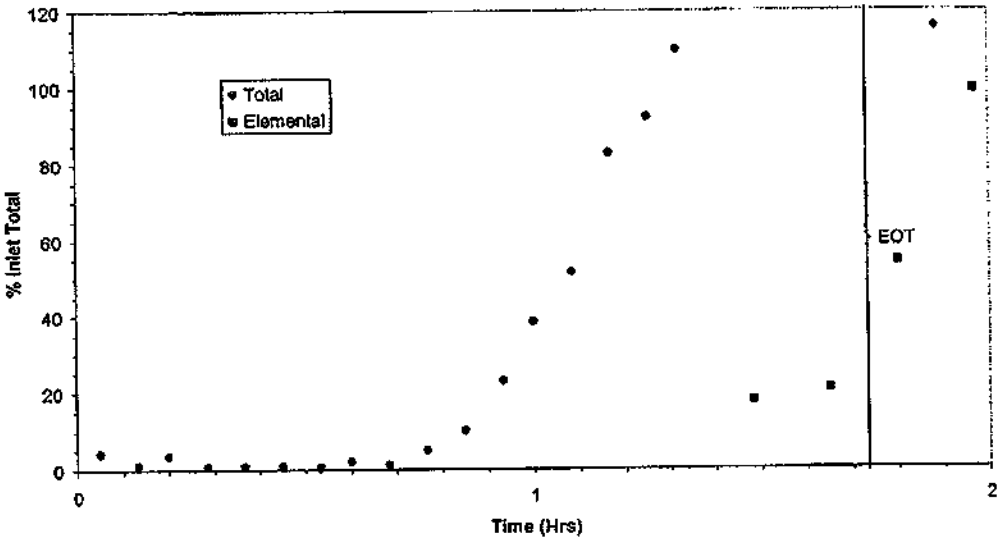

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 4

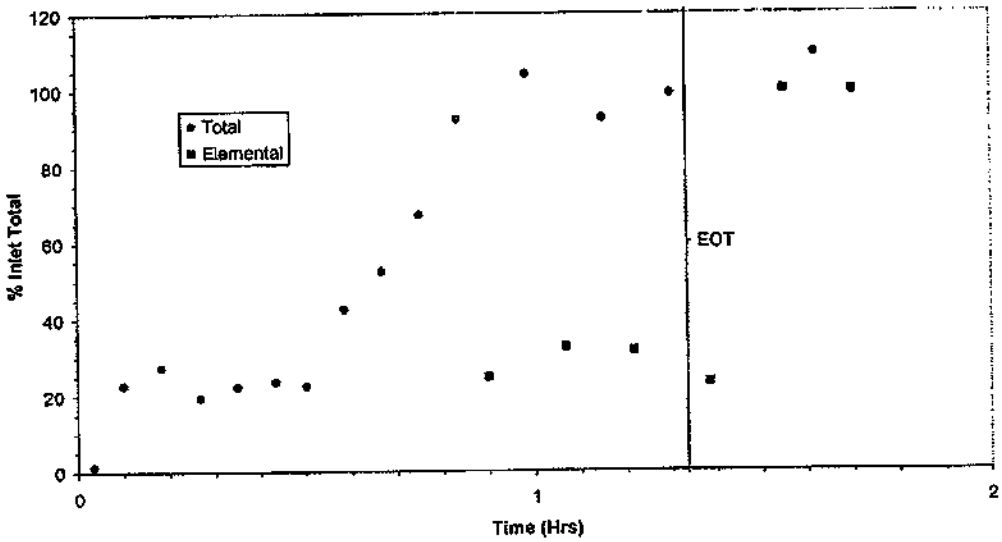

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 5

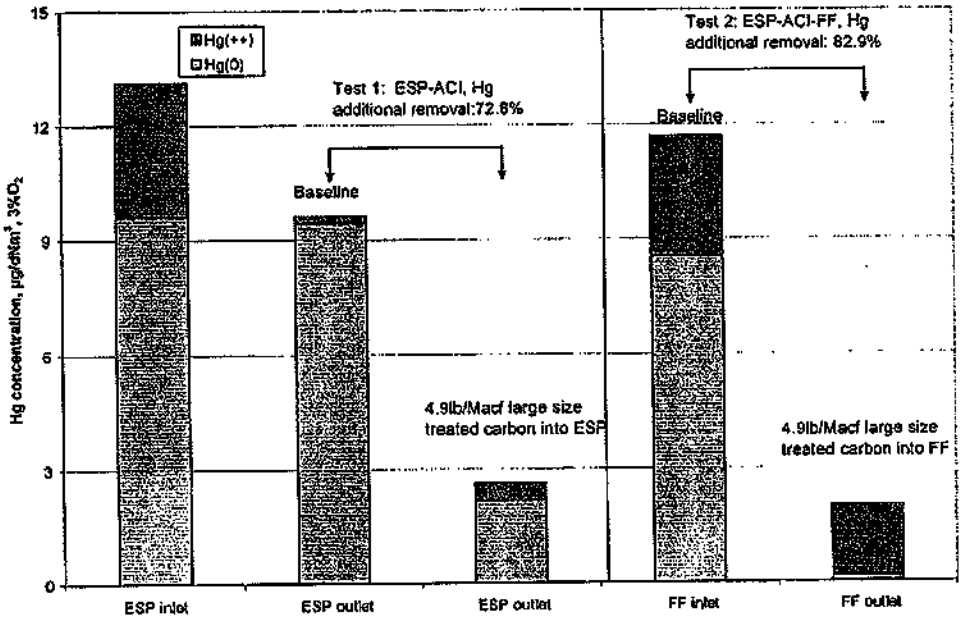

Hg(++)
Hg(0)
Test 1: ESP-ACI, Hg additional removal:72.6%
Baseline
4.9lb/Macf large size treated carbon into ESP
Test 2: ESP-ACI-FF, Hg additional removal: 82.9%
Baseline
4.9lb/Macf large size treated carbon into FF
Hg concentration, µg/dNm³, 3%O2
ESP inlet
ESP outlet
ESP outlet
FF inlet
FF outlet

FIG. 6

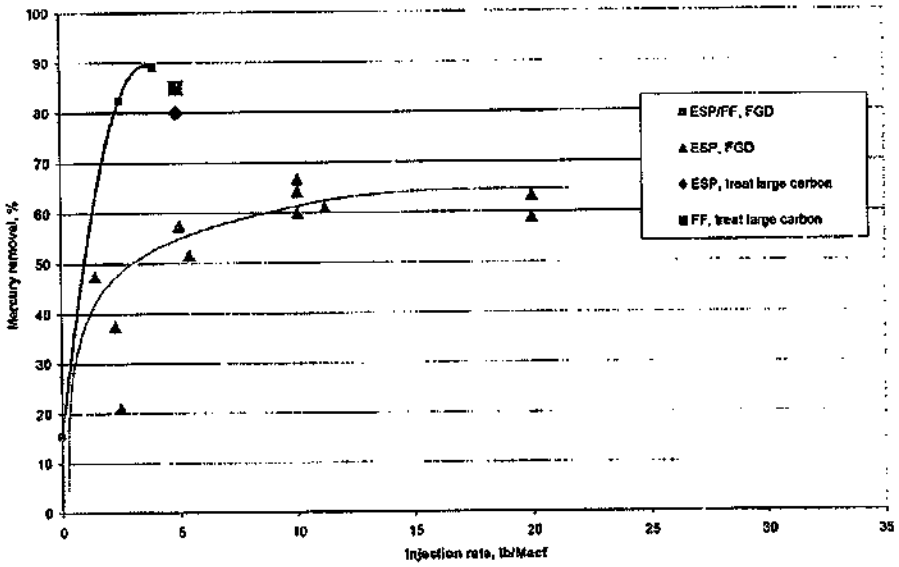

ESP/FF, FGD
ESP, FGD
ESP, treat large carbon
FF, treat large carbon
Mercury removal, %
Injection rate, lb/Macf

FIG. 7

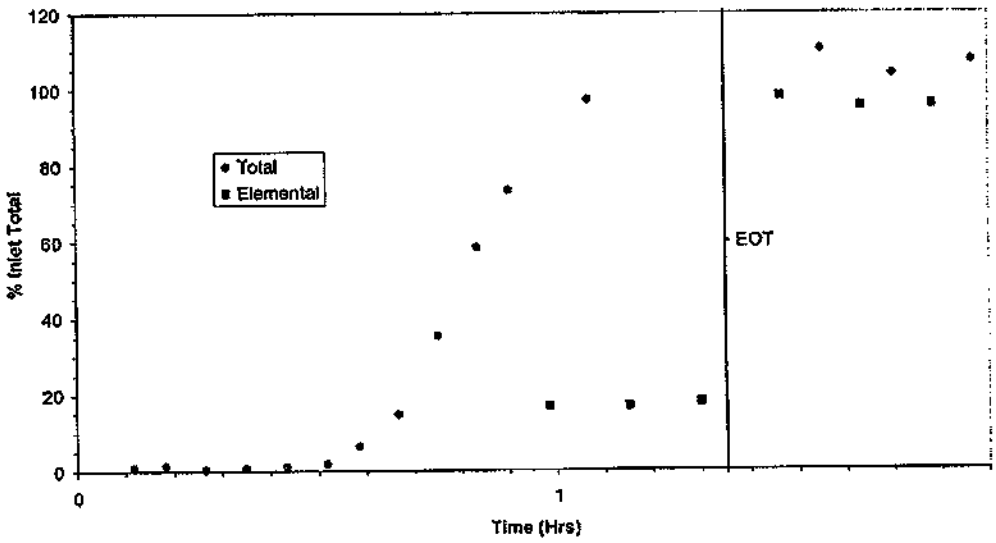

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
Time (Hrs)

FIG. 8

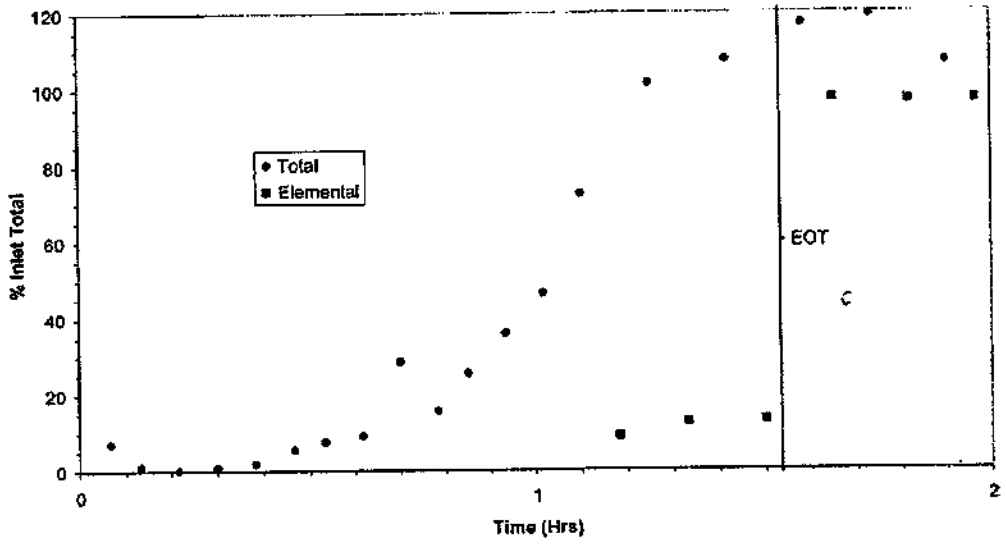

120
100
80
60
40
20
0
% Inlet Total
Total
Elemental
EOT
0
1
2
Time (Hrs)

FIG. 9

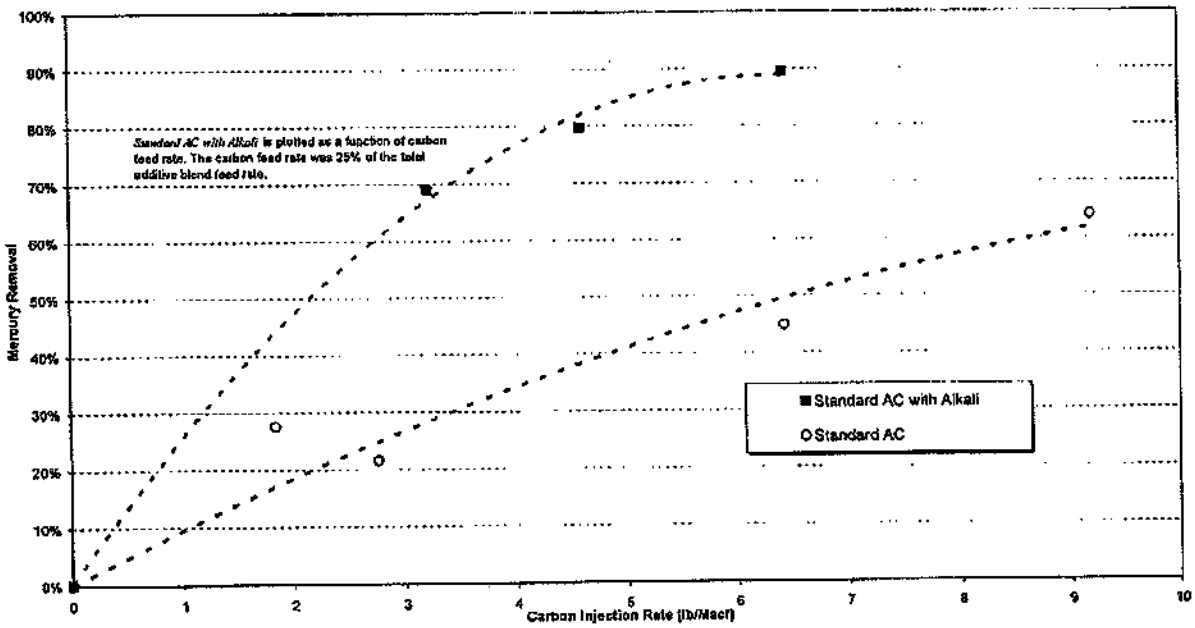

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mercury Removal
Standard AC with Alkali is plotted as a function of carbon feed rate. The carbon feed rate was 25% of the total additive blend feed rate.
Standard AC with Alkali
Standard AC
0
1
2
3
4
5
6
7
8
9
10
Carbon Injection Rate (lb/Macf)

FIG. 10

SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. Patent Application No. 11/209,163 filed August 22, 2005, entitled "Sorbents for the Oxidation and Removal of Mercury", which claims the benefit of U.S. Provisional Application Serial No. 60/605,640, filed August 30, 2004, both applications are hereby incorporated herein by reference in their entirety for all purposes.

STATEMENT REGARDING F EDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] This invention was made with United States Government support under Grant Numbers R 827649-01 and CR 830929-01 awarded by the United States Environmental Protection Agency and under Contract Number DE-FC26-98FT40320 awarded by the United States Department of Energy. The United States Government has certain rights in this invention.

BACKGROUND OF THE INVENTION

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

[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 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 a 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 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 in a flue gas with substantially lower sorbent requirements. Through enhanced sorbent reactivity, mercury removal per gram of sorbent is increase, thereby decreasing the capital and operating costs by decreasing sorbent requirements.

[0020] In an embodiment, a method is provided for reducing mercury in flue gas comprising providing a sorbent, injecting the sorbent into a mercury-containing flue gas stream, collecting greater than 70 wt-% of the mercury in the flue gas on the sorbent to produce a cleaned flue gas, and substantially recovering the sorbent from the cleaned flue gas. In embodiments where less than 70 wt-% mercury removal is desired, the required removal may preferably be attained using less than half as much carbon as would be required with standard (non-enhanced) carbon. In a further embodiment, the method further comprises monitoring the mercury content of the clean flue gas, regenerating the recovered sorbent, and using the monitored mercury content of the cleaned flue gas to control the rate of injection of the sorbent. In another embodiment the injected sorbent is prepared in-flight by reacting an activated carbon and a promoter within a pneumatic transport line from which the reaction product is injected to the mercury-containing flue gas stream.

[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 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.

[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

[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 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 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 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 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 ebulliated 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 ebulliated 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 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.

This phenomenon may not occur with the less reactive iodine, where an I_2 molecular complex can exist on the carbon basal plane. In the case of bromine, modified cationic carbon has a high chemical potential for oxidation of mercury. Thus, an entirely new model is presented for the reactivity of the bromine-treated carbon with mercury. The reactive carbon form can preferably be generated by the addition of bromine, hydrogen bromide, or combinations of bromine and other elements, as described herein. Halogen treatment resulted in higher-activity carbons because the halide anions (especially bromide and iodide) were effective in promoting the oxidation by stabilizing the developing positive charge on the mercury in the transition state for oxidation. Based on this model, several innovative, inexpensive, activity-enhancing features have been developed.

Optional Second Component

[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 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 conjunction with a base activated carbon and/or with the use of a halogen based sorbent and any other combinations of the sorbent technologies provided in this patent. Alternatively, embodiments include methods wherein the sorbent is on a moving contactor consisting of particles or fibers containing one or more of the compositions listed above.

Sorbent Regeneration

[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,

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 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 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.

[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)

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.

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 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 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.

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 and carbon fiber sorbents by treatment with molecular bromine in solution or in dry beds as described above.

Example 9 - Fluidized/Ebulliated 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 ebulliated 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 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 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 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

[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.

CLAIMS

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, 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. 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 an activated carbon matrix in a fixed or a moving bed structure.

4. The promoted carbon sorbent of claim 3 wherein the structure is selected from the group consisting of moving fiber screens and monoliths.

5. The promoted carbon sorbent of claim 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. 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.

7. The promoted carbon sorbent of claim 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.

8. The promoted carbon sorbent of claim 7 wherein the promoter is selected from the group consisting of Br_2, HBr, and combinations thereof.

9. The promoted carbon sorbent of claim 7 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.

10. The promoted carbon sorbent of claim 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.

11. The promoted carbon sorbent of claim 10 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.

12. The promoted carbon sorbent of claim 10 wherein the optional secondary component is selected from the group consisting of Group V halides, Group VI halides, HI, HBr, HCl, and combinations thereof.

13. The promoted carbon sorbent of claim 12 wherein the optional secondary component is selected from the group consisting of I_2, HI, and combinations thereof.

14. The promoted carbon sorbent of claim 13 wherein the promoter is substantially in vapor form when combined with the base activated carbon.

15. The promoted carbon sorbent of claim 13 wherein the promoter is combined with an organic solvent prior to reaction with the base activated carbon.

16. The promoted carbon sorbent of claim 13 wherein the promoter and optional secondary component are combined with the base activated carbon substantially simultaneously.

17. A method of preparing a promoted carbon sorbent comprising providing an 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.

18. The method of claim 17 wherein the activated carbon has an average particle size 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.

19. The method of claim 18 wherein the reaction product has an average particle size distribution greater than about 40 micrometers.

20. The method of claim 17 further comprising preparing the sorbent in-flight by reacting the activated carbon, the promoter, and an optional secondary component to enhance the reactivity and mercury capacity of the sorbent.

21. The method of claim 17 further comprising continuously monitoring the mercury content of the cleaned gas stream.

22. The promoted carbon sorbent prepared by the method of claim 21.

23. The method of claim 17 wherein the sorbent comprises an activated carbon matrix in a fixed or a moving bed structure.

24. The method of claim 23 wherein the structure is selected from the group consisting of moving fiber screens and monoliths.

25. The method of claim 17 wherein the ratio of activated carbon to promoter is adjusted for optimization of economic removal of mercury from the gas stream.

26. The method of claim 17 wherein the reaction product comprises from about 1 to about 30 grams promoter per 100 grams activated carbon.

27. The method of claim 26 wherein the promoter is in an organic solvent when contacting the activated carbon.

28. The method of claim 26 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

29. The method of claim 26 wherein the promoter is in the gas phase when contacting the activated carbon.

30. The method of claim 29 wherein the promoter is selected from the group consisting of Br_2, a Group V bromide, a Group VI bromide, and combinations thereof.

31. The method of claim 29 further comprising reacting the 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.

32. The method of claim 31 further comprising providing an optional alkaline component to improve the effectiveness of mercury removal.

33. The method of claim 31 wherein the promoter and optional secondary component are contacted substantially simultaneously with the activated carbon.

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.

Electronic Acknowledgement Receipt

EFS ID:	5106669
Application Number:	12419219
International Application Number:	
Confirmation Number:	1149
Title of Invention:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY
First Named Inventor/Applicant Name:	Edwin S. Olson
Customer Number:	23552
Filer:	Dennis Robert Daley/Karen Nejedly
Filer Authorized By:	Dennis Robert Daley
Attorney Docket Number:	16291.0001USC1
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Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		prelamd_20090406182004.pdf	192447 3e90d0b056b5fa750e979abdb810a2d7260a13d9	yes	7

	Multipart Description/PDF files in .zip description				
	Document Description	Start	End		
	Preliminary Amendment	1	1		
	Specification	2	2		
	Claims	3	6		
	Applicant Arguments/Remarks Made in an Amendment	7	7		
Warnings:					
Information:					
2	Transmittal of New Application	cont_20090406181914.pdf	101855 e958de3acf98db48dea559e965e49d0f7ac14819	no	3
Warnings:					
Information:					
3	Oath or Declaration filed	dec_20090406181857.pdf	71870 ab1d94819eb2507a2bc7f2d0c195663e53a1c601	no	1
Warnings:					
Information:					
4	Application Data Sheet	ads_20090406181839.pdf	90558 b27e1f62a7734cc8f9fd523930b5e55e62fadb6d	no	4
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
5	Drawings-only black and white line drawings	dwg_20090406181812.pdf	109840 bce4f99656fde899fb804446fe3d562fe6562c82	no	7
Warnings:					
Information:					
6	Miscellaneous Incoming Letter	prior_20090406181713.pdf	2027417 13adcd4553543ed29e7247ffa89895eb57a10f6d	no	34
Warnings:					
Information:					
		Total Files Size (in bytes):	2593987		

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

S/N New Filing PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Olson et al.	Examiner:	Unknown
Serial No.:	New Filing	Group Art Unit:	1709
Filed:	Herewith	Docket No.:	16291.0001USC1
Title:	SORBENTS FOR THE OXIDATION AND REMOVAL OF MERCURY		

Filed electronically on April 6, 2009.

PRELIMINARY AMENDMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Dear Sir:

Before examination, kindly amend the application as follows:

Amendments to the Specification begin on page 2.

Amendments to the Claims begin on page 3.

Remarks begin on page 7.

Amendments to the Specification:

Please replace paragraph [0001] of the specification as filed with the following:

[0001] This application is a continuation of U.S. patent application 12/201,595 filed on August 29, 2008, which is a division of U.S. patent application 11/209,163, filed on August 22, 2005 (now Patent No. 7,435,286), which claims priority to the extent appropriate from provisional application 60/605,640, filed on August 30, 2004. Application Serial Numbers 12/201,595; 11/209,163; and 60/605,640 are incorporated herein by reference.

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Amendments to the Claims:

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

Listing of Claims:

1-33. (Canceled)

34. (NEW) A method for separating mercury from a mercury containing gas comprising:

(a) providing a sorbent material;

(b) providing a halogen or halide promoter;

(c) promoting at least a portion of the sorbent material by chemically reacting the sorbent material with the halogen or halide promoter to form a promoted halogenated sorbent;

(d) chemically reacting elemental mercury in the mercury containing gas with the promoted halogenated sorbent to form a mercury/sorbent chemical composition; and

(e) separating particulates from the mercury containing gas, the particulates including ash and the mercury/sorbent chemical composition.

35. (NEW) A method according to claim 34, wherein the halogen or halide promoter comprises molecular halogen in vapor form.

36. (NEW) A method according to claim 34, wherein the halogen or halide promoter comprises molecular halogen in an organic solvent.

37. (NEW) A method according to claim 34, wherein the halogen or halide promoter comprises at least one of Group V halide in a non-aqueous solvent, Group VI halide in a non-aqueous solvent, or mixtures thereof.

38. (NEW) A method according to claim 34, wherein the sorbent material comprises base activated carbon that contains basic binding sites which react with halogens, hydrohalides, and Group V and Group 6 halides to form highly reactive acidic binding sites in the promoted sorbent for oxidation of the mercury .

39. (NEW) A method according to claim 38, wherein the acidic binding sites in the promoted activated carbon chemically react with elemental mercury form the mercury/sorbent composition.

40. (NEW) A method according to claim 38, wherein at least a portion of the basic binding sites of the activated carbon reacts with oxidized mercury in the mercury containing gas to form another mercury/sorbent chemical composition.

41. (NEW) A method according to claim 38, wherein the base activated carbon material comprises at least one of powdered activated carbon, granular activated carbon, carbon black, carbon fiber, carbon honeycomb, aerogel carbon film, pyrolysis char, or mixtures thereof.

42. (NEW) A method according to claim 34, wherein the step of separating particulates from the mercury containing gas comprises separating in a particulate separator comprising one or more electrostatic precipitators.

43. (NEW) A method according to claim 34, further comprising a step of regenerating a promoted halogenated sorbent from the mercury/sorbent chemical composition.

44. (NEW) A method according to claim 43, further comprising injecting the regenerated promoted halogenated sorbent into a mercury containing gas.

45. (NEW) A method according to claim 34, further comprising injecting an alkaline component into the mercury containing gas.

46. (NEW) A method according to claim 43, wherein the alkali component comprises an oxide, hydroxide, carbonate, phosphate of an alkali or alkaline earth element.

47. (NEW) A method according to claim 34, further comprising adding a second halogen or halide promoter to the promoted halogen containing sorbent.

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48. (NEW) A method according to claim 47, wherein the second halogen or halide promoter comprises HI, HBr, HCl, Group V element with halogen, or Group VI element with halogen.

49. (NEW) A method according to claim 34, further comprising adding a stabilizing agent to the promoted halogen containing sorbent.

50. (NEW) A method according to claim 49, wherein the stabilizing agent comprises at least one of S, Se, H_2S, SO_2, H_2Se, SeO_2, CS_2, P_2S_5, or mixtures thereof.

51. (NEW) A method according to claim 34, wherein the step of promoting at least a portion of the available sorbent material occurs at least partially outside of the mercury containing gas.

52. (NEW) A method according to claim 34, wherein the promoted halogen containing sorbent combines with at least 70% of the mercury present in the mercury containing gas.

53. (NEW) A method according to claim 34, further comprising injecting the sorbent material at an sorbent material injection rate and injecting separately at least one promoter at a promoter injection rate into a gas stream whereby in-flight reaction produces the promoted halogenated sorbent, 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 sorbent material.

54. (NEW) A method according to claim 53, wherein the gas stream is a mercury containing gas.

55. (NEW) A method according to claim 54, wherein the gas stream is a transport gas.

56. (NEW) A method according to claim 53, wherein the promoter injection rate and the sorbent injection rate into the gas are determined at least in part on the monitored mercury content of the cleaned gas.

57. (NEW) A method according to claim 34, wherein the composition of the promoted sorbent is controlled by the mercury content of the cleaned gas stream.

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REMARKS

This application is a continuation of U.S. patent application 12/201,595 filed on August 29, 2008, which is a division of U.S. patent application 11/209,163, filed on August 22, 2005 (now Patent No. 7,435,286), which claims priority from provisional application 60/605,640, filed on August 30, 2004.

Claims 1-33 have been cancelled. Claims 34-57 have been added. Claims 34-57 are pending. It is believed that this application is in condition for examination.

Respectfully submitted,

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Date: April 6, 2009

Dennis R. Daley
Reg. No. 34,944
DRD:TPJ:cjc

23552
PATENT TRADEMARK OFFICE

PTO/SB/06 (12-04)

Filing Date: 04/06/09

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	Application or Docket Number 12/419,219

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	82		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	270		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	110		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	24 minus 20 =	4	x$26	104	OR	x$52	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x$110			x$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	566		TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T 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.**

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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
12/419,219	04/06/2009	

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))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT 04/06/2009	(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))	* 24	Minus	** 24	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

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:
/CORALIA BETANCOURT/

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