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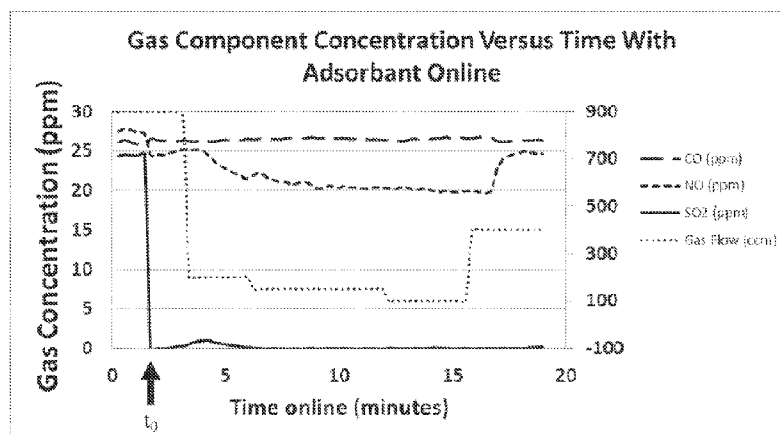
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(54) Title: BIOGENIC ACTIVATED CARBON AND METHODS OF MAKING AND USING SAME



(57) Abstract: Biogenic activated carbon compositions disclosed herein comprise at least 55 wt% carbon, some of which may be present as graphene, and have high surface areas, such as Iodine Numbers of greater than 2000. Some embodiments provide biogenic activated carbon that is responsive to a magnetic field. A continuous process for producing biogenic activated carbon comprises countercurrently contacting, by mechanical means, a feedstock with a vapor stream comprising an activation agent including water and/or carbon dioxide; removing vapor from the reaction zone; recycling at least some of the separated vapor stream, or a thermally treated form thereof, to an inlet of the reaction zone(s) and/or to the feedstock; and recovering solids from the reaction zone(s) as biogenic activated carbon. Methods of using the biogenic activated carbon are disclosed.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/039991

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B01D 53/06 (2013.01)

USPC - 95/107

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B01D 53/00, 53/02, 53/06, 53/34; C01B 31/08 (2013.01)

USPC - 95/90, 107; 110/203, 341, 342, 345; 502/400, 416, 417

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

CPC - B01D 53/00, 53/02, 53/06, 53/34; C01B 31/08 (2013.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Orbit, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8,080,088 B1 (SRINIVASACHAR) 20 December 2011 (20.12.2011) entire document	1, 2, 4-7, 10
Y		3, 8, 9, 11-14
Y	EP 0 930 091 A1 (HAMAGUCHI et al) 21 July 1999 (21.07.1999) entire document	3
Y	US 2001/0009125 A1 (MONEREAU et al) 26 July 2001 (26.07.2001) entire document	8, 9, 13
Y	US 2007/0140941 A1 (COMRIE) 21 June 2007 (21.06.2007) entire document	11, 12
Y	US 2012/0021123 A1 (LEVESON et al) 26 January 2012 (26.01.2012) entire document	14
A	US 5,167,797 A (OU) 01 December 1992 (01.12.1992) entire document	1-14
A	US 5,976,373 A (TROCCIOLA et al) 02 November 1999 (02.11.1999) entire document	1-14

Further documents are listed in the continuation of Box C.

* 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 application or patent but 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 06 December 2013	Date of mailing of the international search report 16 DEC 2013
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/039991

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 30
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Extra Sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-14

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 - No protest accompanied the payment of additional search fees.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees need to be paid.

Group I: Claims 1-14 are drawn to a method for reducing or removing contaminant from a gas-phase stream.

Group II: Claims 15-18 are drawn a method of using biogenic activated carbon to reduce mercury emissions.

Group III: Claims 19-29 are drawn to a process for producing energy.

Group IV: Claims 31-42 are drawn to a method of using a biogenic activated carbon composition to purify a liquid.

Group V: Claims 43-62 and 64 are drawn to a method of removing at least a portion of a sulfur contaminant from a liquid.

Group VI: Claims 63 and 65-71 are drawn to a method of removing a sulfur contaminant from a gas-phase stream.

Group VII: Claims 72-76 are drawn to a method of reducing or removing one or more contaminants from a gas or liquid using a composition responsive to a magnetic field or comprising graphene.

The inventions listed as Groups I through VII do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I, a method of reducing or removing at least one contaminant from a gas-phase emission stream, said method comprising: (a) providing a gas-phase emissions stream comprising at least one contaminant; (b) contacting the gas-phase emissions stream with an additive and activated carbon particles comprising a biogenic activated carbon composition to generate contaminant-adsorbed particles; and (c) separating at least a portion of said contaminant-adsorbed particles from said gas-phase emissions stream to produce a contaminant-reduced gas-phase emissions stream, are not found in Groups II through VII; the special technical features of Group II, a method of using a biogenic activated carbon composition to reduce mercury emissions, comprising: providing a gas-phase emissions stream comprising mercury and contacting the stream with activated-carbon particles of biogenic activated carbon composition to generate mercury-adsorbed carbon particles and separating at least a portion of the mercury-adsorbed carbon particles using electrostatic precipitation, are not found in Groups I and III through VII; and the special technical features of Group III, a process for producing energy comprising: oxidizing a carbon-containing feedstock to generate energy and a gas-phase emissions stream comprising at least one contaminant, are not found in Groups I, II and IV through VII; the special technical features of Group IV, a method of using a biogenic activated carbon composition to purify a liquid, comprising: providing a liquid comprising at least one contaminant; and contacting said liquid with an additive and activated-carbon particles comprising a biogenic activated carbon composition to generate contaminant-adsorbed carbon particles and a contaminant-reduced liquid, are not found in Groups I through III and V through VII; the special technical features of Group V, a method of removing at least a portion of a sulfur contaminant from a liquid, are not found in Groups I through IV, VI and VII; the special technical features of Group VI, a method of removing a sulfur contaminant from a gas-phase emissions stream, are not found in Groups I through V and VII; and the special technical features of Group VII, a method of reducing or removing one or more contaminants from a gas or liquid, comprising contacting a gas or liquid stream with a biogenic activated carbon composition comprising, on a dry basis, about 55 wt% or more total carbon, about 15 wt% or less hydrogen, and less than or equal to about 1 wt% nitrogen, and an Iodine Number of at least about 500, wherein said composition is responsive to an externally applied magnetic field or wherein at least a portion of said carbon is present in the form of graphene, are not present in Groups I through VI.

Groups I through VII share the technical features of a method of reducing or removing at least one contaminant from a gas-phase or liquid-phase emission stream, said method comprising: (a) providing a gas-phase or liquid-phase emissions stream comprising at least one contaminant; (b) contacting the gas-phase or liquid-phase emissions stream with an additive and activated carbon particles comprising a biogenic activated carbon composition to generate contaminant-adsorbed particles; and (c) separating at least a portion of said contaminant-adsorbed particles from a gas-phase or liquid-phase emissions stream to produce a contaminant-reduced gas-phase or liquid-phase emissions stream; and further a method of reducing or removing sulfur contaminants from a gas-phase or liquid-phase emission stream by contacting the gas-phase or liquid-phase stream with an additive and activated carbon. However, these technical features do not represent a contribution over the prior art.

<Continued in next Extra Sheet>

US 2012/0021123 A1 to Leveson et al. teach a method of reducing or removing at least one contaminant from a gas-phase or liquid-phase emission stream (Para. [0005], ...the activated carbon may also be utilized as an absorbent or adsorbent material to capture mercury or other heavy metal, such as from the flue gas of coal-fired power station...; Para. [0014], ...pelletized activated carbon can also be packed to produce fixed beds which can then be used to capture components from both gaseous and liquid streams...), said method comprising: (a) providing a gas-phase or liquid-phase emissions stream comprising at least one contaminant (Para. [0005], A combustible fuel, such as syngas, and activated carbon are produced from biomass...the activated carbon may also be utilized as an absorbent or adsorbent material to capture mercury or other heavy metal, such as from the flue gas of coal-fired power station...; Para. [0014], ...pelletized activated carbon can also be packed to produce fixed beds which can then be used to capture components from both gaseous and liquid streams...); (b) contacting the gas-phase or liquid-phase emissions stream with an additive and activated carbon particles comprising a biogenic activated carbon composition to generate contaminant-adsorbed particles (Para. [0005], A combustible fuel, such as syngas, and activated carbon are produced from biomass...the activated carbon may also be utilized as an absorbent or adsorbent material to capture mercury or other heavy metal, such as from the flue gas of coal-fired power station...; Para. [0014], ...pelletized activated carbon can also be packed to produce fixed beds which can then be used to capture components from both gaseous and liquid streams...the activated carbon can be used as an adsorbent to capture VOCs (volatile organic compounds) or other contaminants; Para. [0013], ...The skeletal structure of the activated carbon may also undergo impregnation of compounds to increase its ability to capture mercury and other heavy metals. Such treatments may include, for example, the impregnation of sulphur, the acid derivatives of sulphur oxides, or ionic halogen salts...); and (c) separating at least a portion of said contaminant-adsorbed particles from said gas-phase or liquid-phase emissions stream to produce a contaminant-reduced gas-phase or liquid-phase emissions stream (Para. [0005], ...activated carbon may also be used...as an adsorbent, and then, after use, is disposed of...where the contaminant will not be quickly released into the environment...; Paras. [0013]-[0015]).

In addition, US 5,167,797 A to Ou discloses a method of reducing or removing sulfur contaminants from a liquid-phase emission stream (Col. 3, Lines 16-25, ...removing chemically-combined sulfur, such as organosulfur compounds, from liquid hydrocarbon streams...) by contacting the liquid-phase stream with an additive and activated carbon (Col. 10, Lines 57-65, ...sulfur removal is accomplished using adsorbents with are pre-loaded with N-halogeno compounds...adsorbents are prepared by saturating pore supports, such as activated carbon and zeolites with N-halogeno compounds. The N-halogeno-loaded adsorbent is then placed in a fixed-bed for sulfur removal and the hydrocarbon stream containing sulfur contaminants is passed...).

Further, US 5,976,373 A to Trocciola et al. discloses a method of reducing or removing sulfur contaminants from a gas-phase emission stream (Col. 1, Lines 54-67, ...gas stream is then directed through a blower into a hydrogen sulfide removal bed...) by contacting the gas-phase stream with an additive and activated carbon (Col. 1, Lines 54-67, ...H₂S removal bed may consist of an adsorbent activated carbon bed such as a potassium impregnated activated carbon adsorbent...).

The inventions listed in Groups I through VII therefore lack unity under Rule 13 because they do not share a same or corresponding special technical feature.