

(51) International Patent Classification:
B01D 53/02 (2006.01)(21) International Application Number:
PCT/US2013/042239(22) International Filing Date:
22 May 2013 (22.05.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/650,204	22 May 2012 (22.05.2012)	US
61/664,168	26 June 2012 (26.06.2012)	US
61/664,748	27 June 2012 (27.06.2012)	US
61/704,796	24 September 2012 (24.09.2012)	US

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BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

6 March 2014

(54) Title: EFFICIENT USE OF ADSORBENTS FOR INDOOR AIR SCRUBBING

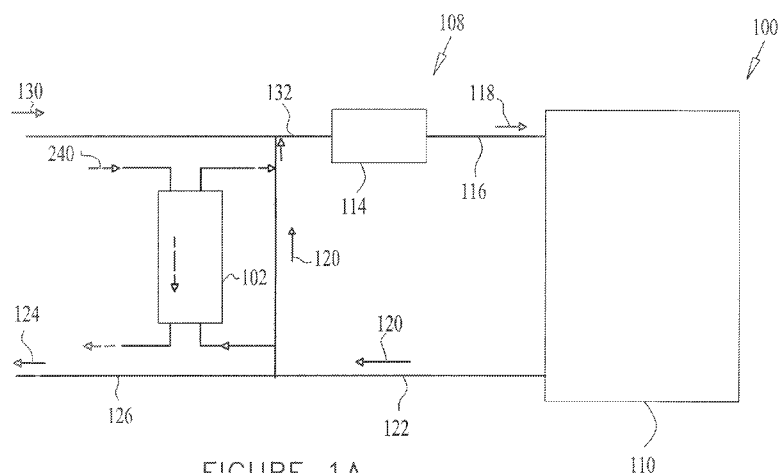


FIGURE 1A

(57) **Abstract:** Some embodiments of the disclosure correspond to, for example, a method for controlling a scrubber containing an adsorbent. The scrubber may be configured to cycle between scrubbing at least one pollutant/gas from a stream of gases with the pollutant/gas being adsorbed onto the adsorbent, and regenerating at least some of the adsorbent and thereby purging at least some of the one pollutant and/or first gas from the adsorbent via a regeneration gas flow. The method may include flowing a stream of gases through the scrubber, the scrubber including the adsorbent and adsorbing at least some of the one pollutant/gas from the stream of gases onto the adsorbent during an adsorption phase over a first time period. The method may also include purging at least a portion of the one pollutant/gas from the adsorbent during a regeneration phase over a second time period with a regeneration gas flow, and cycling therebetween.



INTERNATIONAL SEARCH REPORT

International application no.

PCT/US2013/042239

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B01D 53/02 (2014.01)

USPC - 95/114

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 53/02 (2014.01)

USPC - 95/114, 116, 139, 140, 141; 96/109, 130, 143, 144, 145, 146

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - B01D 53/02, 53/0462, 53/047 (2014.01)

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 8,157,892 B2 (MEIRAV) 17 April 2012 (17.04.2012) entire document	1-18, 20-23, 27
Y		19, 24, 34, 39-44
X ---	US 2011/0079143 A1 (MAROTTA et al) 07 April 2011 (07.04.2011) entire document	29-33, 37
Y		34-36, 38-44
Y	US 2002/0183201 A1 (BARNWELL et al) 05 December 2002 (05.12.2002) entire document	19, 35
Y	United States Environmental Protection Agency. Carbon Adsorption for Control of VOC Emissions: Theory and Full Scale System Performance. EPA-450/3-88-012. 1988. [retrieved on 12 December 2013]. Retrieved from the Internet. <URL: http://nepis.epa.gov/Exe/ZyNET.exe/91009Z7B.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt%5C00000020%5C91009Z7B.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL#>. entire document	24, 36, 38, 40-44

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 December 2013

Date of mailing of the international search report

03 JAN 2014

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PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

international application no.

PCT/US2013/042239

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

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

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

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

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

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

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

See 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.:
1-24, 27, 29-44
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.:

Remark on Protest

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

INTERNATIONAL SEARCH REPORT

international application no.

PCT/US2013/042239

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 1-24, 27 are drawn to a method for controlling a scrubber.

Group II: Claim 25, 26, and 28 are drawn to a system for controlling a scrubber.

Group III: Claims 29-44 are drawn to systems and methods for reducing at least one pollutant contained in indoor air from an enclosed, human-occupied environment.

The inventions listed as Groups I through III 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 a method for controlling a scrubber, are not found in Groups II and III; the special technical features of Group II, a system for controlling a scrubber, are not found in Groups I and III; and the special technical features of Group III, systems and methods for reducing at least one pollutant contained in indoor air from an enclosed, human-occupied environment, are not found in Groups I and II.

Groups I through III share the technical features of a computer implement method for controlling a scrubber containing an adsorbent, the scrubber configured to cycle between scrubbing at least one pollutant and/or first gas from a stream of gases with the at least one pollutant and/or first gas being adsorbed onto the adsorbent, and regenerating at least some of the adsorbent and thereby purging at least some of the at least one pollutant and/or first gas from the adsorbent via a regeneration gas flow, the system comprising at least one processor and a non-transitory machine-readable medium storing instructions that, when executed by the at least one processor, perform the method comprising: flowing a stream of gases through the scrubber, the scrubber comprising the adsorbent; adsorbing at least some of the one pollutant and/or first gas from the stream of gases onto the adsorbent during an adsorption phase over a first time period; purging a portion of the at least one pollutant and/or first gas from the adsorbent during a regeneration phase over a second time period with a regeneration gas flow, and cycling between the adsorption phase and the regeneration phase, wherein one cycle comprises at least an adsorption phase followed by a regeneration phase, one cycle period comprises the total time elapsed during one cycle, the at least one pollutant and/or first gas purged from the adsorbent is carried away by the regeneration gas flow, and a complete regeneration phase comprises a time period for removing substantially all of the pollutant and/or first gas from the adsorbent during the regeneration phase, and a complete adsorption phase comprises a time period for substantially saturating all the adsorbent during the adsorption; and limiting at least one of: the duration of the first time period to a period of time which is less than the complete adsorption phase, and the duration of the second time period to a period of time which is less than the complete regeneration phase. However, these technical features do not represent a contribution over the prior art.

Specifically, US 8,157,892 B2 to Meirav teaches a computer implement method (Col. 11, Lines 9-11, "...central control system (CC) 502 can be...computerized...") for controlling a scrubber (Col. 11, Lines 22-23, "The control system 502 can permit the amount of scrubbing or injection of oxygen to be adjustable...; Figs. 2A-2C and 3) containing an adsorbent (Col. 7, Lines 12-16, "...the scrubber adsorbent bed design can include an appropriate choice of adsorbent material...; Col. 5, Line 37-Col. 6, Line 3), the scrubber configured to cycle between scrubbing at least one pollutant and/or first gas from a stream of gases with the at least one pollutant and/or first gas being adsorbed onto the adsorbent, and regenerating at least some of the adsorbent and thereby purging at least some of the at least one pollutant and/or first gas from the adsorbent via a regeneration gas flow (Col. 6, Lines 15-67, "...The scrubber 310 can be configured to operate in two cycles: an adsorption cycle and a regeneration cycle...), the system comprising at least one processor and a non-transitory machine-readable medium storing instructions that, when executed by the at least one processor (Col. 10, Lines 39-57, "...The central control system 502 can include a processor, a memory...It can control/operate components automatically...; Col. 11, Lines 9-34), perform the method comprising: flowing a stream of gases through the scrubber (Fig. 3, Circulating Supply Air; Col. 6, Lines 15-31), the scrubber comprising the adsorbent (Col. 7, Lines 12-16, "...the scrubber adsorbent bed design can include an appropriate choice of adsorbent material...; Col. 5, Line 37-Col. 6, Line 3); adsorbing at least some of the one pollutant and/or first gas from the stream of gases onto the adsorbent during an adsorption phase over a first time period (Col. 6, Lines 15-67, "...During the adsorption cycle, Valves 1 and 2 are open and can allow entry of, adsorption of substances, particles, fumes, gases, etc. from, and subsequent exit of the circulating air...As such substances, particles, fumes, gases, hazardous vapors (e.g. radioactive vapors) etc. (hereinafter, "substances") captured from the circulating air accumulate in the scrubber 310...); purging a portion of the at least one pollutant and/or first gas from the adsorbent during a regeneration phase over a second time period with a regeneration gas flow (Col. 6, Lines 15-67, "As such substances, particles, fumes, gases, hazardous vapors (e.g. radioactive vapors) etc. (hereinafter, "substances") captured from the circulating air accumulate in the scrubber 310, the substances can be removed from the scrubber 310 at a predetermined rate. Removal of substances can be referred to as a "regeneration" or a "regeneration cycle"...during the regeneration cycle, the scrubber 310 can be isolated from the HVAC system circulation by Valves 1 and 2, shown in Fig. 3, and instead, can be connected to the incoming and outgoing purging lines using Valves 3 and 4. While Valves 1 and 2 are closed and Valves 3 and 4 are open during the regeneration cycle, purge gas, air, and/or any other purge substance can be configured to flow through the scrubber 310...), and cycling between the adsorption phase and the regeneration phase (Col. 6, Lines 15-67, "...The scrubber 310 can be configured to operate in two cycles: an adsorption cycle and a regeneration cycle...The scrubber 310 can run the adsorption and regeneration cycles at periodically, at predetermined times, and/or as necessary...), wherein one cycle comprises at least an adsorption phase followed by a regeneration phase (Col. 6, Lines 15-67, "...The scrubber 310 can be configured to operate in two cycles: an adsorption cycle and a regeneration cycle...The scrubber 310 can be also configured to run each cycle for a predetermined period of time...), one cycle period comprises the total time elapsed during one cycle (Col. 7, Lines 12-38, "...The cycles as well as their frequency can...constrain the cycle time...; Col. 6, Lines 15-67), the at least one pollutant and/or first gas purged from the adsorbent is carried away by the regeneration gas flow (Fig. 3; Col. 6, Lines 15-67, "...the substances can be removed from the scrubber 310...Removal of substances can be referred to as "regeneration"...during the regeneration cycle, purge gas, air, and/or any other purge substance can be configured to flow through the scrubber 310), and a complete regeneration phase comprises a time period for removing substantially all of the pollutant and/or first gas from the adsorbent during the regeneration phase (Col. 6, Lines 59-67, "...the length of time that each cycle can be performed depends on...time that it takes to adsorb/purge a substance or a particular amount of the substance...), and a complete adsorption phase comprises a time period for substantially saturating all the adsorbent during the adsorption (Col. 6, Lines 59-67, "...the length of time that each cycle can be performed depends on...

<Continued in next Extra Sheet>

INTERNATIONAL SEARCH REPORT

international application no.

PCT/US2013/042239

...time that it takes to adsorb/purge a substance or a particular amount of the substance...), and the duration of the second time period to a period of time which is less than the complete regeneration phase (Col. 6, Lines 59-67, ...the length of time that each cycle can be performed depends on...time that it takes to adsorb/purge a substance or a particular amount of the substance...).

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