

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|   |  |   |
|---|--|---|
| Applicant's or agent's file reference<br>121-53-PCT       | <b>FOR FURTHER ACTION</b> see Form PCT/ISA/220 as well as, where applicable, item 5 below. |   |
| International application No.<br><b>PCT/US2018/044781</b> | International filing date ( <i>day/month/year</i> )<br><b>01 August 2018 (01.08.2018)</b>  | (Earliest) Priority Date ( <i>day/month/year</i> )<br>01 August 2017 (01.08.2017) |
| Applicant<br><b>RESEARCH TRIANGLE INSTITUTE</b>           |  |   |

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

- the international application in the language in which it was filed  
 a translation of the international application into \_\_\_\_\_, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b.  This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c.  With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2.  **Certain claims were found unsearchable** (See Box No. II)

3.  **Unity of invention is lacking** (See Box No. III)

4. With regard to the **title**,

- the text is approved as submitted by the applicant.  
 the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

- the text is approved as submitted by the applicant.  
 the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

- a. the figure of the **drawings** to be published with the abstract is Figure No. 1  
 as suggested by the applicant.  
 as selected by this Authority, because the applicant failed to suggest a figure.  
 as selected by this Authority, because this figure better characterizes the invention.
- b.  none of the figures is to be published with the abstract.

**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.: 14-16,19,21,25,26,30  
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:  
Claims 14-16, 19, 21, 25, 26 and 30 each refer to one of claims which are not drafted in accordance with PCT Rule 6.4(a).
  
3.  Claims Nos.: 9-13,17,18,20,22-24,27-29  
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:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any 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.:

**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.

**A. CLASSIFICATION OF SUBJECT MATTER****B01J 20/06(2006.01)i, B01J 20/02(2006.01)i, B01J 20/28(2006.01)i, B01J 35/00(2006.01)i, B01D 53/02(2006.01)i**

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

**B. FIELDS SEARCHED**Minimum documentation searched (classification system followed by classification symbols)  
B01J 20/06; B01D 53/14; B01J 20/10; B01J 20/02; B01J 20/28; B01J 35/00; B01D 53/02Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Korean utility models and applications for utility models  
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
eKOMPASS(KIPO internal) & Keywords: zinc oxide-based sorbent, zinc oxide, zinc aluminate, two phase component, coprecipitate, alkali metal hydroxide**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|-----------|--|-----------------------|
| Y         | US 6951635 B2 (GANGWAL, SANTOSH KUMAR et al.) 04 October 2005<br>See paragraphs [0002], [0054], [0073]–[0075]; and claims 1, 20–22.                                | 1–8                   |
| Y         | SASAOKA, EIJI et al., "Stability of zinc oxide high-temperature desulfurization sorbents for reduction", 1994, Energy & Fuels, vol.8, pp.763–769<br>See page 764.  | 1–8                   |
| Y         | US 7956006 B2 (GANGWAL, SANTOSH KUMAR et al.) 07 June 2011<br>See paragraphs [0003], [0054]; and claims 1–13, 20.  | 1–8                   |
| A         | SASAOKA, EIJI et al., "Characterization of reaction between zinc oxide and hydrogen sulfide", Energy & Fuels, 1994, vol.8, pp.1100–1105<br>See the whole document. | 1–8                   |
| A         | US 2010-0170394 A1 (DODWELL, GLENN W. et al.) 08 July 2010<br>See the whole document.  | 1–8                   |

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

18 December 2018 (18.12.2018)

Date of mailing of the international search report

**18 December 2018 (18.12.2018)**

Name and mailing address of the ISA/KR

International Application Division  
Korean Intellectual Property Office  
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

NAM, EUI HO

Telephone No. +82-42-481-5580



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2018/044781**

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| US 6951635 B2                          | 04/10/2005       | US 2005-070430 A1       | 31/03/2005       |
| US 7956006 B2                          | 07/06/2011       | AU 2005-323528 A1       | 13/07/2006       |
|  |                  | AU 2005-323528 B2       | 25/02/2010       |
|  |                  | CA 2593799 A1           | 13/07/2006       |
|  |                  | CA 2593799 C            | 16/04/2013       |
|  |                  | CN 101119796 A          | 06/02/2008       |
|  |                  | CN 101119796 B          | 17/11/2010       |
|  |                  | EP 1843840 A1           | 17/10/2007       |
|  |                  | EP 1843840 A4           | 03/04/2013       |
|  |                  | JP 2008-526488 A        | 24/07/2008       |
|  |                  | JP 5112078 B2           | 09/01/2013       |
|  |                  | KR 10-1236612 B1        | 22/02/2013       |
|  |                  | KR 10-2007-0100788 A    | 11/10/2007       |
|  |                  | US 2008-0022852 A1      | 31/01/2008       |
|  |                  | US 2008-0026939 A1      | 31/01/2008       |
|  |                  | US 7682423              | 23/03/2010       |
|  |                  | US 7682423 B2           | 23/03/2010       |
|  |                  | WO 2006-073389 A1       | 13/07/2006       |
| US 2010-0170394 A1                     | 08/07/2010       | CN 101773815 A          | 14/07/2010       |
|  |                  | CN 101773815 B          | 17/07/2013       |
|  |                  | US 8268745 B2           | 18/09/2012       |