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(54) Title: PHOSPHOROUS PENTOXIDE PRODUCING METHODS AND SYSTEMS WITH INCREASED AGGLOMERATE COMPRESSION STRENGTH

(57) Abstract: A phosphorous pentoxide producing method includes forming pre-feed agglomerates containing phosphate ore particles, carbonaceous material particles, and silica particles and heating the pre-feed agglomerates in a reducing or inert atmosphere to an induction temperature from above 900 °C to less than 1180 °C and maintaining the induction temperature for 15 minutes or more. The method includes forming feed agglomerates and increasing a compression strength of the feed agglomerates to above 25 lb/h using the heating, the feed agglomerates exhibiting a calcium-to-silica mole ratio less than 1 and a silica-to-calcium (calcium + magnesium) mole ratio greater than 2. A reducing kiln bed is formed using the feed agglomerates, kiln off-gas is generated, and phosphorous pentoxide is collected from the kiln off gas.
INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/052402

A. CLASSIFICATION OF SUBJECT MATTER
INV. C01B25/12
ADD.

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)
C01B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>X</td>
<td>US 2013/136682 A1 (MEGY JOSEPH A [US]) 30 May 2013 (2013-05-30) paragraphs [0027], [0028], [0051], [0052], [0070]-[0077], [0133]; claims 1,11,17 the whole document</td>
<td>1-11</td>
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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

X* 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

*"A"* document member of the same patent family

Date of the actual completion of the international search
21 December 2015

Date of mailing of the international search report
22/03/2016

Name and mailing address of the ISA/
European Patent Office, P.O. 5619 Patentlaan 2
NL 2280 HV Rijswijk
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Fax (31-70) 940-3018

Authorized officer

Straub, Thomas

Form PCT/ISA/210 (second sheet) (April 2009)
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INTERNATIONAL SEARCH REPORT

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 additional 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 an 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.:
   1-11

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 International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-11

A phosphorous pentoxide producing method comprising:
forming pre-feed agglomerates containing phosphate ore particles, carbonaceous material particles, and silica particles;
heating the pre-feed agglomerates in a reducing or inert atmosphere to an induration temperature from above 900 °C to less than 1180 °C and maintaining the induration temperature for 15 minutes or more;
forming feed agglomerates and increasing a compression strength of the feed agglomerates to above 25 lbf using the heating, the feed agglomerates exhibiting a calcium-to-silica mole ratio less than 1 and a silica-to-(calcium + magnesium) mole ratio greater than 2;
forming a reducing kiln bed using the feed agglomerates; and generating kiln off-gas and collecting phosphorous pentoxide from the kiln off gas.

2. claims: 12-19

A phosphorous pentoxide producing method comprising:
forming green agglomerates containing phosphate ore particles, carbonaceous material particles, silica particles, and a polymer;
drying the green agglomerates at a drying temperature from 40 °C to 300 °C, the dried agglomerates exhibiting a compression strength above 25 lbf;
heating the dried agglomerates in a reducing or inert atmosphere to an induration temperature from above 900 °C to less than 1180 °C and maintaining the induration temperature for 15 minutes or more;
forming feed agglomerates, the feed agglomerates exhibiting a calcium-to-silica mole ratio less than 1 and a silica-to-(calcium + magnesium) mole ratio greater than 2;
forming a reducing kiln bed using the feed agglomerates; and generating kiln off-gas and collecting phosphorous pentoxide from the kiln off gas.

3. claims: 20-23

A phosphorous pentoxide producing method comprising:
extruding a material to form green agglomerates containing phosphate ore particles, carbonaceous material particles, silica particles, and 2 to 5 wt% (dry basis) clay particles;
drying the extruded, green agglomerates at a drying temperature from 40 °C to 150 °C, the dried agglomerates exhibiting a compression strength above 50 lbf;
heating the dried agglomerates in a reducing or inert atmosphere to an induration temperature from above 900 °C to
less than 1180 oC and maintaining the induration temperature for 15 minutes or more; forming feed agglomerates, the feed agglomerates exhibiting a calcium-to-silica mole ratio less than 1 and a silica-to-(calcium + magnesium) mole ratio greater than 2; forming a reducing kiln bed using the feed agglomerates; and generating kiln off-gas and collecting phosphorous pentoxide from the kiln off gas.

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