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(54) Title: PROCESS FOR THE OXYGEN FREE CONVERSION OF METHANE TO ETHYLENE ON ZEOLITE CATALYSTS

(57) Abstract: The present invention relates to a process comprising the step of converting methane to ethene under non-oxidative conditions in the presence of a catalyst comprising (a) a zeolite with a largest pore opening which is larger than 8; (b) a metal where- as the metal (b) is loaded onto the zeolite (a); and whereas the zeolite (a) is selected from zeolites -with a maximum diameter of a sphere that can be included of 4.5 Å or smaller and/or -with a maximum diameter of a sphere which can diffuse along a of 4.4 Å or smaller and/or -with a maximum diameter of a sphere which can diffuse along b of 4.4 Å or smaller and/or -with a maximum diameter of a sphere which can diffuse along c of 4.4 Å or smaller. Zeolite (a) is preferably a RRO catalyst, in particular RUB-41.



INTERNATIONAL SEARCH REPORT

International application No.
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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.:

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/EP2014/066757

A. CLASSIFICATION OF SUBJECT MATTER INV. B01J29/78 B01J29/80 C07C2/76 C07C11/04 B01J29/72 B01J29/82 B01J29/83 B01J29/86 B01J38/10 B01J29/90 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) B01J C07C		
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		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	She-Tin Wong ET AL: "Methane Direct Conversion to Ethene over Mo/SAP0-34 Catalysts", Chinese Journal of Catalysis, 1 January 1995 (1995-01-01), pages 3-4, XP055151776, Retrieved from the Internet: URL:http://www.chxb.cn/CN/abstract/abstract18677.shtml [retrieved on 2014-11-07] cited in the application the whole document <div style="text-align: center; margin-top: 20px;">----- -/-</div>	1-18
<div style="display: flex; justify-content: space-between;"> ☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex. </div>		
<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search <div style="text-align: center; font-size: 1.2em;">26 February 2015</div>		Date of mailing of the international search report <div style="text-align: center; font-size: 1.2em;">04/03/2015</div>
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer <div style="text-align: center; font-size: 1.2em;">Omegna, Anna</div>

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>Richard W. Borry ET AL: "Non-oxidative catalytic conversion of methane with continuous hydrogen removal"</p> <p>In: "Scientific Bases for the Preparation of Heterogeneous Catalysts - Proceedings of the 10th International Symposium, Louvain-la-Neuve, Belgium, July 11-15, 2010",</p> <p>1 January 1998 (1998-01-01), Elsevier, XP055151858,</p> <p>ISSN: 0167-2991</p> <p>ISBN: 978-0-44-453601-3</p> <p>vol. 119, pages 403-410, DOI: 10.1016/S0167-2991(98)80465-5,</p> <p>the whole document</p> <p>-----</p>	1-18
A	<p>CHRISTOPHER L GORDON ET AL: "Ethylene production using a Pd and Ag-Pd-Y-Zeolite catalyst in a DC plasma reactor",</p> <p>CATALYSIS TODAY, ELSEVIER, NL,</p> <p>vol. 84, 1 January 2003 (2003-01-01),</p> <p>pages 51-75, XP002730026,</p> <p>ISSN: 0920-5861, DOI: 10.1016/S0920-5861(03)00300-6</p> <p>the whole document</p> <p>-----</p>	1-18
A	<p>Ch. Baerlocher ET AL: "Appendix E"</p> <p>In: "ATLAS OF ZEOLITE FRAMEWORK TYPES",</p> <p>1 January 2007 (2007-01-01), Elsevier,</p> <p>XP055151882,</p> <p>pages 381-386,</p> <p>the whole document</p> <p>-----</p>	1-18
A	<p>Ch. Baerlocher ET AL: "Isotypic Material Index"</p> <p>In: "ATLAS OF ZEOLITE FRAMEWORK TYPES",</p> <p>1 January 2007 (2007-01-01), Elsevier,</p> <p>XP055151883,</p> <p>pages 393-398,</p> <p>the whole document</p> <p>-----</p>	1-18
X	<p>DE 10 2007 005703 A1 (SUED CHEMIE AG [DE])</p> <p>30 April 2008 (2008-04-30)</p> <p>abstract</p> <p>paragraphs [0015], [0018], [0023] - [0028]</p> <p>examples</p> <p>claims</p> <p>-----</p>	19-26
X	<p>US 4 397 825 A (WHITTAM THOMAS V [GB])</p> <p>9 August 1983 (1983-08-09)</p> <p>abstract</p> <p>line 59 - column 5, line 2</p> <p>examples</p> <p>-----</p>	19-26

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013/092707 A1 (CLARIANT PRODUKTE DEUTSCHLAND [DE]) 27 June 2013 (2013-06-27) page 9, line 31 - page 10, line 14 page 12, line 4 - line 8 -----	19-26
X	US 2010/119442 A1 (MUELLER ULRICH [DE] ET AL) 13 May 2010 (2010-05-13) abstract paragraphs [0001], [0062] examples -----	19-26
X	US 2012/189518 A1 (ANDERSEN PAUL J [US] ET AL) 26 July 2012 (2012-07-26) paragraphs [0042] - [0043] -----	19-26

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/066757

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-18

A process comprising the step of converting methane to ethene under non-oxidative conditions in the presence of a catalyst comprising (a) a zeolite with a largest pore opening which is larger than 8; (b) a metal whereas the metal (b) is loaded onto the zeolite (a)

2. claims: 19-26

Catalyst comprising (a) a zeolite; (b) a metal; and (c) a further component selected from the group consisting of (c1) at least one small-pore zeolite and/or (c2) at least one small-pore zeolite analogous material and/or (c3) at least one further metal different from (b)
