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- Published:**  
— with international search report
- (88) **Date of publication of the international search report:**  
18 December 2008



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(54) **Title:** PRODUCTION OF BUTENES AND DERIVATIVES THEREFORM FROM DRY ETHANOL

(57) **Abstract:** The present invention relates to the production of butenes and derivatives thereof from dry ethanol, optionally obtained from a fermentation broth. The butenes thus produced find use as intermediates for the production of polyethylenes and other materials.

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/US07/24668

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC: C07C 1/24( 2006.01),2/54( 2006.01),7/00( 2006.01),41/06( 2006.01),15/08( 2006.01)

USPC: 585/639,640,700,708,800,400,407,408,415;568/697,699

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)

U.S. : 585/639,640,700,708,800,400,407,408,415;568/697,699

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)  
Please See Continuation Sheet

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|------------|---|-----------------------|
| Y          | US 2,004,350 A (SCOTT) 11 June 1935 (11.06.1935), entire disclosure, in particular column 1, lines 30-55 and Examples III-VI.   | 1-3, 5, 10 and 11     |
| Y          | US 4,234,752 A (WU et al) 18 November 1980 (18.11.1980), entire disclosure, in particular column 1, line 33 to column 3, line 6.  | 1-3,5,10 and 11       |
| Y          | US 6,755,975 B2 (VANE et al) 29 June 2004 (24.06.2004), column 6, lines 1-32.   | 1 and 2               |
| Y          | US 3,324,196 A (KRAMER et al) 06 June 1967 (06.06.1967), entire disclosure, in particular column 1, line 14 to column 25 and column 4, line 15 to column 5, line 8.               | 3                     |
| Y          | US 2,077,042 A (FRANCIS) 13 April 1937 (13.04.1937), entire disclosure, in particular column 1, lines 7-50 and column 2, line 49 to column 3, line 29.                            | 5                     |
| Y          | US 3,202,725 A (W. LORZ et al) 02 June 1961 (02.06.1961), entire disclosure, in particular column 1, line 47 to column 3, line 34.  | 10 and 11             |
| Y          | US 2,785,209 A (SCHMETTERLING et al) 12 March 1957 (12. 03.1957), entire disclosure, in particular column 1, line 17 to column 2, line 7; column 3, line 56 to column 5, line 63. | 10 and 11             |

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  | "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  |
| "E"                                      | earlier application or patent published on or after the international filing date   | "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   |
| "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) | "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 |
| "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  | "&" document member of the same patent family  |

Date of the actual completion of the international search  
25 August 2008 (25.08.2008)

Date of mailing of the international search report

**26 SEP 2008**

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/24668

## 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:  
Please See Continuation 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 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.: 1-3,5,10 and 11
  
  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/US07/24668

**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|------------|--|-----------------------|
| Y          | US 2005/0228203 A1 (MANZER) 13 October 2005 (13.10.2005), entire disclosure, in particular paragraphs 0011-0012, 0017, 0018, 0022, 0024, 0027-0029, 0031, 0033, 0034, Example 29 and claim 10. | 10 and 11             |
| Y          | US 3,529,033 A (FRILETTE et al) 15 September 1970 (15.09.1970), Examples 1 and 2 and claims 1-3.   | 1-3, 5, 10 and 11     |

**BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING**

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 must be paid.

Group I, claim(s) 1-3, drawn to a process for making at least one butene and a process for making at least one isoalkane.

Group II, claim(s) 4, drawn to a process for making at least one C10 to C13 substituted aromatic compound.

Group III, claim(s) 5, drawn to a process for making at least one butyl alkyl ether.

Group IV, claim(s) 6, drawn to a process for making at least one isooctene.

Group V, claim(s) 7, drawn to a process for making at least one isooctane.

Group VI, claim(s) 8, drawn to a process for making at least one isooctanol.

Group VII, claim(s) 9, drawn to a process for making at least one isooctyl alkyl ether.

Group VIII, claim(s) 10, drawn to a process for making p-xylene.

Group IX, claim(s) 11, drawn to another process for making p-xylene.

The inventions listed as Groups I-IX 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: steps a)-d) are known and thus does not constitute a special technical feature. Groups II-IX contain steps which are not required by Group I.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/24668

Continuation of B. FIELDS SEARCHED Item 3:

EAST

search terms: butene, isobutene, ethanol, dry ethanol, butanol, acid, catalyst, base, isoalkane, isobutane, isooctene, diisobutene, p-xylene, dehydrocyclization, water, dehydration, dehydrogenation, butylene, sulfuric acid