(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 August 2013 (29.08.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/126362 A3

(51) International Patent Classification:
C10G 65/12 (2006.01) *C10G 47/22* (2006.01)
C10G 65/10 (2006.01) *C10G 47/24* (2006.01)
C10G 1/00 (2006.01) *C10G 47/28* (2006.01)
C10G 1/08 (2006.01) *B01J 21/18* (2006.01)
C10G 47/26 (2006.01)

(21) International Application Number:
PCT/US2013/026785

(22) International Filing Date:
20 February 2013 (20.02.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/601,366 21 February 2012 (21.02.2012) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, 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 February 2014

(54) Title: TWO-ZONE, CLOSE-COUPLED, HEAVY OIL HYDROCONVERSION PROCESS UTILIZING AN EBULLATING BED FIRST ZONE

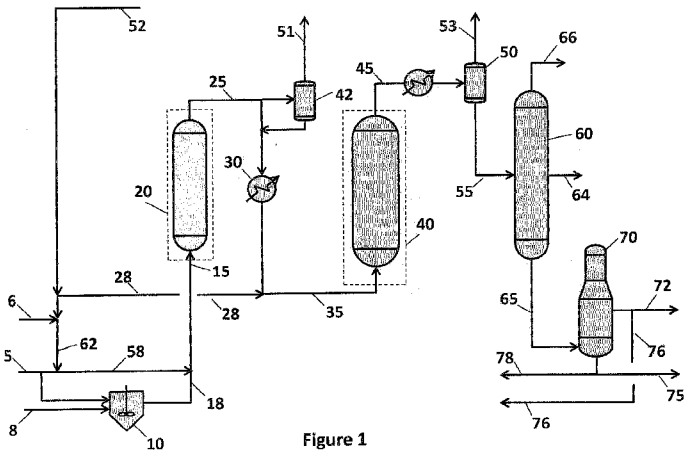


Figure 1

(57) Abstract: A process for hydroconversion of heavy oil feedstocks that effectively controls the condensation of asphaltenes by utilizing a two-zone, close-coupled reactor(s) combination comprising an ebullating bed thermo-catalytic zone operated at high temperature to achieve high conversion of the heavy oil to lower boiling point products, followed by a closely-coupled, catalytic-hydrotreating second zone which may be comprise fixed, moving and/or ebullated reactors wherein the first zone liquid effluent is stabilized and reduced in heteroatom content. This close-coupled combination converts heavy hydrocarbonaceous feed-stocks, a significant portion of which boils above 540°C, to high yields of high quality products boiling below 540°C. In cases with heavy oil feedstocks that are more difficult to process, a dispersed catalyst and/or dispersed coal may be added to the first zone feed to further promote the conversion to lower boiling point products.

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A. CLASSIFICATION OF SUBJECT MATTER
INV. C10G65/12 C10G65/10 C10G1/00 C10G1/08 C10G47/26
C10G47/22 C10G47/24 C10G47/28
ADD. B01J21/18
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)
C10G B01J

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.
X	US 2004/163996 A1 (COLYAR JAMES J [US]) 26 August 2004 (2004-08-26)	1,5,6, 10-20, 26-29
Y	abstract figures 1-2 paragraphs [0001] - [0002], [0011] - [0014], [0017], [0021] - [0023] paragraphs [0030] - [0048] paragraphs [0052] - [0053] claims 1,4,5,7,10	1,5,6, 12-15, 18-21, 26,28,29

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[X] Further documents are listed in the continuation of Box C.

[X] 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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 December 2013	17/12/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Marchand, Karin

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	US 4 456 699 A (HENSLEY JR ALBERT L [US] ET AL) 26 June 1984 (1984-06-26)	1,5,7, 10,14, 16,17, 20,26-30
Y	example III figure 1 column 1, lines 9-23,30-34 column 10, lines 49-55 column 11, lines 44-48 column 12, lines 13-24 column 13, lines 4-12 column 14, lines 17-22,29-38,41-42 column 14, line 52 - column 16, line 30	7,21,26

X	US 7 938 952 B2 (COLYAR JAMES J [US] ET AL) 10 May 2011 (2011-05-10)	1,6,7, 20,28
Y	abstract figure 1 column 1, lines 8-12,17-28 column 2, lines 39-43 column 3, lines 1-7,57-62 column 4, lines 60-61,65-67 column 5, lines 1-7,24-29,34-40,50-67 column 6, lines 1-15	1,6,7, 20,21,28

X	US 2011/226667 A1 (LOTT ROGER K [CA] ET AL) 22 September 2011 (2011-09-22)	3,5, 7-11,14, 18,20, 21,25, 28,29
Y	figures 10-22; example 6 claims 13-22, 25-27 paragraph [0155]	3,5, 7-11,14, 18-21, 25,28,29

Y	US 2009/326304 A1 (BHATTACHARYYA ALAKANANDA [US] ET AL) 31 December 2009 (2009-12-31) abstract claim 1 paragraph [0038]	9

Y	MATSUMURA A ET AL: "Hydrocracking Brazilian Marlim vacuum residue with natural limonite. Part 1: catalytic activity of natural limonite", FUEL, IPC SCIENCE AND TECHNOLOGY PRESS, GUILDFORD, GB, vol. 84, no. 4, 1 March 2005 (2005-03-01), pages 411-416, XP027700469, ISSN: 0016-2361 [retrieved on 2005-03-01] page 412, left-hand column, paragraph 1 abstract	9

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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	US 2011/042272 A1 (MACARTHUR JAMES B [US] ET AL) 24 February 2011 (2011-02-24)	2,13
Y	paragraphs [0017] - [0018], [0051] paragraph [0048]; figure 1	4,13,18, 19

X	US 4 761 220 A (BERET SAMIL [US] ET AL) 2 August 1988 (1988-08-02) cited in the application	1,3,5-8, 10,11, 14-17, 20,25, 28-30
Y	abstract column 2, lines 32-35,40-48 column 3, lines 12-22,52-65 column 4, line 51 - column 5, line 10 column 5, lines 18-52 column 5, line 55 - column 6, line 3 column 6, lines 10-36, 43-45 example 1	1,3,5-8, 10,11, 14-17, 20,25, 28-30

Y	CA 1 073 389 A1 (CANADA MAJESTY IN RIGHT OF) 11 March 1980 (1980-03-11) page 1, lines 1-2,18, 24-27 page 2, lines 20-33 page 3, lines 3-13	22-24

Y	US 4 422 922 A (ROSENTHAL JOEL W [US] ET AL) 27 December 1983 (1983-12-27) cited in the application abstract column 2, lines 1-23,43-50 column 2, line 66 - column 3, line 11 column 4, lines 3-21, 24-26,40-48 column 4, line 59 - column 5, line 13 column 5, lines 11-13,36-42,49-57 column 6, lines 3-5,11-20	4-11, 14-17, 22-30

Y	WO 2008/151792 A1 (ENI SPA [IT]; RISPOLI GIACOMO [IT]; BELLUSSI GIUSEPPE [IT]; PANARITI N) 18 December 2008 (2008-12-18) cited in the application abstract claims 1-5, 15 figure 1 page 1, lines 12-20 page 2, lines 24-25 page 5, lines 9-20 page 6, lines 3-25 page 7, lines 23-25 page 8, lines 3-6,15-25 page 9, lines 6-10,15-18 page 10, lines 12-20 table 2	3,7,8, 10-13, 15,20, 21,27, 29,30

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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
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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, 12(completely); 5-7, 10, 11, 14-21, 26-30(partially)

a process for conversion of heavy oils to produce lower boiling hydrocarbon products comprising;
- heating the heavy oil feedstock and passing it into a first reaction zone which is an ebullating bed reactor(s) operating at thermo-catalytic conditions in the presence of hydrogen and a supported catalyst;
- reducing the temperature of the product from said first reaction zone;
1.4 - passing the product, the temperature of which is reduced, to a second reaction zone which is a fixed, moving, or ebullated bed reactor(s) having a supported hydrotreating catalyst operating at catalytic-hydrotreating conditions;
- recovering the product of the second reaction zone;
- wherein the first and second reaction zones are close-coupled and operated at elevated temperature and pressure.

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2. claims: 2, 4, 13, 22-24(completely); 5-7, 10, 11, 14-21, 26-30(partially)

process for conversion of heavy oils to produce lower boiling hydrocarbon products comprising;
- dispersing finely divided coal in the heavy oil feedstock;
- heating the coal-containing heavy oil feedstock and passing it into a first reaction zone which is an ebullating bed reactor(s) operating at thermo-catalytic conditions in the presence of hydrogen and a supported catalyst;
- reducing the temperature of the product from said first reaction zone;
- passing the product, the temperature of which is reduced, to a second reaction zone which is an ebullated bed reactor(s) having a supported hydrotreating catalyst operating at catalytic-hydrotreating conditions;
- recovering the product of the second reaction zone;
- wherein the first and second reaction zones are close-coupled and operated at elevated temperature and pressure.

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3. claims: 3, 8, 9, 25(completely); 5-7, 10, 11, 14-21, 26-30(partially)

process for conversion of heavy oils to produce lower boiling hydrocarbon products comprising:
- dispersing a finely divided catalyst in the heavy oil feedstock;
- heating the heavy oil feedstock and passing it into a first reaction zone which is an ebullating bed reactor(s)

operating at thermo-catalytic conditions in the presence of hydrogen and a supported catalyst;
- reducing the temperature of the product from said first reaction zone;
- passing the product, the temperature of which is reduced, to a second reaction zone which is an ebullated bed reactor(s) having a supported hydrotreating catalyst operating at catalytic-hydrotreating conditions;
- recovering the product of the second reaction zone;
- wherein the first and second reaction zones are close-coupled and operated at elevated temperature and pressure.
