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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, 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,

[Continued on next page]

(54) Title: METHODS OF IMPROVING HYDRAULIC FRACTURE NETWORK

(57) Abstract: The complexity of a fracture network may be enhanced during a hydraulic fracturing operation by monitoring operational parameters of the fracturing job and altering stress conditions in the well in response to the monitoring of the operational parameters. The operational parameters monitored may include the injection rate of the pumped fluid, the density of the pumped fluid or the bottomhole pressure of the well after the fluid is pumped. The method provides an increase to the stimulated reservoir volume (SRV).

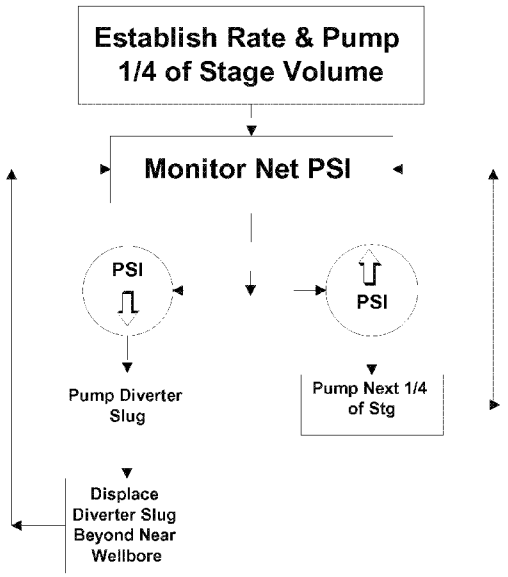

Figure 1

WO 2014/004611 A3

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19 June 2014

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. C09K8/60 C09K8/62
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)
C09K

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 Y	GB 2 137 262 A (DOW CHEMICAL CO) 3 October 1984 (1984-10-03) claims -----	1-5 6,7
Y	US 3 480 084 A (EILERS LOUIS H) 25 November 1969 (1969-11-25) claims -----	6,7
A	US 4 501 672 A (CONNELL DAVID L [GB] ET AL) 26 February 1985 (1985-02-26) claims; example 3 ----- -/--	1-7

[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
16 September 2013	30/04/2014

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	Zimpfer, Emmanuel

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/047779

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	R.R. HANNAH ET AL: "The Real-Time Calculation of Accurate Bottomhole Fracturing Pressure From Surface Measurements Using Measured Pressure as a Base", SPE 12062, 5 August 1983 (1983-08-05), pages 1-12, XP055062488, the whole document -----	1-7
A	US 4 444 264 A (DILL WALTER R [US]) 24 April 1984 (1984-04-24) claims -----	1-7

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/047779

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.:

1-7

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-7

Claim 1 relates to a method of hydraulically fracturing a hydrocarbon-bearing subterranean formation penetrated by a reservoir which comprises: (a) pumping a fluid into the formation at a pressure sufficient to create or enlarge a primary fracture; (b) determining a bottomhole treating pressure within the well; (c) diverting the flow of fluid from loss zones by introducing into the formation a chemical diverter; (d) comparing the determined bottomhole treating pressure with a pre- determined targeted bottomhole treating pressure; (e) pumping a fracturing fluid into the formation, wherein the flow of the fracturing fluid to the loss zone is impeded by the chemical diverter, and (f) extending the primary fracture in the formation.

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2. claims: 8-14

Claim 8 relates to a method of hydraulically fracturing a hydrocarbon-bearing subterranean formation penetrated by a well which comprises:(a) pumping a fluid into the formation at a pressure sufficient to create or enlarge a fracture; (b) determining a surface pressure at or near the surface of the well; (c) diverting a flow of fluid from highly conductive zones to less conductive zones by introducing into the formation a diverting agent; (d) comparing the determined surface pressure with a targeted surface pressure; and (e) altering stress in the well and extending the fracture, wherein stress is altered in the well by varying at least one of the following:(i) the injection rate of the fluid; (ii) the bottomhole pressure of the well; or (iii) the density of the fluid.

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3. claims: 15-19

Claim 15 relates to a method of hydraulically fracturing a hydrocarbon-bearing subterranean formation penetrated by a well wherein a fluid is introduced into the well at a pressure sufficient to enlarge or create a fracture, the method comprising:(a) defining at least one of the following operational parameters:(i) an injection rate of the fluid, (ii) a density of the fluid; or (iii) a bottomhole treating pressure of the well (b) pumping the fluid into the formation and creating or enlarging a fracture; (b) comparing the difference between at least one of the operational parameters of step (a) after the fluid is pumped into the formation with the defined operational parameter; (c) altering the injection rate of the fluid into the formation or pumping into the formation a diverting agent wherein the a flow of fluid introduced into the formation is

diverted from highly conductive fractures to less conductive fractures; (d) comparing the difference between at least one of the operational parameters of step (a) with the defined operational parameters of step (a); (e) altering stress in the well and extending the fracture, wherein a stress is altered in the well by varying at least one of the operational parameters of step (a) wherein, after step (e) the stimulated reservoir volume is greater than the stimulated reservoir volume after step (c).

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4. claim: 20

Claim 20 relates to a method of hydraulically fracturing a hydrocarbon-bearing subterranean formation penetrated by a well comprising:(a) pumping a fracturing fluid into the formation at a pressure sufficient to create or enlarge a fracture; (b) pumping into the formation a diverter fluid, wherein a flow of diverter fluid introduced into the formation proceeds from a highly conductive zone to a less conductive zone; and (c) pumping into the formation additional fracturing fluid at a pressure greater than the pressure defined in step (a) wherein the fracture area within the formation after step (c) is greater than the fracture area created from a substantially similar method not employing step (b).

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5. claims: 21, 22

Claim 21 relates to a method of hydraulically fracturing a hydrocarbon-bearing subterranean formation penetrated by a well which comprises:(a) pumping a fluid into the formation at a pressure sufficient to create or enlarge a primary fracture; (b) monitoring an operational parameter and comparing the operational parameter after pumping of the fluid into the formation with a pre-determined value for the operational parameter, wherein the operational parameter is at least one of the following:(i) the injection rate of the fluid, (ii) the density of the fluid; or (iii) the bottomhole treating pressure of the well (c) diverting the flow of fluid from a highly conductive zone to a less conductive zone by diversion; (d) comparing the operational parameter after step (c) with the pre-determined value for the operational parameter; (e) pumping a fracturing fluid into the formation, wherein the flow of the fracturing fluid to the less conductive zone is impeded by the diverter; and (f) extending the primary fracture in the formation.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/047779

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