

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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| Applicant's or agent's file reference<br>LNDE0002PCT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>FOR FURTHER ACTION</b>                                         |                                                                                                                                                                                                                 | See Form PCT/IPEA/416 |
| International application No.<br>PCT/US2015/055627                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | International filing date ( <i>day/month/year</i> )<br>15.10.2015 | Priority date ( <i>day/month/year</i> )<br>22.10.2014                                                                                                                                                           |                       |
| International Patent Classification (IPC) or national classification and IPC<br>INV. C09K8/64                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                   |                                                                                                                                                                                                                 |                       |
| Applicant<br>Linde AG                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                   |                                                                                                                                                                                                                 |                       |
| <p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>10</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p style="margin-left: 20px;">a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of <u>17</u> sheets, as follows:</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).</p> <p style="margin-left: 40px;"><input type="checkbox"/> superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).</p> <p style="margin-left: 20px;">b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions).</p> |                                                                   |                                                                                                                                                                                                                 |                       |
| <p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I      Basis of the report</p> <p><input type="checkbox"/> Box No. II      Priority</p> <p><input type="checkbox"/> Box No. III      Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV      Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V      Reasoned conclusion under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI      Certain documents cited</p> <p><input type="checkbox"/> Box No. VII      Certain defects in the international application</p> <p><input checked="" type="checkbox"/> Box No. VIII      Certain observations on the international application</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                   |                                                                                                                                                                                                                 |                       |
| Date of submission of the demand<br><br>19.05.2016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                   | Date of completion of this report<br><br>03.02.2017                                                                                                                                                             |                       |
| Name and mailing address of the international preliminary examining authority:<br><br> European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0<br>Fax: +49 89 2399 - 4465                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                   | Authorized officer<br><br>Redecker, Michael<br><br>Telephone No. +49 89 2399-2286 <div style="text-align: right;">  </div> |                       |

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/US2015/055627

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on
- ☒ the international application in the language in which it was filed
  - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
    - ☐ international search (under Rules 12.3(a) and 23.1(b))
    - ☐ publication of the international application (under Rule 12.4(a))
    - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))
2. With regard to the **elements\*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

**Description, Pages**

1-29 as originally filed

**Claims, Numbers**

1-27 filed with the letter of 18-11-2016

**Drawings, Sheets**

1/11-11/11 as originally filed

- ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
4. ☒ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
- ☐ the description, pages
  - ☒ the claims, Nos. 1-27
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
5. ☐ This report has been established:
- ☐ taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
  - ☐ without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/US2015/055627

6. ☒ With regard to top-up searches (Rules 66.1 *ter* and 70.2(f)):
- ☒ A top-up search was carried out by this Authority on 13.01.2017 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
  - ☐ Additional relevant documents have been discovered during the top-up search.
  - ☐ No top-up search was carried out by this Authority because it would serve no useful purpose.
7. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

\* If item 4 applies, some or all of those sheets may be marked "superseded".

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

|                               |             |                       |
|-------------------------------|-------------|-----------------------|
| Novelty (N)                   | Yes: Claims |                       |
|                               | No: Claims  | <u>11, 21, 26, 27</u> |
| Inventive step (IS)           | Yes: Claims |                       |
|                               | No: Claims  | <u>1-27</u>           |
| Industrial applicability (IA) | Yes: Claims | <u>1-27</u>           |
|                               | No: Claims  |                       |

2. Citations and explanations (Rule 70.7):

**see separate sheet**

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**Box No. VIII Certain observations on the international application**

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The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

**Re Item I**

**Basis of the report**

1. The amendments filed with letter of 18.11.2016 introduce subject matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following:

1.1 The following amendments have been carried out in claim 1:

(a) The term "Y-grade NGL" has been deleted and the terms "an unfractionated hydrocarbon mixture" and "wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream" have been inserted.

(b) The individual contents for ethane, propane, butane, isobutane and pentane plus have been deleted.

The applicant has identified the passages § 59, 60 of the description as published as suitable basis.

However, said passage is silent about a stimulation fluid comprising a proppant. Therefore said passage cannot serve as basis for a fluid where no limitation is imposed on the amounts of the individual hydrocarbons, see feature (b).

1.2 The same objection applies to amended claim 6, where the contents of individual hydrocarbons, which are defined by their number of carbon atoms, has been deleted. Furthermore, said claim now contains a proppant, while claim 6 as-published is silent about a proppant.

1.3 It is therefore considered that at least claims 1, 6 do not comply with the provisions of Article 34(2)(b).

2. In accordance with the provisions of rules 70.2(c) and 70.2(c-bis) PCT, this opinion is therefore based on the set of claims as originally filed.



**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Reference is made to the following documents:

- D1        US 3 368 627 A (HURST ROBERT E ET AL) 13 February 1968  
(1968-02-13)
- D2        US 2014/124208 A1 (LOREE DWIGHT N [CA] ET AL) 8 May 2014  
(2014-05-08)
- D3        US 2005/189112 A1 (TAYLOR ROBERT S [CA] ET AL) 1 September  
2005 (2005-09-01)

**1. Novelty**

The present application does not meet the criteria of Article 33(1) PCT, because the subject matter of claims 11, 21, 26, 27 (see point I-2) is not new in the sense of Article 33(2) PCT.

1.1 The document D1 discloses (the references in parentheses applying to this document) a method of fracturing a subterranean formation, using a fluid comprising a mixture of liquefied C<sub>2</sub>-C<sub>6</sub> hydrocarbon and liquefied carbon dioxide (cls.1, 3). Example 1 shows the method using a mixture of butane and approx. 50% CO<sub>2</sub>, with the addition of sand as the proppant.

The presence of respective reservoirs for hydrocarbon, CO<sub>2</sub> and proppant as well as the presence of a receiver-blender and of a pump is considered to be inherent to the method of D1.

Therefore, the disclosure of document D1 seems to anticipate the subject matter of independent claims 11, 21, which are not considered to be novel over D1 in the sense of Article 33(2) PCT.

Dependent claim 26 does not contain any features which, in combination with the features of any claim to which it refers, meet the requirements of the PCT in respect of novelty, since the respective technical features are disclosed by D1 as cited above.

1.2 The document D2 discloses an apparatus for fracturing a formation, comprising a frac pressure pump, a frac fluid source connected to a frac fluid supply comprising predominantly propane and butane, and an inert gas source (cl. 1). The apparatus furthermore comprises a proppant supply source (cl. 2) and a gellant supply source (cl. 3).

The fluid flow to/from the wellhead is controlled by valve V8, while release of the frac fluid for flaring is done through valves V7 (descr. § 23). Therefore at least a valve for closing the supply of frac fluid to the wellhead and a vent line are provided (see also clarity point VIII-6).

Therefore, the disclosure of document D2 seems to anticipate the subject matter of independent claim 27, which is not considered to be novel over D2 in the sense of Article 33(2) PCT.

## **2. Inventive Step**

The present application does not meet the criteria of Article 33(1) PCT, because the subject matter of claims 1-10, 12-20, 22-25 (see point I-2) does not involve an inventive step in the sense of Article 33(3) PCT.

2.1 Dependent claims 12-20, 22-25 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, since the disclosed additional technical features represent routine modifications of the compositions or processes of D1, which are carried out by the skilled person without the involvement of an inventive step.

2.2 The document D3 is regarded as being the closest prior art to the subject matter of claim 1, and discloses a method of fracturing a subterranean formation, using a fluid comprising liquefied petroleum gas and a gelling

agent (cl. 8) and where the fluid furthermore comprises particulates (cl. 14). A phosphate ester in combination with aluminium or ferric ions is used as gelling agent (cl. 12). The gas contains hydrocarbons ranging from methane up to pentanes, while its use reduces formation damage and helps to maximise fluid recovery (descr. § 19).

The subject matter of claim 1 (see also the corresponding clarity objections in section VIII) therefore differs from the disclosure of D3 in that a specific mix of hydrocarbons is used, where the content of each of the C<sub>2</sub>-C<sub>5</sub> saturated hydrocarbons is defined.

2.2.1 With letter of 19.05.2016, the applicant argues that the document D3 relies on liquid petroleum gas (LPG), which represents a fractionation product of natural gas. He concludes that LPG is a product of commercial value, while Y-grade NGL has no dedicated market value per se.

The same argument is used in the present application, where the passage § 17 of the description states that natural gas liquid has advantages with respect to cost and availability, as compared to liquefied petroleum gas (see descr. § 17).

The introduction of a lower limit of 5% for pentane plus in the stimulation fluid of claim 1 represents a slight modification, which cannot be regarded as a significant change in cost.

Beyond said economic considerations, no example is shown in the present application that could demonstrate a technical effect for said specific hydrocarbon composition.

The problem to be solved by the present application may therefore be regarded as to provide an alternative hydrocarbon-based stimulation fluid.

2.2.2 The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The modification of the gas mix, where only the amounts of the individual C<sub>2</sub>-C<sub>5</sub> hydrocarbon constituents of the fluid of D3 are changed, is carried out by the skilled person as a matter of common practice in the field, without the involvement of an inventive step.

It is noted that even if lower cost and better availability were taken into account, such factors would be naturally involved in any modification or optimisation carried out by the skilled person.

The same reasoning applies, *mutatis mutandis*, to the subject matter of the corresponding independent claim 6, which therefore also lacks an inventive step.

Dependent claims 2-5, 7-10 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, since the disclosed additional technical features represent routine modifications of the compositions of D3, which are carried out by the skilled person without the involvement of an inventive step.

### **Re Item VIII**

#### **Certain observations on the international application**

The application does not meet the requirements of Article 6 PCT, because claims 1-12, 14, 17, 19, 21-27 are not clear.

1. The terms "Y-grade NGL" and "Y-grade stimulation fluid", respectively, used in claims 1, 5, 6, 10, 11, 12, 17, 19, 21-25, 27, are unclear and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject matter of said claims unclear (Article 6 PCT).

There is no consistent definition in the claims as to the ingredients of said materials.

However, the description teaches that Y-grade NGL is a mixture of ethane, propane, butanes and pentanes (see § 59).

Said definition is therefore used for the examination of novelty and inventive step.

2. The subject matter described in § 65-77 does not fall within the scope of independent claims 1, 6, since either the ethane content can be too low and/or the content of butanes or pentanes can be outside the definition given by claims 1 or 6, respectively. This inconsistency between the claims and the description leads to doubt concerning the matter for which protection is sought, thereby rendering claims 1-10 unclear (Article 6 PCT).

3. The percentage ranges disclosed in claim 1 are not consistent, since a maximum content of one component is not compatible with the sum of the lower limits of the remaining constituents (Art. 6 PCT). For example, the sum of 80% ethane, 15% propane, 15% butane, 15% isobutane and 5% pentane plus would amount to 130%.

4. Claim 6 is unclear in using the term "carbon elements", while it appears that carbon atoms are meant (Art. 6 PCT).

5. Claims 4, 9, 14, 23 are not clear in that they appear to include the use of either a phosphate ester or an organometallic complex crosslinker as the gelling agent.

However, it is known in the art that a combination of phosphate ester and multivalent metal ion, such as aluminium or trivalent iron, works as a gelling agent for hydrocarbons (Art. 6 PCT).

6. Claim 27 is unclear in that the extension of the passage to which the term "or" refers is not clearly defined (Art. 6 PCT). For example, it is not clear if the term starting with "a vent line" is meant to represent an alternative to the spray bar header, or to the combination of the remote controlled emergency valve with the spray bar header.

7. The terms "about", used in claims 1, 5, 6, 10, 26, and "pentane plus", used in claim 1, are vague and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject matter of said claims unclear (Article 6 PCT).

8. The expression "incorporated by reference", used in § 27 of the description, is unclear (Art. 5 PCT and GL 4.26) and should be deleted.

**PATENT COOPERATION TREATY (PCT)**

**THE INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY**

|                                    |   |                                |
|------------------------------------|---|--------------------------------|
| In re Application of:              | § |                                |
| LINDE AKTIENGESELLSCHAFT           | § |                                |
|                                    | § | Priority Date: 22 October 2014 |
| Application No.: PCT/US2015/055627 | § | (22-10-2014)                   |
|                                    | § |                                |
| Intl. Filing Date: 15 October 2015 | § | Attorney Ref.: LNDE/0002PC     |
| (15-10-2015)                       | § |                                |
|                                    | § |                                |
| Title: Y-GRADE NGL STIMULATION     | § |                                |
| FLUIDS                             | § |                                |

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EUROPEAN PATENT OFFICE (IPEA/EP)  
P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk

**RESPONSE TO SECOND WRITTEN OPINION OF THE INTERNATIONAL  
PRELIMINARY EXAMINING AUTHORITY UNDER PCT ARTICLE 34**

Dear Sir:

In response to Second Written Opinion mailed on September 9, 2016, Applicant submits the following claim amendments and remarks for consideration.

**Amendments to the Claims** begin on page 2.

**Remarks** begin on page 8.

**Clean Copy of Claims** begins on page 12.

**AMENDMENTS TO THE CLAIMS**

Please amend the claims as follows, where underlined text shows inserted text, and where strikethrough and/or square brackets shows deleted text:

1. (Currently Amended) A stimulation fluid ~~consisting of an as-produced Y-Grade NGL byproduct~~, comprising:

a proppant; and

an unfractionated hydrocarbon mixture comprising:

ethane;

propane;

butane;

isobutane; and

pentane plus;

wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream.

~~wherein the propane, butane, and isobutane combined comprise no more than 85% of the fluid;~~ and

~~wherein the pentane plus comprises at least 10% of the fluid.~~

2. (Original) The fluid of claim 1, further comprising at least one of carbon dioxide and nitrogen.

3. (Original) The fluid of claim 1, further comprising a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.

4. (Currently Amended) The fluid of claim 1, further comprising a gelling agent that includes ~~at least one of~~ phosphate esters and organo-metallic complex cross-linkers.



5. (Currently Amended) The fluid of claim 1, further comprising an emulsifying agent that includes surfactants, co-surfactants, and/or co-solvents, ~~to form a Y-Grade NGL emulsion having up to about~~ wherein the stimulation fluid includes up to 10% water, seawater, formation water, and/or brine.

6. (Currently Amended) A stimulation fluid ~~consisting of an as-produced Y-Grade NGL byproduct~~, comprising:

a proppant; and

an unfractionated hydrocarbon mixture comprising:

at least one hydrocarbon compound having two carbon ~~elements~~ atoms (C2);

at least one hydrocarbon compound having three carbon ~~elements~~ atoms (C3);

at least one hydrocarbon compound having four carbon ~~elements~~ atoms (C4);

and

at least one hydrocarbon compound having five carbon ~~elements~~ atoms (C5) or

more;

wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream.

~~wherein the at least one hydrocarbon compound having three carbons elements and the at least one hydrocarbon compound having four carbon elements combined comprise no more than 85% of the fluid; and~~

~~wherein the at least one hydrocarbon compound having five carbon elements comprises at least 10% of the fluid.~~

7. (Currently Amended) The fluid of claim 6, further comprising ~~a proppant, and~~ at least one of carbon dioxide and nitrogen.

8. (Original) The fluid of claim 7, further comprising a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.

9. (Currently Amended) The fluid of claim 7, further comprising a gelling agent that includes ~~at least one of~~ phosphate esters and organo-metallic complex cross-linkers.
10. (Currently Amended) The fluid of claim 7, further comprising an emulsifying agent that includes surfactants, co-surfactants, and/or co-solvents, ~~to form a Y-Grade NGL emulsion having up to about~~ wherein the stimulation fluid includes up to 10% water, seawater, formation water, and/or brine.
11. (Currently Amended) A Y-Grade NGL system, comprising:  
a nitrogen and/or carbon dioxide source;  
~~an as-produced Y-Grade NGL byproduct~~ a Y-Grade NGL source in fluid communication with the nitrogen and/or carbon dioxide source;  
a proppant source in fluid communication with the nitrogen and/or carbon dioxide source;  
a receiver-blender in fluid communication with the ~~as-produced Y-Grade NGL byproduct~~ Y-Grade NGL source and the proppant source; and  
a pump configured to pump a stimulation fluid from the receiver-blender into a wellhead, wherein the stimulation fluid comprises a proppant from the proppant source, ~~as-produced Y-Grade NGL byproduct~~ an unfractionated hydrocarbon mixture from the ~~as-produced Y-Grade NGL byproduct~~ Y-Grade NGL source, and at least one of nitrogen and carbon dioxide from the nitrogen and/or carbon dioxide source, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, and wherein the unfractionated hydrocarbon mixture comprises ethane, propane, butane, isobutane, and pentane plus.
12. (Currently Amended) The system of claim 11, further comprising a foaming agent source and a foaming unit in fluid communication with the ~~as-produced Y-Grade NGL byproduct~~ Y-Grade NGL source and the receiver-blender, wherein the foaming agent source

comprises a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent.

13. (Original) The system of claim 11, wherein the foaming unit includes a venturi eductor, a high frequency ultrasonic sonde, and/or a micro mesh screen.

14. (Currently Amended) The system of claim 11, further comprising a gelling agent source in fluid communication with the receiver-blender, wherein the gelling agent source comprises a gelling agent that includes ~~at least one of~~ phosphate esters and organo-metallic complex cross-linkers.

15. (Original) The system of claim 11, further comprising an emulsifying agent source in fluid communication with the receiver-blender, wherein the emulsifying agent source comprises an emulsifying agent.

16. (Original) The system of claim 11, further comprising a pressure regulation compressor configured to regulate pressure within the receiver-blender.

17. (Currently Amended) The system of claim 11, further comprising a field separation unit configured to receive a wet gas stream from the same or a different wellhead, separate ~~as-produced Y-Grade NGL byproduct~~ the unfractionated hydrocarbon mixture from the wet gas stream, and supply ~~as-produced Y-Grade NGL byproduct~~ the unfractionated hydrocarbon mixture to the ~~as-produced Y-Grade NGL byproduct~~ Y-Grade NGL source directly via a fluid line or storage tankers.

18. (Original) The system of claim 11, further comprising air separation equipment configured to separate nitrogen from air and supply nitrogen to the nitrogen source.

19. (Currently Amended) The system of claim 11, further comprising onsite ~~Y-Grade NGL~~ pressurized storage vessels filled with additional amounts of the unfractionated hydrocarbon mixture supplied from a regional ~~Y-Grade~~ gathering pipeline, a regional gas splitter, or a gas processing facility via tanker trucks.

20. (Original) The system of claim 11, wherein the proppant source comprises a pressurized proppant silo where the proppant is temporally stored and pneumatically conveyed to the receiver-blender using nitrogen or carbon dioxide.

21. (Currently Amended) A method of pumping a ~~Y-Grade NGL~~ stimulation fluid into a hydrocarbon bearing reservoir, comprising:

blending ~~as-produced Y-Grade NGL byproduct~~ an unfractionated hydrocarbon mixture, a proppant, and at least one of nitrogen and carbon dioxide in a receiver-blender to form ~~the stimulation fluid, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, and wherein the unfractionated hydrocarbon mixture comprises ethane, propane, butane, isobutane, and pentane plus;~~ and

pumping the stimulation fluid into the hydrocarbon bearing reservoir.

22. (Currently Amended) The method of claim 21, further comprising blending a foaming agent and optionally a foam stabilizer with the ~~as-produced Y-Grade NGL byproduct~~ unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon dioxide in the receiver-blender to form the stimulation fluid, wherein the foaming agent includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.

23. (Currently Amended) The method of claim 21, further comprising blending a gelling agent with the ~~as-produced Y-Grade NGL byproduct~~ unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon dioxide in the receiver-blender to form the

stimulation fluid, wherein the gelling agent includes ~~at least one of~~ phosphate esters and organo-metallic complex cross-linkers.

24. (Currently Amended) The method of claim 21, further comprising blending an emulsifying agent and water or brine with the ~~as-produced Y-Grade NGL byproduct~~ unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon dioxide in the receiver-blender to form the stimulation fluid.

25. (Currently Amended) The method of claim 21, further comprising acquiring ~~as-produced Y-Grade NGL byproduct~~ the unfractionated hydrocarbon mixture from a wet gas stream, a fluid line, or storage tankers, and supplying the ~~as-produced Y-Grade NGL byproduct~~ unfractionated hydrocarbon mixture to a Y-Grade NGL source that is in fluid communication with the receiver-blender.

26. (Currently Amended) The method of claim 21, wherein the stimulation fluid includes a nitrogen concentration greater than ~~about~~ 50%, a carbon dioxide concentration greater than ~~about~~ 35%, or a combination of nitrogen and carbon dioxide concentration greater than ~~about~~ 50% so that the stimulation fluid is outside the flammability limit.

27. (Currently Amended) An emergency system, comprising:

a header configured to supply ~~an as-produced Y-Grade NGL byproduct~~ a stimulation fluid to a wellhead, wherein the stimulation fluid comprises an unfractionated hydrocarbon mixture comprising ethane, propane, butane, isobutane, and pentane plus, and wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream;

a remote controlled emergency valve configured to close the supply of the ~~Y-Grade NGL~~ stimulation fluid to the wellhead; ~~and~~

a spray bar header having a plurality of spray nozzles configured to spray carbon dioxide into the atmosphere adjacent to the header; ~~or and~~

a vent line in communication with the header to vent the ~~as-produced Y-Grade NGL~~  
~~byproduct~~ stimulation fluid from the header; or

a plurality of gas detectors configured to detect combustible gas from the header and in  
response ~~actuation~~ actuate the remote controlled emergency valve to close supply of the ~~as-~~  
~~produced Y-Grade NGL-byproduct~~ stimulation fluid to the wellhead.

### **REMARKS**

The following remarks are submitted in response to the Second Written Opinion mailed on September 9, 2016 for the above-referenced international application. In support of the following remarks, Applicant submits a declaration of John A. Babcock, who is listed as one of the inventors on the above-referenced international application.

Applicant would like to thank Examiner Michael Redecker for taking the time to conduct a telephonic interview on November 9, 2016 with Applicant's representatives.

Claims 1-27 remain pending. Independent claims 1, 6, 11, 21, and 27 have been amended herein to recite a stimulation fluid comprising "an unfractionated hydrocarbon mixture," "wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream." Support for the amendments is found at least in paragraphs [0059] and [0060] of the originally filed specification. Applicant respectfully submits that the pending claims as amended are novel and inventive, and that the references cited in the Second Written Opinion fail to disclose or suggest each and every element of claims 1-27.

A natural byproduct of a de-methanized hydrocarbon stream is Y-Grade NGL. Y-Grade NGL is an unfractionated hydrocarbon mixture that is condensed out of the de-methanized hydrocarbon stream. In its unfractionated state, Y-Grade NGL has no dedicated market or known use. Therefore, Y-Grade NGL must undergo processing at a fractionation facility to fractionate out usable fractionated hydrocarbons, which can be used to form fractionated hydrocarbon mixtures, such as liquefied petroleum gas. The inventors of the claimed subject matter have invented novel and inventive stimulation fluids and systems for using an unfractionated hydrocarbon mixture of a de-methanized hydrocarbon stream, wherein the unfractionated hydrocarbon mixture comprises ethane, propane, butane, isobutane, and pentane plus.

Regarding Items I and VIII of the Second Written Opinion, the pending claims have been amended as shown above to clarify the claimed subject matter. Applicant submits that the claimed subject matter is fully supported by the specification and does not extend beyond the content of the application as filed.

Regarding Item V, under novelty, the Examiner states that claims 11, 21, and 26 are not new in view of the D1 reference (US 3,368,627). Claims 11, 21, and 26 recite a stimulation fluid comprising an unfractionated hydrocarbon mixture that comprises ethane, propane, butane, isobutane, and pentane plus, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream. The D1 reference discloses a fluid azeotropic mixture that remains a liquid when injected down a well but converts to a gas upon a release of pressure applied to the liquid during injection. See Abstract. However, the fluid azeotropic mixture is a fractionated hydrocarbon mixture which contains carbon dioxide and at least one C2 to C6 hydrocarbon that can be individually liquefied, mixed, and injected down a well. See Col. 2, lines 49-67. The D1 reference does not disclose a stimulation fluid comprising an unfractionated hydrocarbon mixture that comprises ethane, propane, butane, isobutane, and pentane plus, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, as recited in claims 11, 21, and 26.

Regarding Item V, under novelty, the Examiner states that claim 27 is not new in view of the D2 reference (US 2014/124208). Claim 27 recites a stimulation fluid comprising an unfractionated hydrocarbon mixture that comprises ethane, propane, butane, isobutane, and pentane plus, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream. The D2 reference discloses a liquefied petroleum gas mixture that contains propane, butane, or a mix of propane and butane. See paragraph [0020]. The liquefied petroleum gas mixture must be fractionated out of a de-methanized hydrocarbon stream at a fractionation facility before use. The D2 reference does not disclose a stimulation fluid comprising an unfractionated hydrocarbon mixture that comprises ethane, propane, butane,



isobutane, and pentane plus, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, as recited in claim 27.

Regarding Item V, under inventive step, the Examiner states that claims 1-10, 12-20, and 22-25 are not inventive over the D3 reference (US 2014/124208) in view of the practices of a person skilled in the art. As stated above with respect to the D2 reference, the D3 reference discloses a liquefied petroleum gas mixture that must be fractionated out of a de-methanized hydrocarbon stream at a fractionation facility before use. The D3 reference does not disclose or suggest a stimulation fluid comprising an unfractionated hydrocarbon mixture as recited in claims 1-10, 12-20, and 22-25.

Based on the above, independent claims 1, 6, 11, 21, and 27, and claims dependent therefrom are novel and inventive over the D1, D2, and D3 references.

Dated: 11/18/16

Respectfully submitted,

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Article 34 Amendment  
Attorney Ref.: LNDE/0002PC

**CLEAN COPY OF CLAIMS**

1. A stimulation fluid, comprising:  
a proppant; and  
an unfractionated hydrocarbon mixture comprising:  
ethane;  
propane;  
butane;  
isobutane; and  
pentane plus;  
wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream.
2. The fluid of claim 1, further comprising at least one of carbon dioxide and nitrogen.
3. The fluid of claim 1, further comprising a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.
4. The fluid of claim 1, further comprising a gelling agent that includes phosphate esters and organo-metallic complex cross-linkers.
5. The fluid of claim 1, further comprising an emulsifying agent that includes surfactants, co-surfactants, and/or co-solvents, wherein the stimulation fluid includes up to 10% water, seawater, formation water, and/or brine.
6. A stimulation fluid, comprising:  
a proppant; and  
an unfractionated hydrocarbon mixture comprising:  
at least one hydrocarbon compound having two carbon atoms (C<sub>2</sub>);

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at least one hydrocarbon compound having three carbon atoms (C3);  
at least one hydrocarbon compound having four carbon atoms (C4); and  
at least one hydrocarbon compound having five carbon atoms (C5) or more;  
wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream.

7. The fluid of claim 6, further comprising at least one of carbon dioxide and nitrogen.
8. The fluid of claim 7, further comprising a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.
9. The fluid of claim 7, further comprising a gelling agent that includes phosphate esters and organo-metallic complex cross-linkers.
10. The fluid of claim 7, further comprising an emulsifying agent that includes surfactants, co-surfactants, and/or co-solvents, wherein the stimulation fluid includes up to 10% water, seawater, formation water, and/or brine.
11. A Y-Grade NGL system, comprising:
  - a nitrogen and/or carbon dioxide source;
  - a Y-Grade NGL source in fluid communication with the nitrogen and/or carbon dioxide source;
  - a proppant source in fluid communication with the nitrogen and/or carbon dioxide source;
  - a receiver-blender in fluid communication with the Y-Grade NGL source and the proppant source; and
  - a pump configured to pump a stimulation fluid from the receiver-blender into a wellhead, wherein the stimulation fluid comprises a proppant from the proppant source, an unfractionated hydrocarbon mixture from the Y-Grade NGL source, and at least one of

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nitrogen and carbon dioxide from the nitrogen and/or carbon dioxide source, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, and wherein the unfractionated hydrocarbon mixture comprises ethane, propane, butane, isobutane, and pentane plus.

12. The system of claim 11, further comprising a foaming agent source and a foaming unit in fluid communication with the Y-Grade NGL source and the receiver-blender, wherein the foaming agent source comprises a foaming agent that includes at least one of a surfactant, a co-surfactant, and a co-solvent.

13. The system of claim 11, wherein the foaming unit includes a venturi eductor, a high frequency ultrasonic sonde, and/or a micro mesh screen.

14. The system of claim 11, further comprising a gelling agent source in fluid communication with the receiver-blender, wherein the gelling agent source comprises a gelling agent that includes phosphate esters and organo-metallic complex cross-linkers.

15. The system of claim 11, further comprising an emulsifying agent source in fluid communication with the receiver-blender, wherein the emulsifying agent source comprises an emulsifying agent.

16. The system of claim 11, further comprising a pressure regulation compressor configured to regulate pressure within the receiver-blender.

17. The system of claim 11, further comprising a field separation unit configured to receive a wet gas stream from the same or a different wellhead, separate the unfractionated hydrocarbon mixture from the wet gas stream, and supply the unfractionated hydrocarbon mixture to the Y-Grade NGL source directly via a fluid line or storage tankers.

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18. The system of claim 11, further comprising air separation equipment configured to separate nitrogen from air and supply nitrogen to the nitrogen source.

19. The system of claim 11, further comprising onsite pressurized storage vessels filled with additional amounts of the unfractionated hydrocarbon mixture supplied from a regional gathering pipeline, a regional gas splitter, or a gas processing facility via tanker trucks.

20. The system of claim 11, wherein the proppant source comprises a pressurized proppant silo where the proppant is temporally stored and pneumatically conveyed to the receiver-blender using nitrogen or carbon dioxide.

21. A method of pumping a stimulation fluid into a hydrocarbon bearing reservoir, comprising:

blending an unfractionated hydrocarbon mixture, a proppant, and at least one of nitrogen and carbon dioxide in a receiver-blender to form the stimulation fluid, wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream, and wherein the unfractionated hydrocarbon mixture comprises ethane, propane, butane, isobutane, and pentane plus; and

pumping the stimulation fluid into the hydrocarbon bearing reservoir.

22. The method of claim 21, further comprising blending a foaming agent and optionally a foam stabilizer with the unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon dioxide in the receiver-blender to form the stimulation fluid, wherein the foaming agent includes at least one of a surfactant, a co-surfactant, and a co-solvent, and optionally includes a foam stabilizer.

23. The method of claim 21, further comprising blending a gelling agent with the unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon

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dioxide in the receiver-blender to form the stimulation fluid, wherein the gelling agent includes phosphate esters and organo-metallic complex cross-linkers.

24. The method of claim 21, further comprising blending an emulsifying agent and water or brine with the unfractionated hydrocarbon mixture, the proppant, and at least one of nitrogen and carbon dioxide in the receiver-blender to form the stimulation fluid.

25. The method of claim 21, further comprising acquiring the unfractionated hydrocarbon mixture from a wet gas stream, a fluid line, or storage tankers, and supplying the unfractionated hydrocarbon mixture to a Y-Grade NGL source that is in fluid communication with the receiver-blender.

26. The method of claim 21, wherein the stimulation fluid includes a nitrogen concentration greater than 50%, a carbon dioxide concentration greater than 35%, or a combination of nitrogen and carbon dioxide concentration greater than 50% so that the stimulation fluid is outside the flammability limit.

27. An emergency system, comprising:

a header configured to supply a stimulation fluid to a wellhead, wherein the stimulation fluid comprises an unfractionated hydrocarbon mixture comprising ethane, propane, butane, isobutane, and pentane plus, and wherein the unfractionated hydrocarbon mixture is a byproduct of a de-methanized hydrocarbon stream;

a remote controlled emergency valve configured to close the supply of the stimulation fluid to the wellhead; a spray bar header having a plurality of spray nozzles configured to spray carbon dioxide into the atmosphere adjacent to the header; and

a vent line in communication with the header to vent the stimulation fluid from the header; or

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a plurality of gas detectors configured to detect combustible gas from the header and in response actuate the remote controlled emergency valve to close supply of the stimulation fluid to the wellhead.

### **VERSIÓN FINAL DE LAS REIVINDICACIONES**

1. Un fluido de estimulación, que comprende:  
  
un agente de sustentación; y  
  
una mezcla de hidrocarburo no fraccionada que comprende:  
  
etano;  
  
propano;  
  
butano;  
  
isobutano; y  
  
pentano plus;  
  
en donde la mezcla de hidrocarburo no fraccionada es un subproducto de una corriente de hidrocarburo desmetanizada.
2. El fluido de la reivindicación 1, que comprende además uno de dióxido de carbono y nitrógeno.
3. El fluido de la reivindicación 1, que comprende además un agente espumante que incluye al menos uno de un tensioactivo, un co-tensioactivo y un co-disolvente y opcionalmente incluye un estabilizador de espuma.
4. El fluido de la reivindicación 1, que comprende además un agente gelificante que incluye ésteres de fosfato y reticulantes complejos organometálicos.
5. El fluido de la reivindicación 1, que comprende además un agente emulsionante que incluye tensioactivos, co-tensioactivos y/o co-disolventes, en donde el fluido de estimulación incluye hasta 10 % de agua, agua de mar, agua de formación y/o salmuera.
6. Un fluido de estimulación, que comprende:



un agente de sustentación; y

una mezcla de hidrocarburo no fraccionada que comprende:

al menos un compuesto hidrocarbonado que tiene dos átomos de carbono (C2);

al menos un compuesto hidrocarbonado que tiene tres átomos de carbono (C3);

al menos un compuesto hidrocarbonado que tiene cuatro átomos de carbono (C4);

y

al menos un compuesto hidrocarbonado que tiene cinco átomos de carbono (C5)

o más;

en donde la mezcla de hidrocarburo no fraccionada es un subproducto de una corriente de hidrocarburo desmetanizada.

7. El fluido de la reivindicación 6, que comprende además uno de dióxido de carbono y nitrógeno.
8. El fluido de la reivindicación 7, que comprende además un agente espumante que incluye al menos uno de un tensioactivo, un co-tensioactivo y un co-disolvente y opcionalmente incluye un estabilizador de espuma.
9. El fluido de la reivindicación 7, que comprende además un agente gelificante que incluye ésteres de fosfato y reticulantes complejos organometálicos.
10. El fluido de la reivindicación 7, que comprende además un agente emulsionante que incluye tensioactivos, co-tensioactivos y/o co-disolventes, en donde el fluido de estimulación incluye hasta 10 % de agua, agua de mar, agua de formación y/o salmuera.
11. Un sistema de LGN de grado Y, que comprende:  
  
una fuente de nitrógeno y/o de dióxido de carbono;

una fuente de LGN de grado Y en comunicación fluida con la fuente de nitrógeno y/o de dióxido de carbono;

una fuente de agente de sustentación en comunicación fluida con la fuente de nitrógeno y/o de dióxido de carbono;

un mezclador receptor en comunicación fluida con la fuente de LGN de grado Y y la fuente de agente de sustentación; y

una bomba configurada para bombear un fluido de estimulación desde el mezclador receptor a un cabezal de pozo, en donde el fluido de estimulación comprende un agente de sustentación de la fuente de agente de sustentación, una mezcla de hidrocarburo no fraccionada de la fuente de LGN de grado Y y al menos uno de nitrógeno y dióxido de carbono de la fuente de nitrógeno y de dióxido de carbono, en donde la mezcla de hidrocarburo no fraccionada es un subproducto de una corriente de hidrocarburo desmetanizada y en donde la mezcla de hidrocarburo no fraccionada comprende etano, propano, butano, isobutano y pentano plus.

12. El sistema de la reivindicación 11, que comprende además una fuente de agente espumante y una unidad de formación de espuma en comunicación fluida con la fuente de LGN de grado Y y el mezclador receptor, en donde la fuente de agente espumante comprende un agente espumante que incluye al menos uno de un tensioactivo, un co-tensioactivo y un co-disolvente.

13. El sistema de la reivindicación 11, en donde la unidad de formación de espuma incluye un eductor de venturi, una sonda ultrasónica de alta frecuencia y/o una rejilla de malla micro.

14. El sistema de la reivindicación 11, que comprende una fuente de agente gelificante en comunicación fluida con el mezclador receptor, en donde la fuente de agente gelificante comprende un agente gelificante que incluye ésteres de fosfato y reticulantes complejos organometálicos.

15. El sistema de la reivindicación 11, que comprende además una fuente de agente emulsionante en comunicación fluida con el mezclador receptor, en donde la fuente de agente emulsionante comprende un agente emulsionante.
16. El sistema de la reivindicación 11, que comprende además un compresor de regulación de presión que se configura para regular la presión dentro del mezclador receptor.
17. El sistema de la reivindicación 11, que comprende además una unidad de separación de campo que se configura para recibir una corriente de gas húmedo desde el mismo o desde un cabezal de pozo diferente, separar la mezcla de hidrocarburo no fraccionada de la corriente de gas húmedo y suministrar la mezcla de hidrocarburo no fraccionada a la fuente de LGN de grado Y directamente a través de una línea de fluidos o tanques de almacenamiento.
18. El sistema de la reivindicación 11, que comprende además un equipo de separación de aire que se configura para separar el nitrógeno del aire y suministrar el nitrógeno a la fuente de nitrógeno.
19. El sistema de la reivindicación 11, que comprende además recipientes de almacenamiento presurizado llenos con cantidades adicionales de la mezcla de hidrocarburo no fraccionada que se suministran desde una tubería de recolección regional, un divisor de gas regional o instalaciones de procesamiento de gas a través de camiones cisterna.
20. El sistema de la reivindicación 11, en donde la fuente de agente de sustentación comprende un silo de agente de sustentación presurizado donde el agente de sustentación se almacena temporalmente y se transporta neumáticamente al mezclador receptor usando nitrógeno o dióxido de carbono.

21. Un método para bombear un fluido de estimulación en un depósito que contiene hidrocarburos, que comprende:

mezclar una mezcla de hidrocarburo no fraccionada, un agente de sustentación y al menos uno de nitrógeno y dióxido de carbono en un mezclador receptor para formar el fluido de estimulación, en donde la mezcla de hidrocarburo no fraccionada es un subproducto de una corriente de hidrocarburo desmetanizada y en donde la mezcla de hidrocarburo no fraccionada comprende etano, propano, butano, isobutano y pentano plus; y

bombear el fluido de estimulación al depósito de colector de hidrocarburos.

22. El método de la reivindicación 21, que comprende además mezclar un agente espumante y opcionalmente un estabilizador de espuma con la mezcla de hidrocarburo no fraccionada, el agente de sustentación y al menos uno de nitrógeno y dióxido de carbono en el mezclador receptor para formar el fluido de estimulación, en donde el agente espumante incluye al menos uno de un tensioactivo, un co-tensioactivo y un co-disolvente, y opcionalmente incluye un estabilizador de espuma.

23. El método de la reivindicación 21, que comprende además mezclar un agente gelificante con la mezcla de hidrocarburo no fraccionada, el agente de sustentación y al menos uno de nitrógeno y dióxido de carbono en el mezclador receptor para formar el fluido de estimulación, en donde el agente gelificante incluye ésteres de fosfato y reticulantes complejos organometálicos.

24. El método de la reivindicación 21, que comprende además mezclar un agente emulsionante y agua o salmuera con la mezcla de hidrocarburo no fraccionada, el agente de sustentación y al menos uno de nitrógeno y dióxido de carbono en el mezclador receptor para formar el fluido de estimulación.

25. El método de la reivindicación 21, que comprende además adquirir la mezcla de hidrocarburo no fraccionada desde una corriente de gas húmedo, una línea de fluido o tanques de almacenamiento y suministrar la mezcla de hidrocarburo no fraccionada a una fuente de LGN de grado Y que está en comunicación fluida con el mezclador receptor.

26. El método de la reivindicación 21, en donde el fluido de estimulación incluye una concentración de nitrógeno mayor que 50%, una concentración de dióxido de carbono mayor que 35% o una combinación de concentración de nitrógeno y de dióxido de carbono mayor que 50%, de tal manera que el fluido de estimulación está fuera del límite de inflamabilidad.

27. Un sistema de emergencia, que comprende:

una cabecera que se configura para suministrar un fluido de estimulación a un cabezal de pozo, en donde el fluido de estimulación comprende una mezcla de hidrocarburo no fraccionada que comprende etano, propano, butano, isobutano y pentano plus y en donde la mezcla de hidrocarburo no fraccionada es un subproducto de una corriente de hidrocarburo desmetanizada;

una válvula de emergencia a control remoto se configura para cerrar el suministro del fluido de estimulación al cabezal de pozo; una cabecera de barra atomizadora que tiene una pluralidad de boquillas atomizadoras que se configuran para atomizar dióxido de carbono en la atmósfera adyacente a la cabecera; y

una línea de ventilación en comunicación con la cabecera para ventilar el fluido de estimulación desde la cabecera; o

una pluralidad de detectores de gas que se configuran para detectar gas combustible desde la cabecera y en respuesta acciona la válvula de emergencia a control remoto para cerrar el suministro del fluido de estimulación al cabezal de pozo.