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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

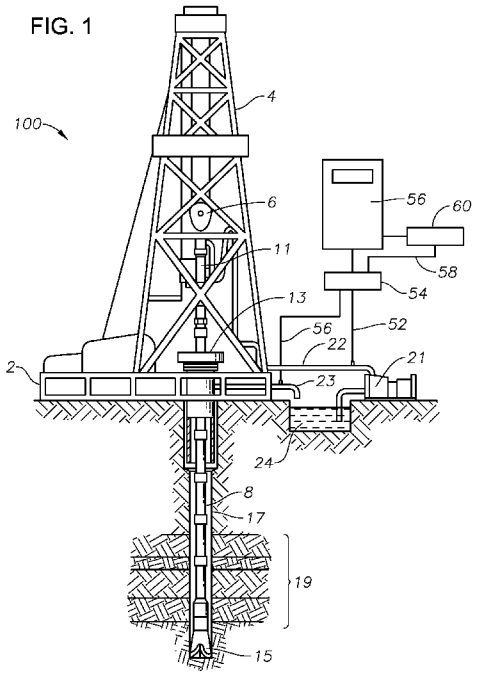
Published:

— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: SURFACE GAS CORRECTION BY GROUP CONTRIBUTION EQUILIBRIUM MODEL

FIG. 1



(57) Abstract: Methods and systems are disclosed to determine total hydrocarbons from fluid-carrying fluids and solids from a geological formation during downhole operations. Gas extraction at a well site occurs through a gas extractor at a set pressure, detected temperature, detected density, and controlled volume rate. The quantities of various components of interest are determined from samples of fluid influent and effluent from the wellbore by solving a system of equations of state using a group contribution equilibrium model. Knowing approximate chemical compositions of the liquid fluid and solid phases before contamination with formation materials, with the detection of the gas phase and description of the solid phase from the geological formation, allows for determination of total detectable hydrocarbons from geological formations at the surface, and their concentrations to be expressed as mole or mass fraction for materials coming from a wellbore while downhole operations.

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— *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))*

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/031888

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - E21B 49/00 (2014.01)
USPC - 166/250.01
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)
IPC(8) - B01J 10/00; C07B 61/00; E21B 49/00; G01N 33/28 (2014.01)
USPC - 166/250.1, 250.01; 703/9, 10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - E21B 43/26, 43/267; 49/08, 49/10 (2014.09)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0088949 A1 (ZUO et al) 21 April 2011 (21.04.2011) entire document	1,3-5,8,10-13
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Y		2,6-7,9
Y	US 5,889,202 A (ALAPATI et al) 30 March 1999 (30.03.1999) entire document	2,6-7,9
A	US 2009/0049889 A1 (POP et al) 26 February 2009 (26.02.2009) entire document	1-13
A	US 2012/0004892 A1 (PITA et al) 05 January 2012 (05.01.2012) entire document	1-13

☐ Further documents are listed in the continuation of Box C. ☐

* 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
06 October 2014	06 NOV 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/031888

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 attached sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of 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.:
1-13

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/031888

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-13, drawn to a method and system for characterizing formation fluid by subtracting a known chemical composition of the fluid from a sum of the determined vapor-phase and liquid-phase molar contributions of all components to characterize the formation fluid.

Group II, claims 14-20, drawn to a method and system for characterizing formation fluid by extracting an effluent gas.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: subtracting a known chemical composition of the fluid from a sum of the determined vapor-phase and liquid-phase molar contributions of all components to characterize the formation fluid as claimed therein is not present in the invention of Group II.

The special technical feature of the Group II invention: extracting an effluent gas sample from fluid of a borehole; determining an effluent liquid-phase molar contribution of each component of the effluent gas sample; characterizing formation fluid based upon the effluent liquid-phase molar contribution of each component of the effluent gas sample as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of characterizing formation fluid comprising: a gas extractor; a temperature detector coupled to the extractor; a pressure detector coupled to the extractor; gas analyzer that selectively generates an output; and an information handling system coupled to the temperature detector, the pressure detector, and the gas analyzer, the information handling system comprising a processor and memory device containing a set of instructions that, when executed by the processor, causes the processor to: determine a partial pressure and calculate liquid-phase molar contribution of each component of interest, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2011/0088949 A1 (ZUO et al) 21 April 2011 (21.04.2011) teaches characterizing formation fluid (abstract) comprising: a gas extractor (using a borehole tool having a flowline to obtain a fluid sample comprising a gas condensate from a fluid in contact with a formation surface, Paras. 22 and 28 and Fig. 28); a temperature detector coupled to the extractor (temperature sensor coupled to flowline, Para. 37 and Fig. 1B); a pressure detector coupled to the extractor (pressure sensor coupled to flowline, Para. 37 and Fig. 1B); gas analyzer that selectively generates an output (dual fluoroscene detectors detect free gas bubbles and retrograde liquid dropout to accurately detect single phase fluid flow in the flowline, Para. 34); and an information handling system coupled to the temperature detector, the pressure detector, and the gas analyzer, the information handling system comprising a processor and memory device containing a set of instructions that, when executed by the processor, causes the processor to: determine a partial pressure and calculate liquid-phase molar contribution of each component of interest (fluid analysis module coupled to temperature sensor, pressure sensor, and dual fluoroscene detectors, wherein the fluid analysis module comprises data processing functionality including one or more microprocessors, associated memory, and other hardware and/or software, to determine the fugacity coefficient of the gas phase as a function of pressure, temperature and molar gas fraction, Paras. 30, 34, and 85).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.