



- (51) **International Patent Classification:**
E21B 49/08 (2006.01) *E21B 47/06* (2006.01)
E21B 49/10 (2006.01)

(21) **International Application Number:**
PCT/US2024/059488

(22) **International Filing Date:**
11 December 2024 (11.12.2024)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
202311776221.3 21 December 2023 (21.12.2023) CN

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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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

(54) Title: SEGREGATION CHAMBER FOR DOWNHOLE FLUID RETENTION AND TESTING

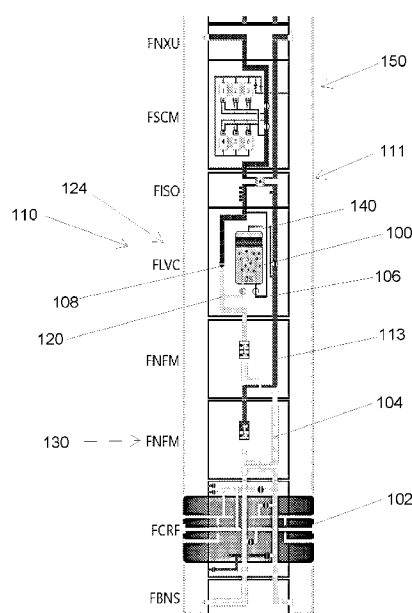


FIG. 1

(57) Abstract: Embodiments presented provide for an arrangement for sampling fluids from a downhole environment. In specific embodiments, the arrangements provided prevent mixing of hydrocarbon fluids with mud filtrates that may be present in the geological stratum. In one embodiment an arrangement for sampling downhole fluid includes a body having at least one sample inlet and at least one guard inlet, a first line connected to the at least one sample inlet, a second line connected to the at least one guard inlet, and a segregation chamber connected to the first line and the second line, where the segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids.

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

SEGREGATION CHAMBER FOR DOWNHOLE FLUID RETENTION AND TESTING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Chinese Patent Application No. 202311776221.3 filed December 21, 2023.

FIELD OF THE DISCLOSURE

[0002] Aspects of the disclosure relate to obtaining fluid samples and testing those samples from a downhole environment. More specifically, aspects of the disclosure relate to a segregation chamber for downhole fluid retention and testing that allows sampling hydrocarbons to be segregated from water-based mud filtrate and other materials.

BACKGROUND

[0003] When sampling hydrocarbons (HC) from a reservoir with a formation tester, it can be difficult to separate the invaded mud filtrate from the native reservoir fluids. Focused sampling techniques exist to help speed up this clean up, but focused sampling only works when native fluids flow in sufficient quantities to separate the native fluid from the filtrate.

[0004] Particularly in water-based mud (WBM) environments and in reservoirs with deep invasion or transition zones, where native HC flow in small quantities, there is a need for a structure to help the segregation of fluids. There is a need for a structure where a mixture of HC and WBM filtrate can be pumped, to allow sampled hydrocarbons to float to the top and WBM filtrates to sink down.

[0005] There is a need to provide apparatus and methods that are easy to operate and provide a separation capability.

[0006] There is a further need to provide apparatus and methods that do not have the drawbacks discussed above, namely sample chambers that allow for the mixing of hydrocarbons and water-based mud materials.

[0007] There is a still further need to reduce economic costs associated with operations and apparatus, described above, with conventional tools for sampling of downhole hydrocarbons.

SUMMARY

[0008] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized below, may be had by reference to embodiments, some of which are illustrated in the drawings. It is to be noted that the drawings illustrate only typical embodiments of this disclosure and are; therefore, not to be considered limiting of its scope, for the disclosure may admit to other equally effective embodiments without specific recitation. Accordingly, the following summary provides just a few aspects of the description and should not be used to limit the described embodiments to a single concept.

[0009] In one embodiment, an arrangement for sampling downhole fluid is disclosed. The arrangement may comprise a body having at least one sample inlet and at least one guard inlet. The arrangement may also comprise a first line connected to the at least one sample inlet. The arrangement may also comprise a second line connected to the at least one guard inlet. The arrangement may also comprise a segregation chamber connected to the first line and the second line, wherein the segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids.

[0010] In another example embodiment, an arrangement for sampling downhole fluid is disclosed. The arrangement may comprise a body having at least one sample inlet and at least one guard inlet. The arrangement may further comprise a first line connected to the at least one sample inlet. The arrangement may further comprise a second line connected to the at least one guard inlet. The arrangement may further comprise a segregation chamber connected to the first line and the second line, wherein the

segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids. The arrangement may further comprise at least one pump arrangement configured to draw the fluid from an exterior of the body through at least one of the at least one sample inlet and the at least one guard inlet. The arrangement may further comprise at least one sample bottle connected to the segregation chamber, the at least one sample bottle configured to store the sampled fluid at a defined pressure and temperature.

[0011] In another example embodiment, a method may be performed. The method may comprise lowering a sampling tool into a wellbore in a geological stratum. The method may further comprise actuating a pump within the sampling tool to draw a volume of fluid from the geological stratum. The method may further comprise transporting the volume of fluid to a segregation chamber within the sampling tool. The method may further comprise segregating the volume of fluid into a hydrocarbon fraction and a second fraction. The method may further comprise removing the hydrocarbon fraction from the segregation chamber and storing the hydrocarbon fraction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the drawings. It is to be noted; however, that the appended drawings illustrate only typical embodiments of this disclosure and are therefore not be considered limiting of its scope, for the disclosure may admit to other equally effective embodiments.

[0013] FIG. 1 is a focused sampling arrangement, in one example embodiment of the disclosure.

[0014] FIG. 2 illustrates the filling of a sample bottle after continuous segregation accomplished with focused sampling.

[0015] FIG. 3 illustrates focused sampling with the sample line fluid flowing through a continuous segregation chamber and with water being routed to the borehole.

[0016] FIG. 4 is a cross-sectional view of the sampling apparatus of FIG. 1, when after continuous segregation with focused sampling, the hydrocarbons captured can be used to fill a sample bottle.

[0017] FIG. 5A is a cross-sectional view of the sampling apparatus of FIG. 1, where unfocused sampling is conducted and flow is comingled from both a sample and guard line.

[0018] FIG. 5B is a cross-sectional view of the sampling apparatus of FIG. 1, where unfocused sampling is conducted and flow is only from a sample line.

[0019] FIG. 6A is a cross-sectional view of the sampling apparatus of FIG. 1, with a comingled flow scenario.

[0020] FIG. 6B is a cross-sectional view of the sampling apparatus of FIG. 1, where unfocused sampling is conducted and flow is only from a sample line.

[0021] FIG. 7 is a cross-sectional view of the sampling apparatus of FIG. 1, showing a path where hydrocarbons will flow under existing pressure.

[0022] FIG. 8A is cross-sectional view of the sample apparatus of FIG. 1, with a continuous segregated sample chamber used during fluid blockage.

[0023] FIG. 8B is a cross-sectional view of the sampling apparatus of FIG. 1, wherein a diverted, continuous, segregated, sample chamber fluid is looped to a comingle valve.

[0024] FIG. 9 is a method for sampling in one example embodiment of the disclosure.

[0025] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures (“FIGS”). It is contemplated that elements disclosed in one embodiment may be beneficially utilized on other embodiments without specific recitation.

DETAILED DESCRIPTION

[0026] In the following, reference is made to embodiments of the disclosure. It should be understood; however, that the disclosure is not limited to specific described embodiments. Instead, any combination of the following features and elements, whether related to different embodiments or not, is contemplated to implement and practice the disclosure. Furthermore, although embodiments of the disclosure may achieve advantages over other possible solutions and/or over the prior art, whether or not a particular advantage is achieved by a given embodiment is not limiting of the disclosure. Thus, the following aspects, features, embodiments and advantages are merely illustrative and are not considered elements or limitations of the claims except where explicitly recited in a claim. Likewise, reference to “the disclosure” shall not be construed as a generalization of inventive subject matter disclosed herein and should not be considered to be an element or limitation of the claims except where explicitly recited in a claim.

[0027] Although the terms first, second, third, etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as “first”, “second” and other numerical terms, when used herein, do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed herein could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

[0028] When an element or layer is referred to as being “on,” “engaged to,” “connected to,” or “coupled to” another element or layer, it may be directly on, engaged, connected, coupled to the other element or layer, or interleaving elements or layers may be present. In contrast, when an element is referred to as being “directly on,” “directly engaged to,” “directly connected to,” or “directly coupled to” another element or layer, there may be no interleaving elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed terms.

[0029] Some embodiments will be described with reference to the figures. Like elements in the various figures will be referenced with like numbers for consistency. In the following description, numerous details are set forth to provide an understanding of various embodiments and/or features. It will be understood, however, by those skilled in the art, that some embodiments may be practiced without many of these details, and that numerous variations or modifications from the described embodiments are possible. As used herein, the terms “above” and “below”, “up” and “down”, “upper” and “lower”, “upwardly” and “downwardly”, and other like terms indicating relative positions above or below a given point are used in this description to more clearly describe certain embodiments.

[0030] Aspects of methods described may be included onto a non-volatile memory system. For definitional purposes, a non-volatile memory system may be a memory system that does not wipe clean after termination of electrical power to the system. Examples of non-volatile memory systems may be compact disks, solid-state drives, and universal serial bus devices. These memory systems may be used to store program executable method steps for a computer, server, or computing arrangement.

[0031] Embodiments of the disclosure describe hardware and workflows for a continuous segregation chamber, where HC and WBM filtrate are continuously pumped

through a formation tester segregation chamber and where the lighter HC phase is allowed to segregate into the chamber, while the heavier WBM filtrate phase is removed from the chamber until the segregation chamber is filled with (mainly) HC. Once sufficient HC has accumulated in the chamber, it can either be diverted to smaller PVT bottles, or the full chamber can be sealed and retrieved to the surface with the formation tester toolstring.

[0032] Several different tool configurations and workflows are presented. Aspects of the disclosure are written with the objective of capturing HC in a WBM environment, but the technique can be used for any two (or more) phase flow scenarios.

[0033] In one embodiment of the disclosure, a formation testing platform with a large volume chamber is used. The chamber can be configured as either a 5, 10, or 25 L chamber with four active seal valves and several surface configurable valves as non-limiting embodiments. This flexibility allows the chamber to have several different functions. For example, the chamber can be filled with clean water to inflate a radial probe or dual packer, or to inject fluid into a fracture. Alternatively, the chamber can be used to capture samples or used as a segregation chamber. In some configurations, a combination of some or all of the functions is possible. Aspects of the disclosure describe the hardware and workflow to use components as a continuous segregation chamber.

[0034] Several different segregation chamber configurations and workflows are described in this section.

Terminology:

FNFM – pump

FSCM – Multi sampling module with six pressure volume temperature bottles

FISO – Fluid analysis module

FLVC – Large volume chamber

FCRF – Focused radial probe

FCII – Dual-packer module

Configuration A: FLVC as a continuous segregation chamber - focused sampling

[0035] FIG. 1 illustrates a schematic for the use of a continuous segregation chamber during focused sampling with a FCRF. In this configuration, a HC-filtrate mixture from the FCRF sample line inlet **102** is pumped on line **104** and directed into the segregation chamber **100**. Once the chamber **100** is full, the heavier phase (filtrate) will be forced through chamber valve 2 **106** which is routed back to line **104**, above the closed flowline 1 valve **108**. Monitoring line 1 **111** with FISO shows pure filtrate on line **104** when the continuous segregation chamber **100** is segregating out the HC. Once the segregation chamber **100** is filled with HC, the FISO will start showing a mixture of HC & filtrate again. At this time, the FLVC chamber valves **110** can be closed and the HC sample is captured.

[0036] Note that in this scenario the water line **140** is routed to line **113**, below the flowline valve for the guard line **113**.. The water line **140** will be at borehole pressure and the FLVC filling is driven by the line **130** FNFM. Chamber valve **106** can be optionally kept closed until the chamber **100** is full. Once full, the chamber valve **106** can be opened to start the continuous segregation process (requiring flow through the chamber).

[0037] Note that variations in sequences are possible, such as closing the FSCM sample valve instead of the FLVC line 1 valve.

[0038] Once the FLVC contains sufficient HC, the chamber **100** can be sealed. It may be preferred; however, to divert the segregated HC into FSCM PVT bottle **150** so that the FLVC may be re-used as a segregation chamber, or filled with filtrate, to be used on a subsequent station as a source fluid to set the FCRF.

[0039] To divert the FLVC HC into an FSCM PVT bottle **150**, the valve positions are changed to the positions indicated in FIG. 2. The lower FNFM **130** is now used to pump fluid up the line into the FLVC water line, forcing the piston down and pushing the captured HC through chamber valve **106**, into line **104**. In embodiments, the FISO **165** is used to

monitor the time that pure segregated HC is observed and at this time the FSCM bottle **150** is opened, and a sample is captured.

Configuration B: FLVC as a continuous segregation chamber - focused sampling using line 2 as exit port

[0040] A second configuration of the disclosure is presented in FIG. 3. FIG. 3 shows the schematic for use of the continuous segregation chamber during focused sampling with an FCRF. A HC-filtrate mixture from the FCRF sample line inlet **202** is pumped to line **204** and directed into the segregation chamber **200**. Once the chamber **200** is full (or earlier) chamber valve **206** is opened, and the heavier phase WBM filtrate will be forced from chamber valve **206** to flowline **208**, where it will mix with the guard fluid **210** that is already being pumped on line **212**. Monitoring line **214** with FISO shows pure filtrate flowing when the continuous segregation chamber **200** is segregating out the HC. Once the segregation chamber is filled with HC, FISO shows a mixture of HC & filtrate on line **212** again. At this time, the FLVC chamber valves **206** can be closed and the HC sample is captured. Note that the segregation chamber flow direction can also be changed with fluid entering on line **212** (chamber valve 2 **206**) and exiting on line **208** (chamber valve **206**). This would require the flowline valve positions to be reversed.

[0041] Once the FLVC contains sufficient HC, the chamber **200** can either be sealed or diverted to the segregated HC into FSCM PVT bottle **220** so that the FLVC may be re-used as a segregation chamber, or filled with filtrate, to be used on a subsequent station as a source fluid used to set the FCRF.

[0042] To divert the FLVC HC into an FSCM PVT bottle **220**, fluid will be drawn, as indicated in FIG. 4, down line **224**, through the FCRF comingle valve **175**, up line 1 to the FSCM bottle **220**. The FCRF interval valves will be closed and the comingle valve open **175**. The FLVC line 1 **240** valve is open, and line 2 valve **242** is closed. Note that either the upper FSCM can be used in up mode or the lower FSCM is used in down mode. In case there is some WBM filtrate in the FLVC, this would flow from the FLVC first. FISO line 1 **250** would be monitored to detect the transition from WBM filtrate to HC, after which flushing and sampling can commence.

Configuration C: FLVC as a continuous segregation chamber - unfocused sampling

[0043] A third configuration for a continuous segregation chamber is illustrated in FIGS. 5A and 5B. FIG. 5B shows how fluid is flowing from the FCRF sample line **502** and is pushed into the FLVC on line 1 **504** with the lower FNFM configured with a routing plug. On line 2 **506** fluid is pulled from the FLVC by the upper FNFM **508** configured with a X-routing plug. In this case the chamber is, e.g. 5 L. The FLVC can either be filled initially, followed a second step where the rate into the chamber with the HC-filtrate mixture is the same as the rate out, or alternatively, the rate into the chamber can be higher than the rate out of the chamber. The difference in rate should be close to the expected HC-cut, so that the volume added to the chamber is mainly HC. The fluid flowing on line 2 is monitored with FISO, confirming that no gas is flowing from the chamber.

[0044] FIG. 5A shows a similar set up **500**, but with a different FLVC configuration that allows comingled sampling during use of the continuous segregation chamber.

[0045] Once the segregation chamber contains sufficient HC, the chamber can either be closed and the sampled HC is secured, or the captured HC can be diverted to one or more smaller (PVT) bottles in the upper FSCM shown in FIGS. 6A and 6B.

[0046] Note that if any WBM filtrate remains in the bottle, this can be pumped from the FLVC with the lower FNFM after changing the operating mode from pump-up to pump-down, or with the upper FNFM on line 2. In this configuration, using line 2 has the advantage that flow is directed upwards through the FISO for detection.

[0047] Next, the segregated gas is pulled from the FLVC by the upper FNFM on line 2 and directed to the upper FSCM where it can be captured using regular drive sampling techniques.

[0048] Alternatively, the HC from the segregation chamber can be diverted to an FSCM PVT bottle by pressurizing the FLVC and diverting the HC to an FSCM bottle under its own pressure. The advantage of the scenario is that the HC can be sampled on line 1 and no additional FSCM required.

[0049] Referring to FIG. 7, line 1 **702** shows the path from the FLVC **704** to the FSCM sample bottle **706**. If sufficient pressure is applied to the FLVC **704** during filling, the HC can flow from the FLVC **704** to the FSCM **706** under its “own” pressure.

[0050] However, this method is not preferred because the heavier phase will always be forced from the segregation chamber first, and every time the chamber is re-pressurized by the pump, new filtrate will likely enter the chamber.

[0051] In embodiments, certain parameters may be changed or altered. This may include, but not be limited to the following:

1. Other inlets, or combinations of inlets, can be used. For example, the focused radial probe could be changed to a focused single probe or a single-inlet or dual-inlet dual-packer.
2. The position of the FISO module can change.
3. Continuous flowline segregation can start either with the FLVC already filled with a fluid, or with the FLVC empty.
4. In configurations above, the chamber can be pre-filled with water from the surface or filled with fluid from a previous station, and this chamber fluid can be used to inflate the probe, radial probe, or dual-packer on a subsequent station.
5. FNFMs can be surface configured with different routing plugs.
6. FSCM sample bottle carrier positions can be changed.
7. Sample down configurations are also possible with continuous segregation indicated in FIG. 8A and subsequent HC diversion to an FSCM bottle in FIG. 8B. FIG. 8B is a mirrored image of FIG. 8A.

[0052] Referring to FIG. 9, a non-limiting method **900** for performing sampling with a downhole tool is presented. The method **900** may comprise, at **902**, lowering a sampling tool into a wellbore in a geological stratum. The method may further comprise, at **904**, actuating a pump within the sampling tool to draw a volume of fluid from the geological stratum. The method may further comprise, at **906**, transporting the volume of fluid to a segregation chamber within the sampling tool. The method may further comprise, at **908**,

segregating the volume of fluid into a hydrocarbon fraction and a second fraction. The method may further comprise, at **910**, removing the hydrocarbon fraction from the segregation chamber and storing the hydrocarbon fraction.

[0053] Example embodiments of the claims are presented next. The embodiments described should not be considered limiting of the inventive concepts described. In one embodiment, an arrangement for sampling downhole fluid is disclosed. The arrangement may comprise a body having at least one sample inlet and at least one guard inlet. The arrangement may also comprise a first line connected to the at least one sample inlet. The arrangement may also comprise a second line connected to the at least one guard inlet. The arrangement may also comprise a segregation chamber connected to the first line and the second line, wherein the segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids.

[0054] In another example embodiment, the arrangement may be configured wherein the other downhole fluids include water-based muds or water-based mud filtrate.

[0055] In another example embodiment, the arrangement may be configured wherein the body has at least one pump arrangement, at least one multi-sampling module, at least one fluid analysis module, at least one large volume chamber, at least one focused radial probe, and at least one dual packer module.

[0056] In another example embodiment, the arrangement may be configured wherein the multi-sampling module includes pressure volume and temperature sampling bottles.

[0057] In another example embodiment, the arrangement may be configured wherein there are at least six sample bottles.

[0058] In another example embodiment, the arrangement may further comprise at least one routing plug configured to alter a flow of fluid within the body.

[0059] In another example embodiment, an arrangement for sampling downhole fluid is disclosed. The arrangement may comprise a body having at least one sample inlet and at least one guard inlet. The arrangement may further comprise a first line connected to the at least one sample inlet. The arrangement may further comprise a second line connected to the at least one guard inlet. The arrangement may further comprise a segregation chamber connected to the first line and the second line, wherein the segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids. The arrangement may further comprise at least one pump arrangement configured to draw the fluid from an exterior of the body through at least one of the at least one sample inlet and the at least one guard inlet. The arrangement may further comprise at least one sample bottle connected to the segregation chamber, the at least one sample bottle configured to store the sampled fluid at a defined pressure and temperature.

[0060] In another example embodiment, the arrangement may be configured wherein the defined pressure and temperature are environmental pressure and temperature on an outside surface of the body while in a wellbore.

[0061] In another example embodiment, the arrangement may be configured wherein the other downhole fluids are water-based muds or water-based mud filtrate.

[0062] In another example embodiment, the arrangement may be configured wherein the body has at least one fluid analysis module, at least one large volume chamber, at least one focused radial probe, and at least one dual packer module.

[0063] In another example embodiment, the arrangement may be configured wherein there are at least six sample bottles.

[0064] In another example embodiment, the arrangement may further comprise at least one routing plug configured to alter a flow of fluid within the body.

[0065] In another example embodiment, a method may be performed. The method may comprise lowering a sampling tool into a wellbore in a geological stratum. The

method may further comprise actuating a pump within the sampling tool to draw a volume of fluid from the geological stratum. The method may further comprise transporting the volume of fluid to a segregation chamber within the sampling tool. The method may further comprise segregating the volume of fluid into a hydrocarbon fraction and a second fraction. The method may further comprise removing the hydrocarbon fraction from the segregation chamber and storing the hydrocarbon fraction.

[0066] In another example embodiment, the method may be performed wherein the storing of the hydrocarbon fraction is in a bottle located within the tool.

[0067] In another example embodiment, the method may be performed wherein the drawing of the volume of fluid from the geological stratum is through at least one of a guard inlet and a sample inlet positioned in the sampling tool.

[0068] In another example embodiment, the method may be performed wherein the segregating of the volume of fluid is performed through action of gravity.

[0069] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

[0070] While embodiments have been described herein, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments are envisioned that do not depart from the inventive scope. Accordingly, the scope of the present claims or any subsequent claims shall not be unduly limited by the description of the embodiments described herein.

CLAIMS

What is claimed is:

1. An arrangement for sampling downhole fluid, comprising:
 - a body having at least one sample inlet and at least one guard inlet;
 - a first line connected to the at least one sample inlet;
 - a second line connected to the at least one guard inlet; and
 - a segregation chamber connected to the first line and the second line,wherein the segregation chamber is configured to separate hydrocarbon fluids from other downhole fluids.
2. The arrangement according to claim 1, wherein the other downhole fluids include water-based muds or mud filtrate.
3. The arrangement according to claim 1, wherein the body has at least one pump arrangement, at least one multi-sampling module, at least one fluid analysis module, at least one large volume chamber, at least one focused radial probe, and at least one dual packer module.
4. The arrangement according to claim 3, wherein the multi-sampling module includes pressure volume and temperature sampling bottles.
5. The arrangement according to claim 4, wherein there are at least six sample bottles.
6. The arrangement according to claim 1, further comprising at least one routing plug configured to alter a flow of fluid within the body.
7. An arrangement for sampling downhole fluid, comprising:
 - a body having at least one sample inlet and at least one guard inlet;
 - a first line connected to the at least one sample inlet;

a second line connected to the at least one guard inlet;
a segregation chamber connected to the first line and the second line,
wherein the segregation chamber is configured to separate hydrocarbon fluids
from other downhole fluids;

at least one pump arrangement configured to draw the fluid from an
exterior of the body through at least one of the at least one sample inlet and the
at least one guard inlet; and

at least one sample bottle connected to the segregation chamber, the at
least one sample bottle configured to store the sampled fluid at a defined
pressure and temperature.

8. The arrangement according to claim 7, wherein the defined pressure and
temperature are environmental pressure and temperature on an outside surface
of the body while in a wellbore.

9. The arrangement according to claim 7, wherein the other downhole fluids are
water-based muds or mud filtrate.

10. The arrangement according to claim 7, wherein the body has at least one
fluid analysis module, at least one large volume chamber, at least one focused
radial probe, and at least one dual packer module.

11. The arrangement according to claim 7, wherein there are at least six sample
bottles.

12. The arrangement according to claim 1, further comprising at least one
routing plug configured to alter a flow of fluid within the body.

13. A method, comprising:
lowering a sampling tool into a wellbore in a geological stratum;

actuating a pump within the sampling tool to draw a volume of fluid from the geological stratum;

transporting the volume of fluid to a segregation chamber within the sampling tool;

segregating the volume of fluid into a hydrocarbon fraction and a second fraction; and

removing the hydrocarbon fraction from the segregation chamber and storing the hydrocarbon fraction.

14. The method according to claim 13, wherein the storing of the hydrocarbon fraction is in a bottle located within the tool.

15. The method according to claim 13, wherein the drawing of the volume of fluid from the geological stratum is through at least one of a guard inlet and a sample inlet positioned in the sampling tool.

16. The method according to claim 13, wherein the segregating of the volume of fluid is performed through action of gravity.

17. The method as illustrated and described.

18. The apparatus as illustrated and described.

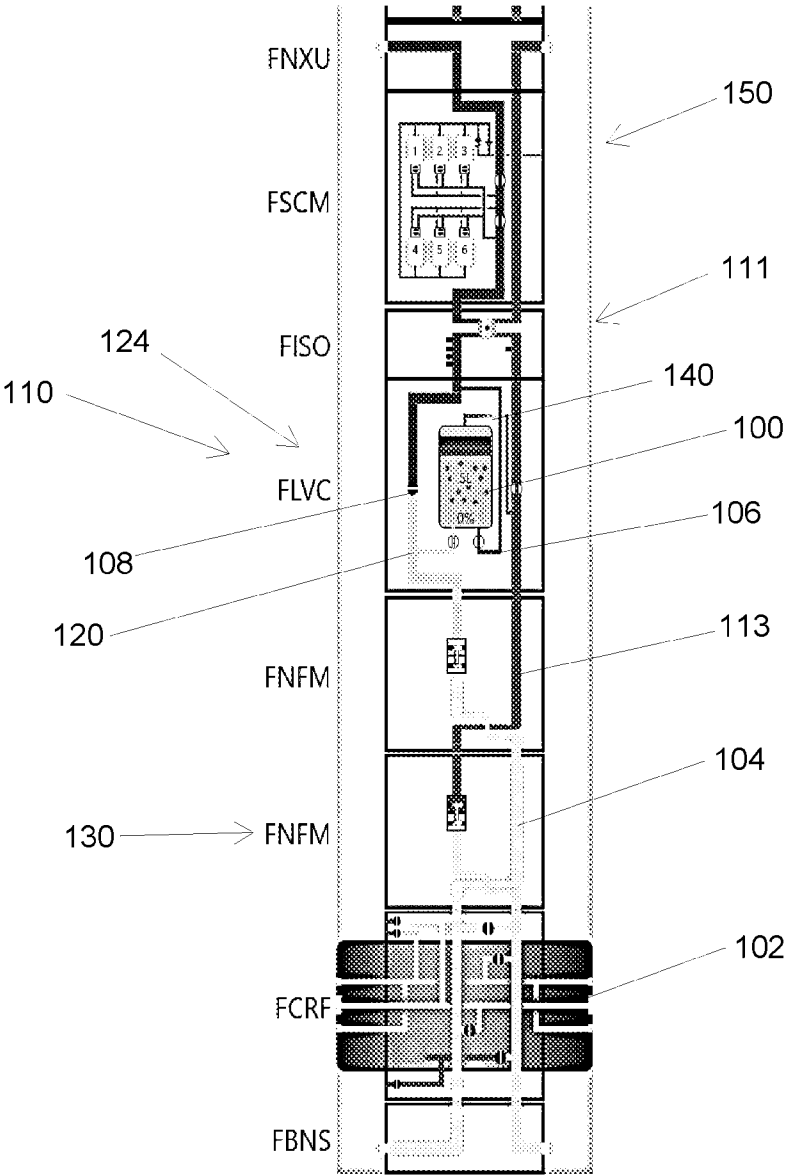


FIG. 1

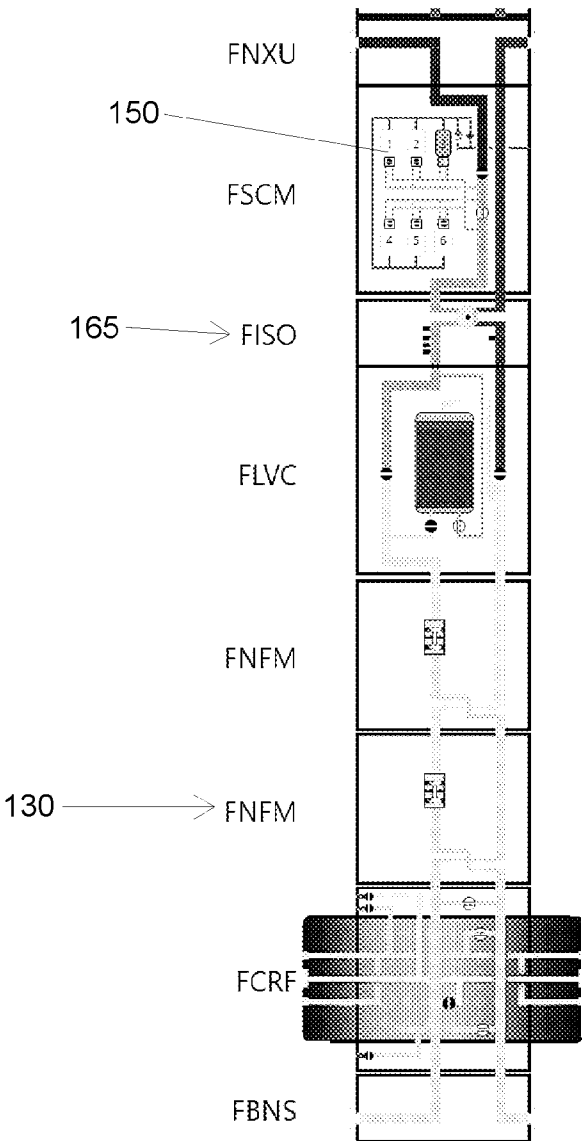


FIG. 2

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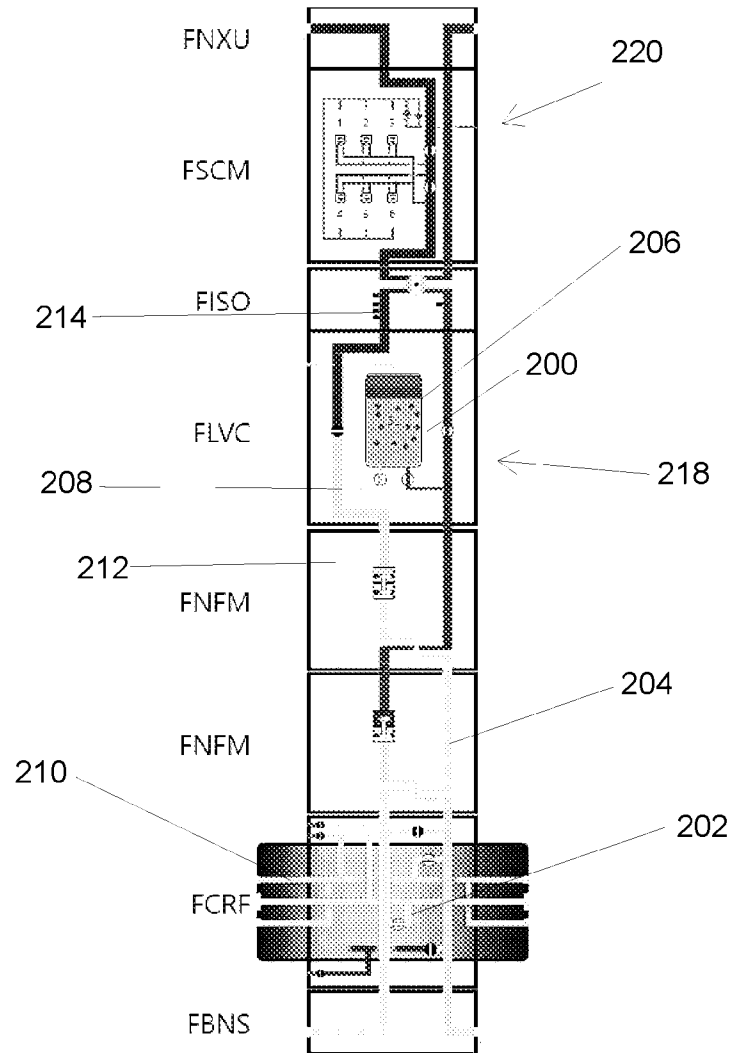


FIG. 3

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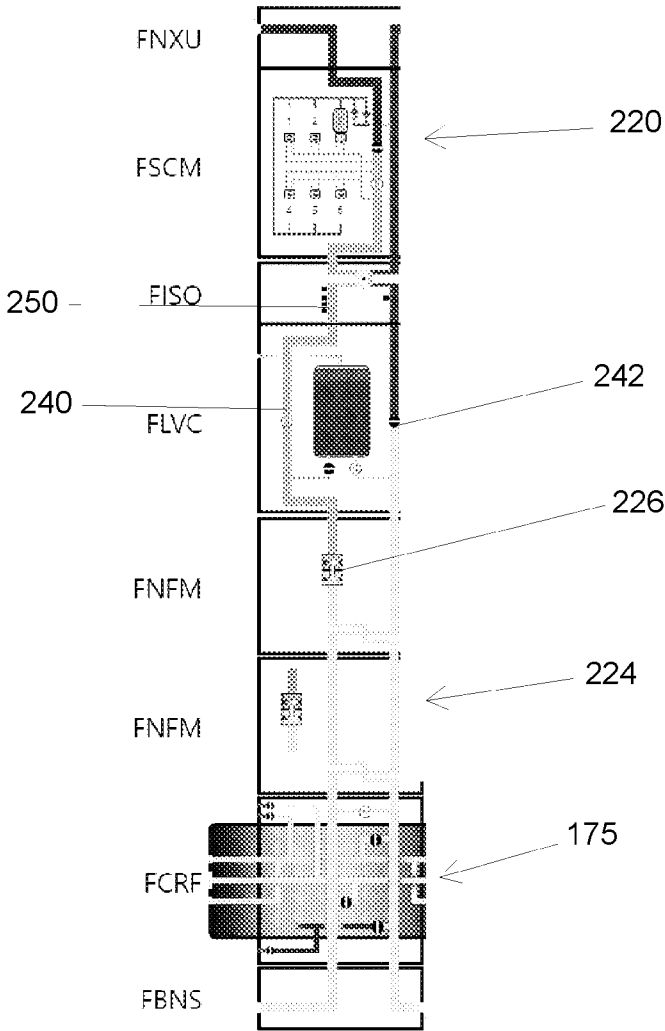


FIG. 4

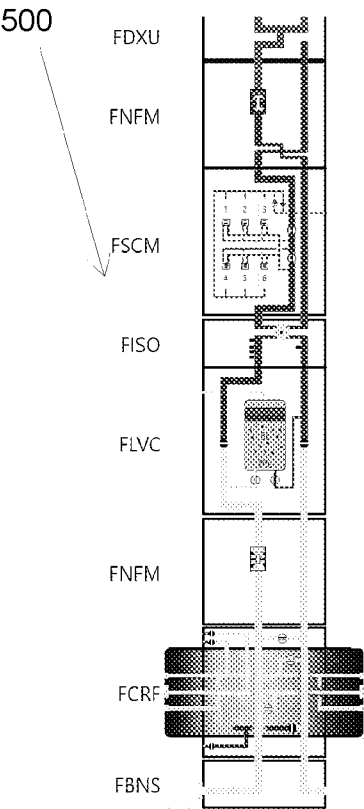


FIG. 5A

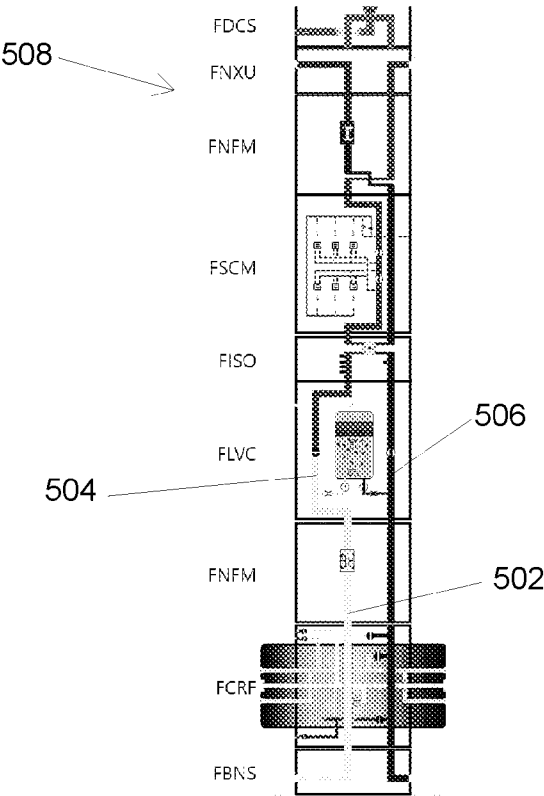


FIG. 5B

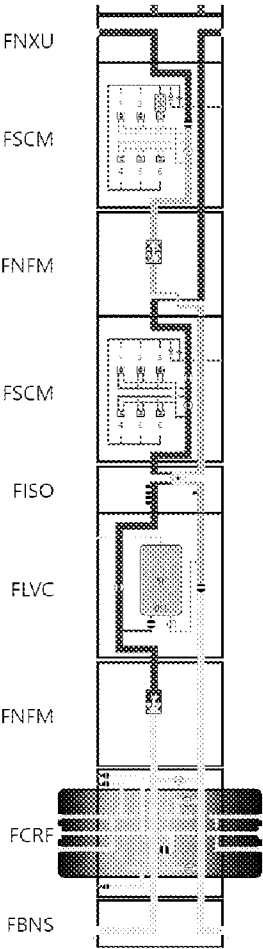


FIG. 6A

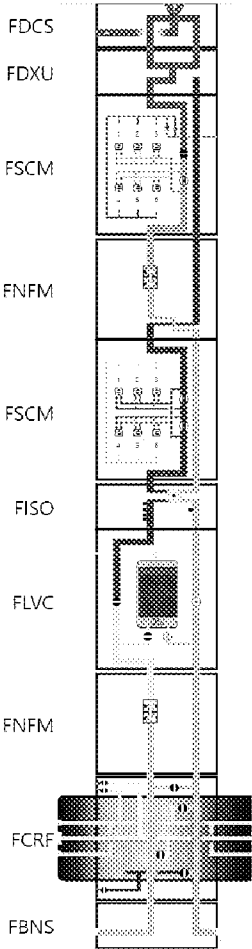


FIG. 6B

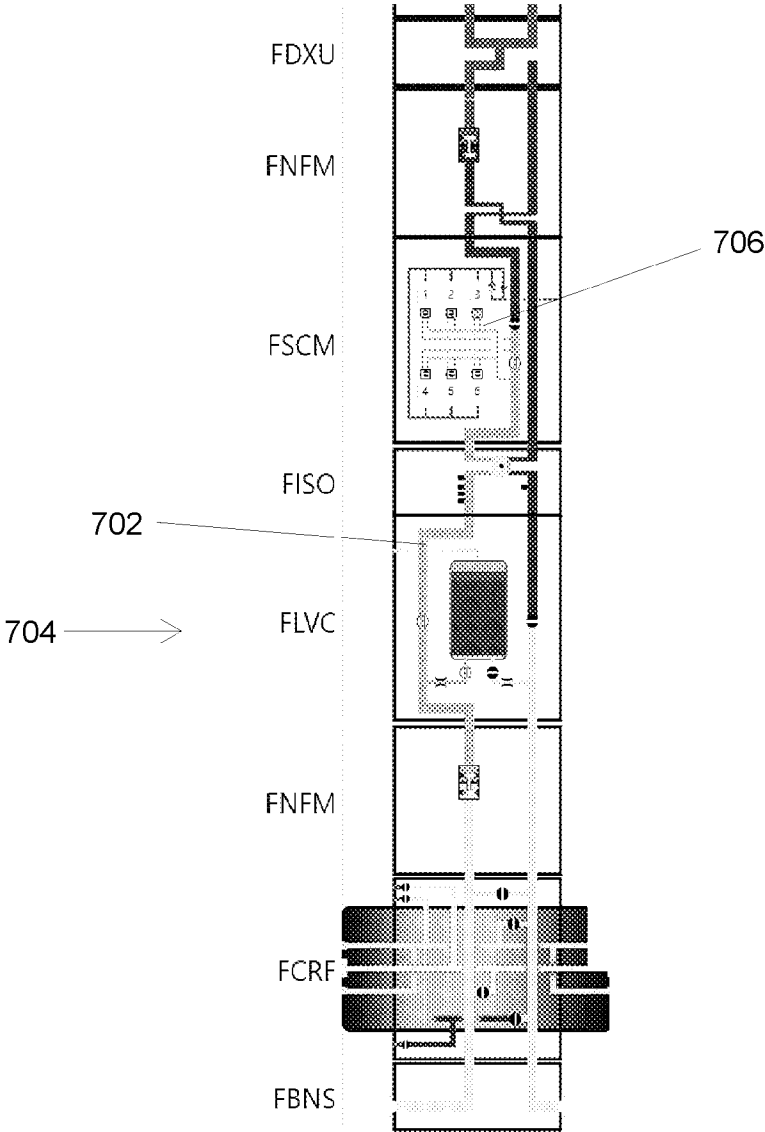


FIG. 7

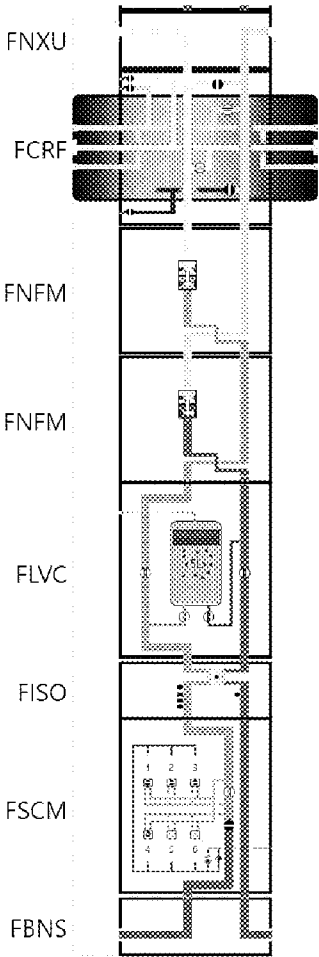


FIG. 8A

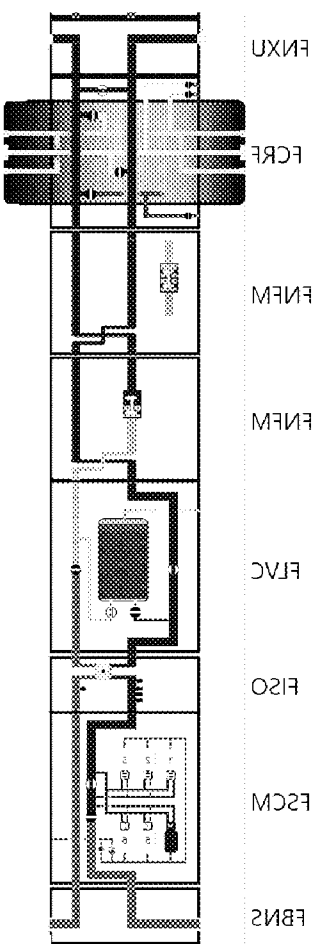


FIG. 8B

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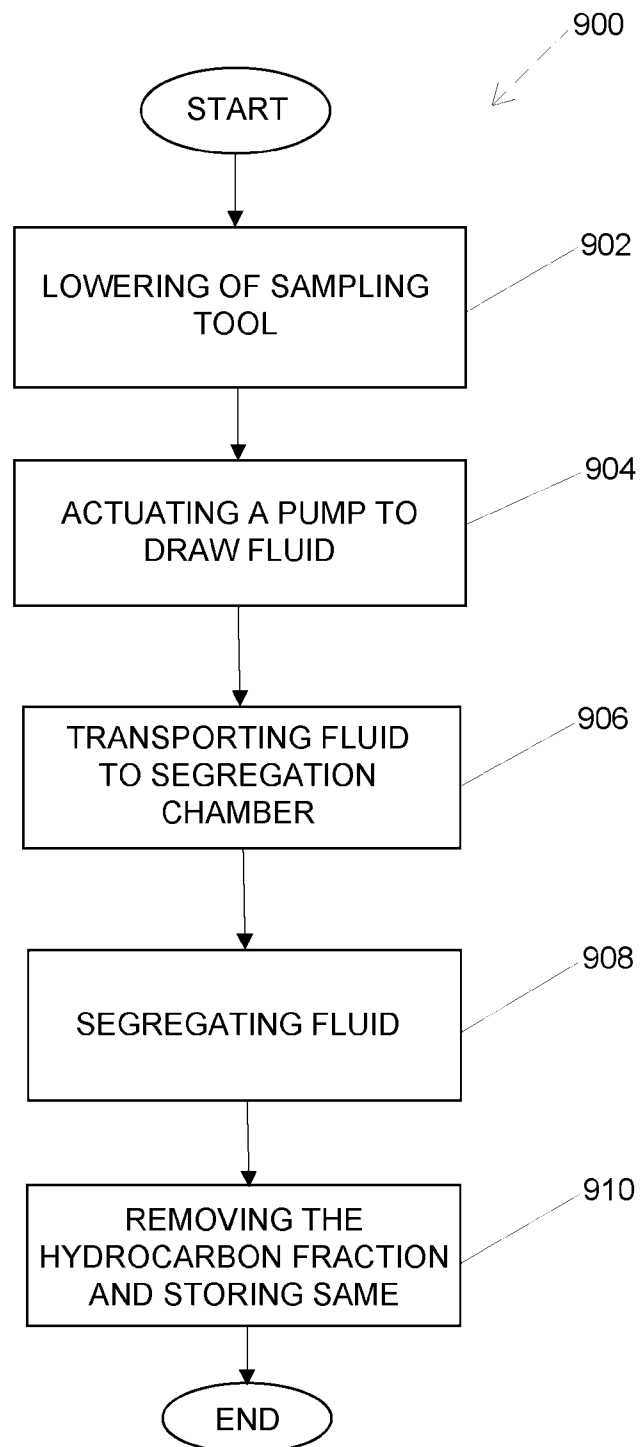


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/059488

A. CLASSIFICATION OF SUBJECT MATTER E21B 49/08(2006.01)i; E21B 49/10(2006.01)i; E21B 47/06(2006.01)i 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) E21B 49/08(2006.01); E21B 33/127(2006.01); E21B 43/26(2006.01); E21B 47/00(2006.01); E21B 49/10(2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: downhole fluid, test, sample, segregation, sample inlet, guard inlet, pump, bottle, filtrate		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2021-0131283 A1 (HALLIBURTON ENERGY SERVICES, INC.) 06 May 2021 (2021-05-06) paragraphs [0003], [0038]-[0039], [0059], [0063], claim 1, and figure 5	1-16
Y	US 2005-0150287 A1 (CARNEGIE et al.) 14 July 2005 (2005-07-14) paragraphs [0019]-[0022] and figures 1-2A	1-16
Y	US 2018-0128077 A1 (SCHLUMBERGER TECHNOLOGY CORPORATION) 10 May 2018 (2018-05-10) claim 1 and figures 23-25	6,12
A	US 2010-0206548 A1 (PISIO et al.) 19 August 2010 (2010-08-19) paragraphs [0018]-[0032] and figures 1A-2	1-16
A	EP 2706191 A2 (SCHLUMBERGER TECHNOLOGY B.V. et al.) 12 March 2014 (2014-03-12) claim 1 and figure 5	1-16
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “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 09 April 2025		Date of mailing of the international search report 10 April 2025
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer PARK, Tae Wook Telephone No. +82-42-481-3405

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/059488

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.: **17-18**
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:

The claims rely on reference to the description and drawings to the extent they are so unclear that no meaningful search can be made.

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).

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2024/059488

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2021-0131283	A1	06 May 2021	NO	20220349	A1	22 March 2022
				US	11125083	B2	21 September 2021
				WO	2021-086415	A1	06 May 2021
US	2005-0150287	A1	14 July 2005	US	6966234	B2	22 November 2005
US	2018-0128077	A1	10 May 2018	US	10753172	B2	25 August 2020
US	2010-0206548	A1	19 August 2010	US	8146416	B2	03 April 2012
				WO	2010-093533	A2	19 August 2010
				WO	2010-093533	A3	11 November 2010
EP	2706191	A2	12 March 2014	CA	2826537	A1	11 March 2014
				EP	2706191	A3	25 May 2016
				US	2014-0069640	A1	13 March 2014