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(54) **Method and tool for performing a pilot fluid injection and production test in a well**

(57) A method for performing a pilot fluid injection and production test in an exploration well traversing a hydrocarbon fluid containing earth formation (3) comprises:
a) lowering into the well a fluid injection and production testing tool (25) with a central body (7) carrying fluid flow and other monitoring sensors (4) and at least three expandable packers (9,10,11);
b) expanding the packers (9,10,11) against the wellbore (8), thereby defining a first and a second cavity (5,6) between the central body and the wellbore;
c) injecting the flooding fluid (41) via the first cavity (5) into hydrocarbon fluid containing pore spaces of the formation (3) and inducing a mixture of the flooding fluid and hydrocarbon fluid to migrate through the pore spaces into the second cavity;
d) inducing the fluid flow and other monitoring sensors (4) to monitor fluid migration through the pore spaces;
e) collecting and analyzing the mixture that flows into the second cavity(6); and
f) assessing the suitability of the flooding fluid(41) using the data generated by the fluid flow and other monitoring sensors(4) and results of the analysis.

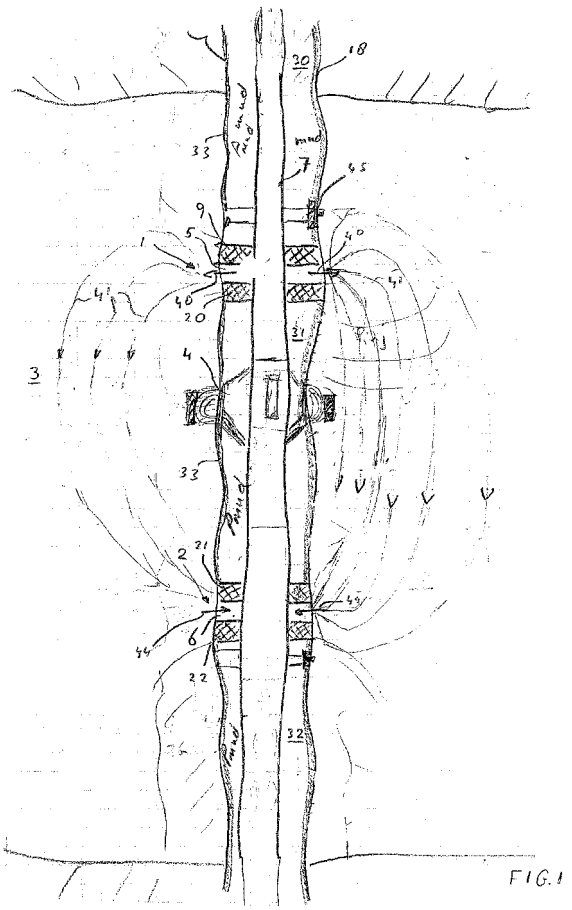


FIG. 1

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Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method and tool for performing a pilot fluid injection and production test in a well, such as an enhanced oil recovery (EOR) pilot test in a cased or uncased exploration well.

[0002] US patent application US2006/0248949 discloses an in-situ pilot fluid injection and production tool with a reversible pump which injects a flooding fluid into an interval of a wellbore of an exploration well, which is sealed from other parts of the wellbore by a pair of expandable packers and which subsequently pumps a mixture of the injected flooding fluid and dissolved hydrocarbon fluid from the formation into the sealed wellbore interval.

[0003] US patent 4,353,249 discloses a method for in-situ determination of permeability and porosity of a formation surrounding an exploration well, wherein a permeable fluid injection conduit extends through a series of expandable packers in the well and the fluid injection rate into the formation surrounding each of the sections of the wellbore between different pairs of adjacent packers is measured.

[0004] A disadvantage of the known methods is that they only provide a limited amount of information about the performance of the flooding fluid in the pore spaces of the hydrocarbon fluid containing formation.

[0005] It is an object of the present invention to provide an improved method and tool for performing pilot fluid injection and production tests in a cased or uncased well, which provide more detailed and extensive data about the performance of the flooding fluid to dissolve and/or displace hydrocarbon fluid in the pores of the formation and about the composition of the produced mixture of flooding and hydrocarbon fluids.

[0006] It is a further object of the present invention to provide a method for monitoring real time the advancement of the flood front and a quick assessment of the resulting improved recovery and of the remaining hydrocarbon saturation left behind the flood front.

SUMMARY OF THE INVENTION

[0007] In accordance with the invention there is provided a method for performing a pilot fluid injection and production test in a well traversing a hydrocarbon fluid containing earth formation, the method comprising:

a) lowering into the well a fluid injection and production testing tool with a central body carrying fluid flow and other monitoring sensors and at least three expandable packers;

b) expanding the packers against the wellbore, thereby defining a first and a second cavity between the central body and the wellbore;

c) injecting the flooding fluid via the first cavity into hydrocarbon fluid containing pore spaces of the formation , thereby displacing a mixture of the flooding fluid and hydrocarbon fluid through the pore spaces into the second cavity;

d) inducing the fluid flow and other monitoring sensors to monitor fluid migration through the pore spaces;

e) collecting and analyzing the mixture that flows into the second cavity; and

f) assessing the suitability of the flooding fluid using the data generated by the fluid flow and other monitoring sensors and results of the analysis.

[0008] The testing tool may comprise a plurality of storage tanks which contain different flooding fluids and a pump assembly, and the method may further comprise:

- lowering the testing tool to a first depth in the well, inducing the pump assembly to pump a first flooding fluid from a first tank into the pore spaces of the surrounding formation, and performing steps b-f with said a first flooding fluid;
- moving the testing tool to a second depth in the well, inducing the pump to pump a second flooding fluid from a second tank into the pore spaces of the surrounding formation and performing steps b-f with the second flooding fluid;
- selecting an optimal first or second flooding fluid by comparing the data generated during step f with the first and second flooding fluid; and
- completing the well as a production well and producing hydrocarbon fluid from the formation using the selected optimal first or second flooding fluid.

[0009] Optionally the testing tool comprises a series of n flooding fluid storage tanks, which comprise n different flooding fluids and the method further comprises:

- moving the testing tool to n different depths in the well, inducing the pump to pump at each depth n one of the n flooding fluids into the pore spaces of the surrounding formation and performing steps b-f with each of the n flooding fluids;
- selecting an optimal flooding fluid by comparing the data generated during step f with each of the n flooding fluids; and
- completing the well as a production well and producing hydrocarbon fluid from the formation using the selected optimal flooding fluid.

[0010] Alternatively the flooding fluid is injected or spotted into and stored within the interior of the wellbore above the upper packer and pumped via an inlet opening in the top of the central body into the first cavity.

[0011] After thus pumping the flooding fluid into the first cavity the packers may be contracted and the central body may be moved along a selected distance through the well, whereupon the packers may be re-expanded

against the wellbore, whereupon a second flooding fluid may be injected into and stored within the interior of the wellbore above the central body and subsequently pumped via an inlet opening in the top of the central body into the first cavity.

[0012] Preferably the packers are ring-shaped and the first and second cavity have an annular shape.

[0013] In accordance with the invention there is further provided a tool for performing a fluid injection and production pilot test in an exploration well traversing a hydrocarbon fluid containing earth formation, the tool comprising:

a) a central body carrying fluid flow and other monitoring sensors and at least three expandable packers;

b) means for expanding the packers against the wellbore, thereby defining a first and a second cavity between the central body and the wellbore;

c) means for injecting the flooding fluid via the first cavity into hydrocarbon fluid containing pore spaces of the formation and inducing a mixture of the flooding fluid and hydrocarbon fluid to migrate through the pore spaces into the second cavity;

d) fluid flow and other monitoring sensors for monitoring fluid migration through the pore spaces;

e) means for collecting and analyzing the mixture that flows into the second cavity; and

f) means for assessing the suitability of the flooding fluid using the data generated by the fluid flow and other monitoring sensors and results of the analysis.

[0014] The fluid flow and other monitoring sensors may comprise electric resistivity (azimuthal or lateral), sonic, density, neutron, NMR, ECS, RST, Pulsed Neutron Capture Logs and/or any other well logging sensors, an optical fluid analyzer or fluid type indicator, a Ph sensor for Alkaline Floods and/or means to compare values measured by fluid flow and other monitoring sensors in the vicinity of the injector by similar fluid flow and other monitoring sensors arranged in the vicinity of the producer.

[0015] Optionally the tool according to the invention comprises a plurality of storage tanks for storage of different flooding fluids, a pump assembly for injecting the flooding fluids sequentially into the pore spaces of the surrounding hydrocarbon containing formation and a plurality of produced fluid collecting tanks for storing a produced mixture of hydrocarbon fluid and flooding fluid.

[0016] These and other features, embodiments and advantages of the method and tool according to the invention are described in the accompanying claims, abstract and the following detailed description of preferred embodiments disclosed in the accompanying drawings in which reference numerals are used which refer to corresponding reference numerals that are shown in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG.1 is a schematic longitudinal view of a first embodiment of an in-situ EOR or flooding fluid pilot testing tool according to the invention within a wellbore of an exploration well; and

FIG.1 is a schematic longitudinal sectional view of a second embodiment of an in-situ EOR or flooding fluid pilot testing tool according to the invention within a wellbore of an exploration well.

DETAILED DESCRIPTION OF THE DEPICTED EMBODIMENTS

[0018] In accordance with the invention an in-situ Enhanced Oil Recovery (EOR) or Flood Pilot Test is performed in a short time thereby reducing the cycle time of such an important step of assessing flood efficiency and remaining oil saturation (ROS) to hours rather than months.

[0019] Optionally the in-situ pilot testing method according to the invention could also replace or complement core laboratory tests that take up to a year, with major improvements in the area of in-situ conditions and real live fluids used in the experiment.

[0020] The pilot testing method according to the invention may be used for miscible and immiscible floods as well as gas injection or any other displacement process in the reservoir or crude improvements in quality.

[0021] Fig. 1 depict how the in-situ pilot flood testing method according to the invention may be carried out with a pair of Wireline Formation Testers (WFT's) of which one is configured as injector 1 and the other as producer 2, wherein real flood and/or EOR fluids may be injected via the injector 1 into the hydrocarbon fluid containing formation 3 to examine the resulting displacement of the hydrocarbon fluid through the pore spaces of the formation 3. One or more commercially available wireline fluid flow and other monitoring sensors 4 are configured to image the flow between the injector 1 and producer 2 to monitor saturation changes or compositional changes. Fluids captured at the producer 2 can be used to analyze the quality of the displaced crude oil and/or other hydrocarbon fluid, especially in the case of miscible floods or crude quality upgrading techniques.

[0022] The pilot testing tool shown in Fig.1 has two Wireline Formation Testing (WFT) tools 1,2 which define two longitudinally spaced annular spaces 5, 6 arranged between a central body 7, the wellbore 8 and a set of four expandable packers 9, 20, 21 and 22 mounted on the central body 7.

[0023] The upper and lower annular spaces 5 and 6 defined between the wellbore 8, central body 7 and the upper, intermediate and lower packers 9, 20, 21 and 21 serve as the injector 1 and producer 2 respectively, and the fluid flow and other monitoring sensors 4 act as the

observation point in-between them.

[0024] The annuli 30,31 and 32 around the central body 7 above the upper packer 9, between the intermediate packers 20 and 21 and below the lower packer 22 are filled with mud and are hydraulically connected such that the mud pressure P_{mud} increases in downhole direction solely as a result of the increased hydrostatic mud pressure and the wall of the wellbore 18 surrounding these annuli 30,31 and 32 is covered with a layer of mudcake 33 which provides a seal between these annuli 30-32 and the pores of the surrounding formation 3. Since the mud pressure P_{mud} is higher than the fluid pressure within the pores of the surrounding formation 3 the mudcake 33 provides an effective seal between the annuli 30-31 and the pores of the surrounding formation 3. The fluid pressure in the upper annular space 5 between the pair of packers 9 and 20 of the upper wireline formation testing (WFT) tool 1 is increased to such a value that the mudcake in this annulus is destroyed and injected fluid is induced to flow through the pores of the formation 3 as illustrated by arrows 40 and 41. Furthermore the pressure in the lower annular space 6 between the lower pair of packers 21,22 of the lower wireline formation testing (WFT) tool 2 is low enough that the hydrocarbon fluid displaced from the pores of the formation 3 by the injected fluid destroys the mudcake 33 and flows into the lower annular space 6 as illustrated by arrows 44.

[0025] The pilot EOR and other flooding fluid pilot testing tool shown in FIG.1 is optimized to minimize the distance between the injector 1 and producer 2 and the have the monitoring sensors 4 closer to the injector 1. The sensors 4 are configured to image and measure the hydrocarbon saturation and the displacement process illustrated by arrows 12 and 13 across a selected investigation depth and volume within pores spaces of the formation 3.

[0026] A monitoring probe 45 for vertical interference testing is mounted on the central body 7 above the upper set of packers 9, 20 of the upper wireline formation tester (WFT) 1.

[0027] Furthermore, after completion of a fluid injection and production test with the Wireline Formation testers (WFT) 1 and 2 rotary cores are drilled from the formation by rotary core drilling and collecting tools (not shown) carried by the central body 7 to measure in the laboratory the remaining oil saturation in these cored plugs.

[0028] Multi depths of investigation using fluid injection and production tests with the Wireline Formation testers (WFT) 1 and 2 are preferred as they provide simultaneous tests, with all environment parameters (porosity, permeability, stresses, etc. are the same and the only variable is the fluid displacement. By providing simultaneous equations to the same problems, multi unknowns can be solved in a determinant way.

[0029] As shown in Fig. 2 the in-situ pilot flood testing method according to the invention may be alternatively carried out with a pair of Wireline Formation Testers (WFT's) of which one is configured as injector 11 and the other as producer 12, wherein real flood and/or EOR fluids may be injected via the injector 11 into the hydrocarbon fluid containing formation 13 to examine the resulting displacement of the hydrocarbon fluid through the pore spaces of the formation 13. One or more commercially available wireline fluid flow and other monitoring sensors 14 are configured to image the flow between the injector 11 and producer 12 to monitor saturation changes or compositional changes. Fluids captured at the producer 12 can be used to analyze the quality of the displaced crude oil and/or other hydrocarbon fluid, especially in the case of miscible floods or crude upgrading techniques.

[0030] The pilot testing tool shown in Fig.2 has two Wireline Formation Testing (WFT) tools 11,12 which define two longitudinally spaced annular spaces 15, 16 arranged between a central body 17, the wellbore 18 and a set of three expandable packers 19, 110 and 111 mounted on the central body 17.

[0031] The upper and lower annular spaces 15 and 16 defined between the wellbore 18, central body 17 and the upper, intermediate and lower packers 19,110 and 111 serve as the injector 11 and producer 12 respectively, and the fluid flow and other monitoring sensors 14 act as the observation point in-between them.

[0032] The pilot EOR and other flooding fluid pilot testing tool shown in FIG.2 is optimized to minimize the distance between the injector 11 and producer 12 and the have the monitoring sensors 14 closer to the injector 11. The sensors 14 are configured to image and measure the displacement process illustrated by arrows 112 and 113 across a selected investigation depth and volume within pores spaces of the formation 13. Multi depths of investigation are preferred as they provide simultaneous tests, with all environment parameters (porosity, permeability, stresses, etc. are the same and the only variable is the fluid displacement. By providing simultaneous equations to the same problems, multi unknowns can be solved in a determinant way.

[0033] The pilot testing tool shown in FIG.2 comprises two flooding or EOR fluid storage tanks 114, 115, which are each provided with a fluid outlet conduit 116,117 in which a valve 118, 119 is arranged and which conduits 116,117 are connected to a pump 120. In the embodiment shown in FIG.2 valve 119 is closed and valve 118 is open such that the pump 120 pumps a first flooding or EOR agent from the first storage tank 114 into a flooding agent injection conduit 121 and the upper annular space 15 into the pores of the formation 13 surrounding the annular space 15 as illustrated by arrows 112. A flushing fluid supply conduit 122 in which a valve 123 is also connected to the inlet of the pump 120 such that the pump 120 may inject slugs and/or a mixture of a flooding or EOR agent and flushing fluid sucked in from the wellbore interior 124 above the test tool 125 as illustrated by dashed arrow 126. The wellbore interior may be filled with a drilling fluid so that a mixture or subsequently slugs of a flooding or EOR agent and drilling fluid may be injected via injection conduit 121 and upper annular space

15 into the pore spaces of the surrounding formation 13.

[0034] The pilot testing tool shown in FIG.2 furthermore comprises a pair of produced fluid collection tanks 127,128, which are connected via a pair of produced fluid inlet conduits 129,130 that are equipped with valves 131,132 to the lower annular space 16. In the situation shown valve 131 is open and valve 132 is closed so that a produced mixture 32 of EOR or flooding agent and hydrocarbon fluid flushed by the agent from the pore spaces of the formation 13 flows via the lower annular space 16 into the first produced fluid collection tank 127 as illustrated by arrows 113 and 133.

[0035] The fluid collection tanks 127,128 are provided with fluid outlet conduits 134,135 that are equipped with one way check valves 136,137 and that are connected to a central fluid outlet conduit 138 which discharges fluid into the wellbore interior 139 below the test tool 125 as illustrated by arrows 140.

[0036] When the first fluid collection tank 127 is substantially filled with a mixture of hydrocarbon fluid and the first flooding or EOR agent 141 from the first flooding or EOR agent storage tank 114 the pump 120 is stopped and the expandable packers 19, 110 and 111 are decompressed or otherwise contracted and the testing tool 125 is lowered through the wellbore to a second depth, where the packers 19, 110 and 111 are expanded and a fluid injection and production test is done with a second flooding or EOR agent 142 by opening valves 119 and 132 and inducing the pump 120 to pump the second agent 142 via the annular space 15 into the pores of the formation 13, thereby forming a mixture of hydrocarbon fluid and the second agent 142 in the pores of the formation 13, which is then induced to flow via the lower annular space 16 into the second produced fluid collection tank 128 as illustrated by arrows 112 and 113.

[0037] If the test tool 125 according to the invention is provided with the flushing fluid inlet conduit 122 the tool may draw a selected amount of flushing fluids from the spotted fluids in the wellbore interior 124 above the tool 125. This provides a Health, Safety and Environment (HSE) improvement, which allows to store only small volumes of highly concentrated potentially hazardous flooding or EOR agents in relatively small flooding or EOR agent storage tanks 114,115 without any exposure to people. The small storage tanks 114,115 can be prepared in the lab under control and used downhole in an efficient and monitored way. By controlling the rate and the pressure of the injected fluid by means of the pump 120 and valves 118,119,123 one can maintain injection at will above Minimum Miscibility Pressure (MMP) and/or below fracture pressure of the formation 13.

[0038] By measuring the break through times at the monitor as well as the producer, and constantly measuring changes in saturation, one can determine by means of the monitoring sensors 14 key reservoir parameters such as relative permeability, Saturation exponent (n), Resistivity Index, Corey Exponents, and could construct a Fractional Flow Curve for the fluids displacement scheme. Ultimately, ROS can be determined and verified by running before and after logs (in the Log-Inject-Log manner), and can be also verified by running rotary cores to measure ROS in the flooded zone and have a relationship versus depth of the efficiency of the flood.

[0039] The pilot testing tool 125 shown in FIG.2 may be operated by the following procedural steps:

- Run Base Logs as described with reference to FIG. 2 at different depths across the interval to be tested.
- Log combination of all potential measurements versus depth to record the Base Log.

[0040] The pilot testing tool 125 according to the invention may be equipped with the following fluid flow and other monitoring tool sensors 14:

- Resistivity (Azimuthal or lateral), Sonic, Density, neutron, NMR, ECS, RST, Pulsed Neutron Capture Logs or any other logs in the future.
- Optical Analyzer or Fluid type indicator, including a ph sensor for Alkaline Floods and compare their values at the injector and producer.

[0041] The produced fluid sample collection tanks 127,128 can carry injected fluids including pressurized gas and foam or foam making components such as Nitrogen and surfactants, and/or they can be used to collect samples at the producer to see the effect of the flooding on the produced oil. This is particularly useful in the case of miscible flood schemes, where the produced fluids at a distance from the injector should have a specific concentration of the flood fluids if the design is correct.

[0042] The sensors 14 of the pilot testing tool according to the invention may furthermore comprise lateral formation sampling probes (not shown) which may be used as a pressure monitoring spot at a distance from the injector/producer, so as to assess the permeability of the formation 13 in the vertical and horizontal directions by using interference testing techniques. This task can be done prior to the beginning of the injection by producing both injection and production spots then stop and monitor the pressure build up at the producing spot as well as the monitoring spot, and then deduce the vertical permeability and the horizontal permeability (Kv & Kh). It can also be used during dynamic injection by solving for the pressure interference between the injection/production spots and the observation spots.

[0043] It is preferred that the first annular space 15 between the upper and intermediate packers 19 and 110 is arranged above the imaging sensor assembly 14

[0044] It is also preferred that the fluid flow and other monitoring sensors 14 would also encompass the first annular space 15 surrounding the injector 11 to see the displacement within the pore spaces of the surrounding formation 13 at the shortest possible time. Such tool could be used for dynamic flow imaging.

[0045] The pilot testing tool 125 according to the in-

vention may be suspended within the wellbore 8,18 from a wireline 150, a coiled tubing, a drill string or other tubular (not shown) or may be inserted into the wellbore 8,18 using a robotic device (not shown).

[0046] The pilot testing tool 125 according to the invention may be operated by performing the following steps.

A) Well Preparation;

i. Depends on the volume needed of the displacing fluid, the flooding fluid is either carried in big storage tanks 114,115 downhole as a module of the WFT string, or spotted across the wellbore interval to be tested.

ii. Displace the wellbore fluids across the tested formation by coil tubing or by tubing. Use spacers ahead and after the flood fluids, if needed, to keep wellbore fluids from contaminating the flooding or EOR fluids.

iii. Run the wireline set of sensors 14 as a base log

iv. Run the WFT flood string as described before.

v. Vertical Interference Test;

vi. Inflate the packers 19,110 and 111 surrounding the upper and lower annular spaces 15 and 16,

vii. Set the monitoring probe sensors 14, and take a pretest pressure, and stabilize the pressure in preparation for monitoring the production/injection pressure interference.

viii. Proceed to get the formation pressure at the injector & producer spots, by pumping (producing) a small volume out of the straddled interval at both spots and allowing for the pressure to build up till it is stable.

ix. Monitor the pressure build-up at the injector & producer 11 and 12, as well as the interference at the observation spots of the upper and lower annular spaces 15 and 16.

x. Derive the Kv & Kh for the injector and producer spots

xi. Repeat the process for a longer production time in both upper and lower spots for a period predetermined by modeling, to ensure radial flow is achieved.

xii. Stop the pumps and monitor the pressure build up at both upper and lower dual packers and their corresponding monitoring probes, determine realtime if the desired response has been achieved to ensure successful interpretation of the vertical and horizontal permeabilities at both injector and producer locations.

xiii. Repeat step v. and compare results.

xiv. Use the later results in adjusting previously prepared reservoir models and history match the performance.

xv. Verify the model assumptions using this method.

xvi. EOR Flooding Test

xvii. Start pumping at both injector and producer spots 11,12. Maintain the pump pressure below the formation fracturing pressures. Producer 12 can be started first to create a pressure sink, forcing the injector fluids 11 to go more towards the producer.

xviii. A top fluid drainage tool (not shown) could pump out to the well bore above the top packer 19

xix. A bottom fluid drainage tool (not shown) could pump out wellbore fluid below the lower packer 111.

xx. The sections of the wellbore above and below the upper and lower packers 19 and 111 may be pressure connected by means of the top and bottom fluid drainage tools.

xxi. As the injected fluids 112 advance towards the producer 12, the area investigated by the flood monitoring tool sensors 14 in-between the injector 11 and producer 12, will record the frontal advance of the displacement process.

xxii. Record the electric resistivity of the formation 13 at different depths of investigation, and construct a matrix for the unknowns that would be solved and iterated between the time and depth of investigation.

xxiii. Monitor the Ph of the injected and produced fluids 141, 132 and compare other fluid properties such as density and viscosity using known fluid composition monitoring sensors 14.

xxiv. Monitor the produced fluids by means of a known optical fluid analyzer (or any other fluids Identification Sensor, internal to the WFT) of each tool, top and bottom.

xxv. Observe the break through at the monitor, and readjust the model accordingly (history matching), then see if the new assumptions would match the break through at the producer 12.

xxvi. Construct Fractional Flow Curve with producer data and monitor tools data.

xxvii. Experiment can be repeated for different fluids to monitor incremental improvements in oil recovery by lowering the remaining oil saturation (ROS). Different fluids can be solvents, surfactants, polymers, foams, miscible or immiscible, or fluids with different salinities. The monitoring tool may have to be changed to ensure that the displacement process is captured.

xxviii. If gas is injected as the displacing fluid 141, it is advisable to switch around the injector producer positions 11,12 and inject from the bottom up. The monitoring sensor assembly 14 is preferably arranged closer to the injector 11 than to the producer 12.

xxix. Salinity spikes can be used to verify the

model.

xxx. From Saturation vs. time and distance between the injector 11 and producer 12 match the model and perform real time history match to deduce the relative permeabilities.

xxxi. In case of the miscible floods test, the produced fluids can be sampled to determine the quality and composition of the produced fluids 132.

xxxii. Recording Status After Injection

xxxiii. After the completion of the flood test, run the base logs vs. depth one more time to record the changes in the formation fluids, using the same combination of logs.

xxxiv. Run rotary cores to determine ROS, and verify the model results.

Claims

1. A method for performing a pilot fluid injection and production test in a well traversing a hydrocarbon fluid containing earth formation, the method comprising:

a) lowering into the well a fluid injection and production testing tool with a central body carrying fluid flow and other monitoring sensors and at least three expandable packers;

b) expanding the packers against the wellbore, thereby defining a first and a second cavity between the central body and the wellbore;

c) injecting the flooding fluid via the first cavity into hydrocarbon fluid containing pore spaces of the formation, thereby displacing a mixture of the flooding fluid and hydrocarbon fluid through the pore spaces into the second cavity;

d) inducing the fluid flow and other monitoring sensors to monitor fluid migration through the pore spaces;

e) collecting and analyzing the mixture that flows into the second cavity; and

f) assessing the suitability of the flooding fluid using the data generated by the fluid flow and other monitoring sensors and results of the analysis.

2. The method of claim 1, wherein the testing tool comprises a plurality of storage tanks which contain different flooding fluids and a pump assembly, and the method further comprises:

- lowering the testing tool to a first depth in the well, inducing the pump assembly to pump a first flooding fluid from a first tank into the pore spaces of the surrounding formation, and performing steps b-f with said a first flooding fluid;
- moving the testing tool to a second depth in the well, inducing the pump to pump a second flooding fluid from a second tank into the pore spaces of the surrounding formation and performing steps b-f with the second flooding fluid;
- selecting an optimal first or second flooding fluid by comparing the data generated during step f with the first and second flooding fluid; and
- completing the well as a production well and producing hydrocarbon fluid from the formation using the selected optimal first or second flooding fluid.

3. The method of claim 2, wherein the testing tool comprises a series of n flooding fluid storage tanks, which comprise n different flooding fluids and the method further comprises:

- moving the testing tool to n different depths in the well, inducing the pump to pump at each depth n one of the n flooding fluids into the pore spaces of the surrounding formation and performing steps b-f with each of the n flooding fluids;
- selecting an optimal flooding fluid by comparing the data generated during step f with each of the n flooding fluids; and
- completing the well as a production well and producing hydrocarbon fluid from the formation using the selected optimal flooding fluid.

4. The method of claim 1, wherein the flooding fluid is injected into and stored within the interior of the wellbore above the upper packer and pumped via an inlet opening in the top of the central body into the first cavity.

5. The method according to claim 4, wherein after pumping the flooding fluid into the first cavity the packers are contracted and the central body is moved along a selected distance through the well, whereupon the packers are expanded against the wellbore, whereupon a second flooding fluid is injected into and stored within the interior of the wellbore above the central body and subsequently pumped via an inlet opening in the top of the central body into the first cavity.

6. The method of claim 1, wherein the packers are ring-shaped and the first and second cavity have an annular shape.

7. A tool for performing a fluid injection and production pilot test in an exploration well traversing a hydrocarbon fluid containing earth formation, the tool comprising:

a) a central body carrying fluid flow and other monitoring sensors and at least three expanda-

ble packers;
b) means for expanding the packers against the wellbore, thereby defining a first and a second cavity between the central body and the wellbore;
c) means for injecting the flooding fluid via the first cavity into hydrocarbon fluid containing pore spaces of the formation and inducing a mixture of the flooding fluid and hydrocarbon fluid to migrate through the pore spaces into the second cavity;
d) fluid flow and other monitoring sensors for monitoring fluid migration through the pore spaces;
e) means for collecting and analyzing the mixture that flows into the second cavity; and
f) means for assessing the suitability of the flooding fluid using the data generated by the fluid flow and other monitoring sensors and results of the analysis.

8. The tool of claim 7, wherein the fluid flow and other monitoring sensors comprises electric resistivity (azimuthal or lateral), sonic, density, neutron, NMR, ECS, RST, Pulsed Neutron Capture Logs and/or any other well logging sensors, an optical fluid analyzer or fluid type indicator, a Ph sensor for Alkaline Floods and/or means to compare values measured by fluid flow and other monitoring sensors in the vicinity of the injector by similar fluid flow and other monitoring sensors arranged in the vicinity of the producer.

9. The tool of claim 7, comprising a plurality of storage tanks for storage of different flooding fluids, a pump assembly for injecting the flooding fluids sequentially into the pore spaces of the surrounding hydrocarbon containing formation and a plurality of produced fluid collecting tanks for storing a produced mixture of hydrocarbon fluid and flooding fluid.

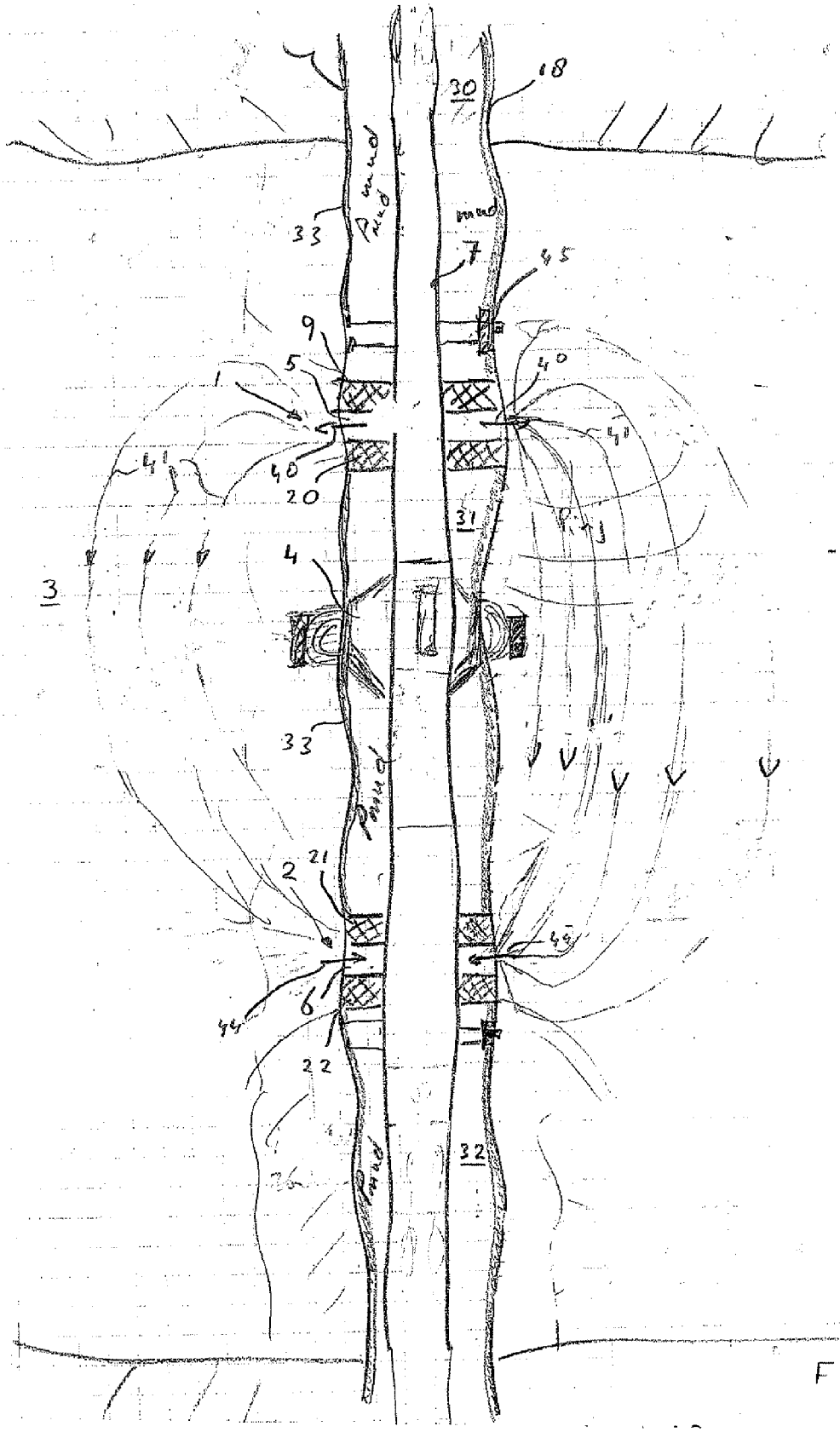


FIG. 1

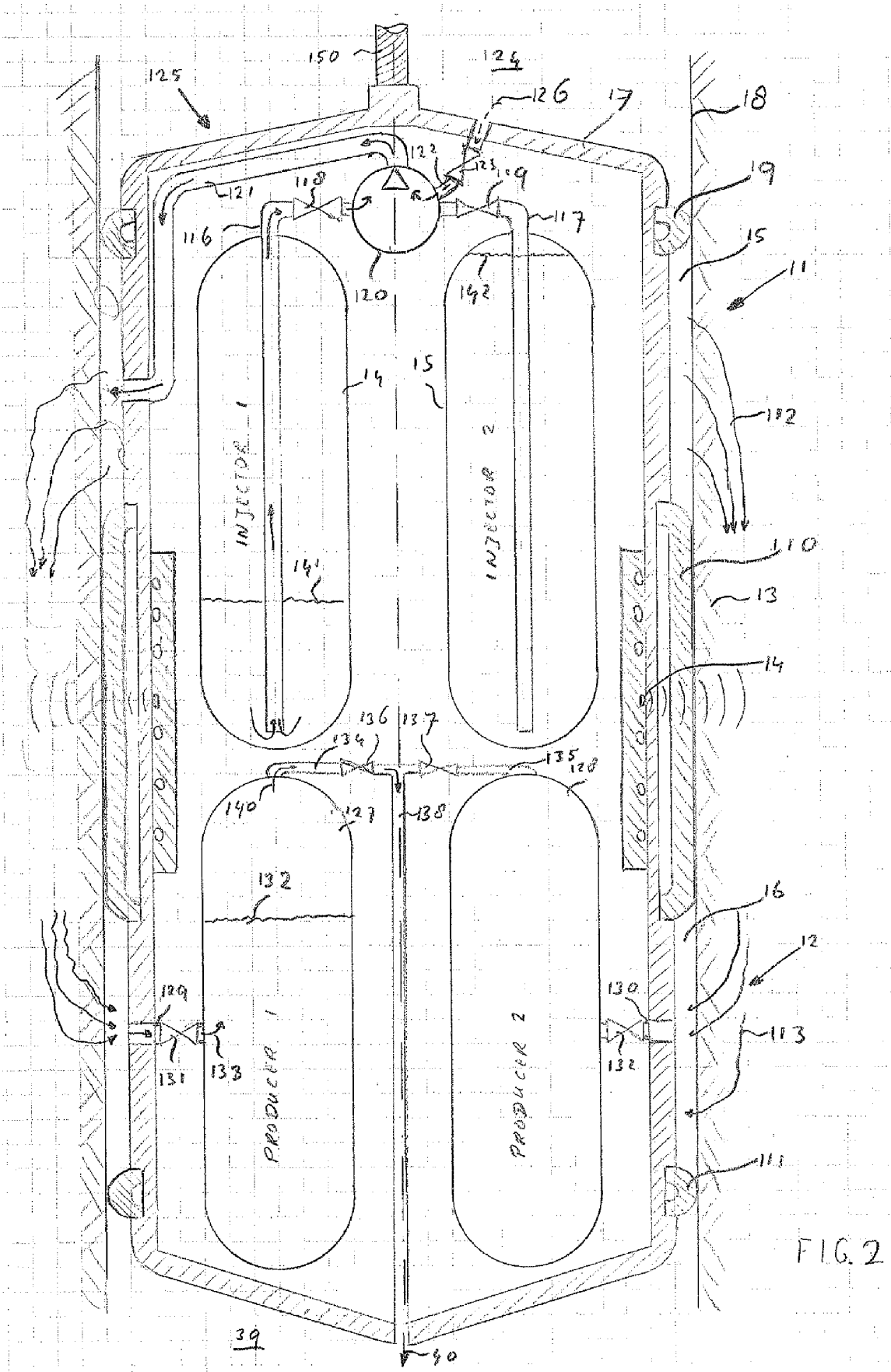

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FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 4323

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 2 441 843 A (SCHLUMBERGER HOLDINGS [VG]) 19 March 2008 (2008-03-19) * page 10, paragraph 3 - page 22, paragraph 2; figures 4-8 * * the whole document *	1,4,6-8 2,3,5,9	INV. E21B33/124 E21B49/08
Y	GB 2 441 842 A (SCHLUMBERGER HOLDINGS [VG]) 19 March 2008 (2008-03-19) * claim 11; figures 1-5 *	2,3,5,9	
X	WO 2008/011189 A (HALLIBURTON ENERGY SERV INC [US]; VAN ZUILEKOM ANTHONY H [US]; PROETT) 24 January 2008 (2008-01-24) vertical interference testing * page 7, paragraph 3 - page 8, paragraph 4; figures 6-8 * * the whole document *	1,7	
X	US 5 831 156 A (MULLINS ALBERT AUGUSTUS [US]) 3 November 1998 (1998-11-03) * column 5, line 5 - column 6, line 45; figures 2,3 * * column 7, lines 14-34 *	7	TECHNICAL FIELDS SEARCHED (IPC) E21B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 February 2009	van Berlo, André

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 16 4323

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10-02-2009

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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