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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

E. S. D.

REF: Expediente No. 12 187.277 - Solicitud de Patente
a favor de **INTEVEP, S.A.**

Titulada: FORMULACIÓN Y MÉTODO DE USO PARA LA EXPLOTACIÓN DE
POZOS DE PETRÓLEO PESADO Y EXTRA PESADO

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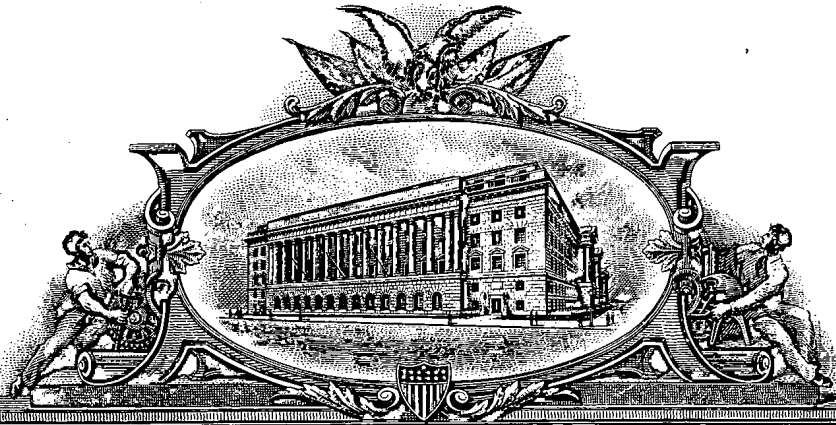
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APPLICATION NUMBER: 61/549,631

FILING DATE: October 20, 2011

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1	Application Data Sheet	11-193_Application_Data_Sheet_10-20-11.pdf	1419707	no	5
			3796041a71efa5dac564355505b6abee3433a1ed		
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2		11_193_Application_10-20-11.pdf	113364	yes	22
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	Specification		1	18	
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3	Drawings-only black and white line drawings	11-193_Drawings_10-20-11.pdf	1061905	no	5
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4	Fee Worksheet (SB06)	fee-info.pdf	29994	no	2
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**FORMULATION AND METHOD OF USE FOR EXPLOITATION
OF HEAVY AND EXTRA HEAVY OIL WELLS**

BACKGROUND OF THE INVENTION

[0001] The invention relates to a formulation and method of using same for improving well productivity in hydrocarbon reservoirs, and use of the formulation in an exploitation method.

[0002] Improvement in productivity of heavy and extra heavy oil wells such as those found in the Orinoco River Belt in Venezuela is clearly desirable. Some of the largest reservoirs of heavy and extra heavy oil in the world are in Venezuela and hold oil having API gravity within the range of 6 to 16. Unfortunately, the production rate of much of this oil is unacceptable.

[0003] It is a high concern in the exploitation of heavy and extra heavy oil reservoirs to increase productivity during the well lifetime. With these wells, primary cold production schemes are quickly abandoned in favor of thermal methods to improve well flowability by reducing oil viscosity in the reservoir. These processes are costly and also still produce a low output in terms of final recovery. They also have serious problems of sour gases production such as H₂S and CO₂ which are very costly to address. Such thermal recovery methods typically produce final oil recovery below 35 - 40%.

[0004] Venezuelan heavy and extra heavy Orinoco River Belt oil sandstones are exceptional reservoirs. 60% of the reservoirs of this type have a KH/U value between 40 and close to 1,000 in very many cases. Unlike other reservoirs, however, the oil in Venezuelan extra heavy oil reservoirs is flowable at reservoir conditions.

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[0005] Even these wells, however, have a final recovery by cold production which is very low and perhaps in most cases below three (3) per cent of the original oil in place. The conditions for flow of oil in those reservoirs, with even excellent petrophysical properties, are very unfavorable to the flow of oil. The components of the heavy and extra heavy oil, particularly the asphaltenes in natural form in the native oil, are capable by natural fluid-rock interactions of generating an oil-wet condition at the surface of the natural mineral components of the sandstone. This produces the most adverse conditions to flow of oil in a porous media. This is a natural oil-wet condition of the reservoir media, which is a completely different condition as compared to formation damage in the well resulting from drilling or production activities, which could also happen in the well.

[0006] The need exists for improvement in production rates from wells producing from formations containing heavy and extra heavy wells, particularly those which contain asphaltenes and other hydrocarbons which lead to oil wet flow environments.

SUMMARY OF THE INVENTION

[0007] As a response to the above problems, especially to the natural oil wet conditions of the sandstone and the extremely low well productivity and recovery of the original oil in place, the present invention provides a formulation or stimulation fluid and a method of using the formulation for improving well productivity in cold production schemes and also in producing wells using thermal methods. The result is reflected by a better flow rate in the well, a lower pressure drawdown, and an improved recovery from the drainage area of the formation.

[0008] Injection wells are sometimes used as part of a production or exploitation scheme, wherein injection of fluids

into one well drives fluids from the area of the injection well to a production well, where production rates are improved.

[0009] The formulation of the present invention can advantageously be used to improve the flow conditions at both the injection well and the production well.

[0010] In accordance with the invention, a combined injection and production method is therefore provided, which method comprises the steps of establishing a production well and an injection well into a hydrocarbon-bearing formation; introducing a mixture of a surfactant, a co-surfactant and a carrier fluid into each of the production well and the injection well so that the mixture flows into porous media surrounding the production well and the injection well; holding the mixture in the porous media in the presence of water for a period of time sufficient to form a water film on surfaces of the porous media; and injecting an injection fluid into the injection well while producing from the production well, whereby hydrocarbons flow from the porous media around the injection well toward the production well.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] A detailed description of preferred embodiments of the present invention follows, with reference to the accompanying drawings, wherein:

[0012] Figure 1 schematically illustrates a treated surface in accordance with the invention;

[0013] Figure 2 illustrates typical and preferred flow rates from the hydrocarbon producing well;

[0014] Figures 3 and 4 illustrate a test glass plate which is oil-wet in Figure 3, and which has been treated in accordance with the present invention in Figure 4;

[0015] Figure 5 shows the test plate is still oil-wet even after solvent cleaning;

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[0016] Figure 6 illustrates results of use of the present invention in the form of pressure drop in a porous media before and after several treatments in accordance with the present invention; and

[0017] Figure 7 further illustrates pressure drop in a test system following initial and subsequent treatments in accordance with the present invention; and

[0018] Figures 8 and 9 illustrate an injection and production method in accordance with the present invention.

DETAILED DESCRIPTION

[0019] The invention relates to a formulation or stimulation fluid which has a surfactant/co-surfactant mixture and a method for using same to treat surfaces of a hydrocarbon bearing formation and thereby enhance flow of hydrocarbons through same. This method is advantageously used to alter flow conditions in the formation to improve production of hydrocarbons from hydrocarbon-bearing formations.

[0020] As mentioned above, many significant hydrocarbon deposits in the world contain very large quantities of hydrocarbons under conditions where it is very difficult to produce them. One example of this is asphaltene-bearing hydrocarbon deposits in the Orinoco River Belt of Venezuela. In these formations, which typically have high and low pressures in the range of 300-1,500 psi, the heavy hydrocarbon fractions contained in the formation, especially asphaltenes, tend to adhere to the pore surfaces of the hydrocarbon and thereby create an oil-wet environment in the reservoir. As detailed above, this oil-wet flow environment is not at all conducive to production of those hydrocarbons from the formation. Further, as will be demonstrated below, this asphaltene is not easily removed because a portion of the hydrocarbon adsorbs into the rock surface making even cleaned surfaces oil wet and,

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therefore, unfavorable for good hydrocarbon flow. According to the invention, a water film is formed over the rock surfaces and also over the chemically adsorbed hydrocarbon so that the surfaces when coated in this manner are water wet. This greatly increases the flowability of hydrocarbons through the treated rock formation.

[0021] In accordance with the present invention, the surfactant/co-surfactant mixture is used to form a water film over the pore spaces of the formation, and also over the asphaltenes adhered to the pore surfaces, so as to provide a water-wet surface between the flow surfaces defined by the pore surface of the rock and asphaltene adhered thereto, and the volume of hydrocarbon in the formation which is intended to be produced. This water film increases flow of hydrocarbons through the formation, and thereby enhances production of hydrocarbon from the formation. Over a period of time, the water film eventually is removed by fluids flowing past the film, at which point the surfactant/co-surfactant mixture of the present invention can again be introduced into the hydrocarbon bearing formation to again deposit a fresh water film for use in the next period of production.

[0022] According to the invention, the surfactant/co-surfactant mixture preferably contains surfactant, co-surfactant and a fluid carrier, each of which has the following preferred constituents.

[0023] The surfactant is preferably selected from the group consisting of cationic surfactants, non-ionic surfactants, amphoteric surfactants and combinations thereof. The surfactant is further preferably an ethoxylated fatty alcohol having between 4 and 60 ethoxylated groups.

[0024] Suitable non-ionic surfactants include but are not limited to octilphenol having 9-16 EO, nonylphenol with an EO number from 4 to 25, preferably 9 - 18, fatty acids of 9-20 EO,

n-tetradecanol of 9-20 EO, n-hexadecanol of 9-20 EO, laurate of sorbitan, and polyethoxilated fatty alcohols with EO number from 4 to 25, preferably 9 - 20. Suitable ionic surfactants include but are not limited to n-alkyl sulfates of K or Na, n-alkyl trimethyl ammonium chloride and combinations thereof.

[0025] The co-surfactant is preferably an alcohol co-surfactant, preferably one or more n-alcohols (C1-C6), and more preferably selected from the group consisting of methanol, ethanol, propanol, butanol, pentanol, isopropanol and combinations thereof. The most preferred co-surfactant is methanol and/or ethanol.

[0026] The carrier fluid can be selected from the group consisting of organic solvents, light hydrocarbons, diluents, light crude oil and combinations thereof and water. More specifically, the carrier fluid can be light oil, a light refinery cut, gasoil, diesel, diluent and water. The most preferred carrier fluid is an oil fluid. One example is compatible light crude oils with API gravity between 20 and 45 API preferably between 20 and 25 API. Also, some mixtures of compatible crude oil with the formation fluids and/or naphtha can be used for reducing viscosity of the heavy and extraheavy oil fluid flow for transportation in surface facilities.

[0027] The surfactant/co-surfactant mixture preferably is prepared having substantially equal amounts by volume of the surfactant and co-surfactant, and the overall mixture with carrier fluid preferably contains each of the surfactant and co-surfactant in an amount between 0.5 and 20% by volume, more preferably between 1 and 4% by volume.

[0028] In accordance with the invention, the surfactant/co-surfactant mixture can be prepared by mixing the above-identified constituents at the surface and then transporting, for example by pumping, the resulting mixture or stimulation fluid into a hydrocarbon producing formation, for example

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through a well positioned from the surface to the subterranean formation, so that the mixture penetrates into the hydrocarbon-bearing formation around the well, typically into a radius surrounding the well of at least about 2 inches, preferably between 12 inches and as large as possible, for example up to 3 feet. The penetration area into the formation is the area to be treated in accordance with the present invention.

[0029] Once a sufficient volume of fluid is pumped into the formation, this volume is then held in place in the formation in the presence of water for a time sufficient to form the desired water film over surfaces of the pore spaces of the hydrocarbon and also over the hydrocarbons adhered to these surfaces. This advantageously provides a water-wet flow environment which is advantageous to the flow of hydrocarbon through the porous media, and therefore produces a flow environment which is far more conducive to the flow of oil than the natural oil-wet flow environment present in the well under natural formation conditions wherein the heavy hydrocarbons, and especially asphaltenes, are adhered to the pore surfaces of the porous media. The suitable amount of time to hold the fluid in the formation will vary with different wells, fluids and conditions, but will typically be between 12 and 24 hours and a preferred range of time between 18 and 24 hours.

[0030] Production from the treated well can be conducted while monitoring pressure drawdown in the well, and when the pressure drops sufficiently, the formation can be treated again in accordance with the present invention.

[0031] The typical formation for which the present invention can be utilized can be any formation wherein the forming of a water film over the pore surfaces would be beneficial to the overall hydrocarbon production from the formation. A particularly desirable application of the present invention is in formations having hydrocarbons with an API gravity of between

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6 and 16, and even more preferably in formations containing hydrocarbons having an API gravity of between 6 and 12. These heavy and extra heavy hydrocarbon deposits in certain areas typically are very large in volume, but also contain asphaltenes as discussed above, and these are ideal candidates for treatment according to the present invention to enhance production. The typical rock formations containing such hydrocarbons have pore spaces which define the void volume which holds the hydrocarbons and which creates the permeability that allows the hydrocarbons to flow. The rock defining the pore surfaces of these formations are typically defined by quartz, feldspar, siliceous mineral, carbonaceous mineral, clays and combinations thereof.

[0032] Figure 1 schematically illustrates a surface of a hydrocarbon bearing formation treated in accordance with the present invention. As seen in Figure 1, a mineral surface **10** which defines the pore space of the formation has rock mineral active sites **12** along surface **10**, and these rock mineral active sites **12** interact with hydrocarbons under the typical pressure in the formation such that chemically adsorbed hydrocarbons **14** are closely adhered to surface **10**, particularly at rock mineral active sites **12**.

[0033] According to the invention, the surfactant/co-surfactant mixture of the present invention is introduced to the formation and held there in the presence of water so that a film of water is formed over the adsorbed hydrocarbons **14** as well as the rock mineral active sites **12** of mineral surface **10**. Figure 1 shows surfactant/co-surfactant mixture adsorbed in the form of water film **16** which is schematically illustrated as a double layer to represent the surfactant/co-surfactant mixture. This produces a water-wet condition at the surface, which enhances flow of hydrocarbon through flow areas and pore space defined by such a treated surface. The water which forms the film can be

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water already present in the rock formation fluids and/or from the carrier fluid if a water containing carrier fluid is used. The water salinity can be in the range between 800 ppm up to 45,000 ppm.

[0034] Pressure drawdown, or the pressure drop from the formation to the well bore, is a good measure of the flowability in the formation. When the pressure drawdown is relatively small, this indicates good flowing properties in the formation to the well. While producing from a well that has been treated according to the invention, it is desirable to monitor the pressure drawdown, and after a certain amount of oil has been produced from a treated well, the pressure drawdown starts to increase. This increase in pressure drawdown indicates that the water film has been worn away or removed due to relatively high velocity flow of well fluids passing over the film to the well. This stream removes the water film by desorption of the surfactant and co-surfactant from the mineral surface and restoring the natural oil-wet initial condition at the mineral surface. At this stage, according to the invention, the well can be treated again with the same formulation, and this process can be repeated as many times as necessary until no more hydrocarbon fluids flow to the well even after treatment. With cyclic stimulation, the porous media will improve final recovery of the initial oil in place in the drainage area by cold production by potentially many times the amount of 3% typically reported as the well output obtained without stimulation. The present invention also reduces the time and need of costly thermal processes to reach this level of oil recovery.

[0035] Figure 2 illustrates typical and desired flow rates from a hydrocarbon production well. The starts and stops shown in actual flow show a trend (line A) which is not desirable, while a preferred pressure behavior is shown at line B. The difference of the area between lines A and line B is an

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indication of greater recovery of oil from same well in same well drained area.

[0036] In the aforesaid discussion, the mixture of surfactant and co-surfactant in accordance with the present invention can advantageously be utilized in an injection and production method to even further enhance oil recovery from an oil field which utilizes such techniques.

[0037] Figure 8 shows a reservoir 20 which would typically be a hydrocarbon bearing formation including porous media, having pore space filled with various fluids, one of which is a heavy or extra-heavy hydrocarbon which may contain asphaltenes. It is desired to produce the hydrocarbon to the surface for refining into various products. A production well 22 is shown extending from surface level 24 to formation 20, and having perforations 26 for allowing communication between well 22 and formation 20. An injection well 28 is similarly positioned from surface 24 to formation 20, and perforations 30 allow communication from well 28 to formation 20. In use, injection of driving fluids such as water or the like into injection well 28 is used to drive fluids toward production well 22 and therefore enhance fluid recovery through production well 22. In accordance with the present invention, the mixture of surfactant and co-surfactant as discussed above can advantageously be used in a method such as discussed herein. In such a method, it is advantageous to produce a water film over the surfaces of porous media and adhered hydrocarbons in the vicinity of both the production well 22 and injection well 28. This can help to provide better flow into the formation through well 28 as well as out of formation 20 into production well 22. Thus, a mixture of surfactants/co-surfactants as discussed above can be prepared and pumped into each of wells 22, 28 as schematically illustrated by arrows 32 in Figure 8. This pumping positions the mixture through wells 22, 28 and into the zones 34, schematically illustrated by

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dashed lines in formation 20. This mixture is then held in position for a time sufficient to form a water film over the surfaces of porous media and also over adhered hydrocarbons as desired. When treatment is completed, the mixture can be pumped from the well, and wells 22, 28 can be returned to a production mode of operation wherein fluids are injected into injection well 28 and pumped out of, or otherwise recovered from well 22. Figure 9 shows this operation mode, and schematically illustrates injection of fluids 36 into well 28, and production of fluids 38 from production well 22. The enhanced flow of subterranean fluids from the vicinity of injection well 28 toward the vicinity of production of well 22 which is also schematically illustrated by arrows 40 shown in formation 20. The enhanced flow conditions around the perforations of each well create enhanced flow into production well 22 as desired, and also provide for better and more uniform flow through the areas between injection well 28 and into production well 22, with reduced risk of "channeling", where injected fluid finds a single preferred path and itself reaches the production well before the desired hydrocarbons.

[0038] As with the embodiment discussed above, this process can be carried out while pressure at relevant locations is monitored, and when the pressure drops and production rates reach certain levels, the treatment with surfactant and co-surfactant according to the invention can again be conducted.

[0039] The following example further illustrates the invention and the results which are obtained using same.

Example 1

[0040] Crude oil and water from several wells in different areas of the Orinoco River Belt fields were collected. The oil and water were placed in closed glass vessels at several oil and water saturations, at reservoir conditions of water salinity and

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temperature, in a thermally controlled oven. Inside each vessel was placed a small glass plate which was monitored for wettability conditions starting with a water-wet condition and further being naturally changed to oil wet after a medium time period of about three to four weeks at reservoir temperature of 145°F. For each glass plate, wettability was measured by contact angle measurement techniques at the well temperature ranging from water-wet at the initial condition to oil wet after three weeks of aging process in the vessels at reservoir conditions.

[0041] After this treatment, the glass plates had a contact angle with oil which shows a strongly oil-wet condition as can be seen in Figure 3, which shows the oil spreading over the plate surface.

[0042] Each plate was then placed in a beaker for a soaking time with a mixture of equal amount of the well fluids in a mean average of 18% formation water and 82% extra heavy oil at 145°F temperature, with the formulation of the present invention, which in this particular example comprised a solution of 1% volume of tridecanol with 16 ethoxylated groups and 1% volume of ethanol, both admixed with 98% diluent which was a light hydrocarbon cut used in the production area to improve the flowability of extra heavy oil at surface conditions. The mixture and the plate were held for an 8 hour exposure time at reservoir temperature of 145°F and contact angle measurement showed wettability reversal from oil wet as shown in Figure 3 to water wet as shown in Figure 4. Note the bubbling up of the oil, and contact angle clearly indicative of the now water wet surface.

[0043] Similar results can be obtained by using various non-ionic and ionic surfactants. Suitable non-ionic surfactants include but are not limited to octilphenol having 9-16 EO, nonylphenol with an EO number from 4 to 25, preferably 9-18,

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fatty acids of 9-20 EO, n-tetradecanol of 9-20 EO, n-hexadecanol of 9-20 EO, laurate of sorbitan, and polyethoxilated fatty alcohols with EO number from 4 to 25, preferably 9 - 20.

[0044] Suitable ionic surfactants include but are not limited to n-alkyl sulfates of K or Na, n-alkyl trimethyl ammonium chloride and combinations thereof.

[0045] Suitable co-surfactants include but are not limited to any alcohol of the series of n-alcohols (C1 - C6), such as methanol, ethanol, propanol, butanol, pentanol, isopropanol and mixtures thereof.

[0046] The carrier fluid of the surfactant composition can be light oil, a light refinery cut, gasoil, diesel, diluent and water. The most preferred carrier fluid is an oil fluid.

[0047] Returning to the example, the glass plates were then soaked with a solution of mutual solvent for more than twenty four (24) hours to remove the water film and any visible hydrocarbon. The cleaned glass plates showed a clear and clean surface, but when a drop of water was placed on the plate, the water drop did not spread on the surface. The contact angle was measured and the plate still exhibited an oil-wet condition, as shown in Figure 5.

[0048] This indicates that even though the mineral surface, such as sandstone, can be cleaned of adhered hydrocarbons still on that surface, there remains a chemically adsorbed film of hydrocarbon and therefore on such a mineral surface there exists a strong oil-wet wettability. As mentioned previously, the oil-wet wettability is the most adverse condition for the recovery of oil in a porous media. Thus, even by undertaking the cost and steps of removing the adhered asphaltenes, the resulting cleaned surface remains oil wet.

[0049] Use of the formulation and method of the present invention creates a water film on the mineral surface, covering the previously chemically adsorbed hydrocarbons. This film

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creates an interface that will conduct hydrocarbon flow for very long periods of time between stimulation cycles. A very low pressure drawdown is achieved with the increased oil flow rates, thereby providing great benefits to the productivity and final recovery of oil from the drained area of the well.

Example 2

[0050] Porous media displacement equipment was set up to run a displacement test to simulate well flow conditions with and without the use of the formulation of the present invention. A Hassler cell was selected since a simulation of the formation grain pressure can be achieved with such a cell. Synthetic core material was made with commercial sand obtaining a core permeability between 6-7 Darcies. Pressure change at the inlet and outlet of the cell was monitored with sensors. Cylinders were coupled to the cell to provide, at reservoir temperature and pressure, the reservoir fluids and the stimulation fluid. After a long period of stabilization of constant flow with only reservoir fluid, the stimulation fluid of the present invention was injected from the outlet and held for a soaking period of 24 hours. After soaking, flow was restarted and the pressure drop was monitored. A measurement was taken of the porous volume displaced and time through the core as a production fluid. The oil used as reservoir fluid had the following characteristics:

- Saturated % : 9 wt
- Aromatics % : 42 wt
- Resins %: 38 wt
- Asphaltenes % : 11 wt
- Acidity: 3.02 mg KOH/g
- Viscosidad CP 12,620 at 145 F
- API: 7.6
- % C wt 70.65

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% H wt 11.48

Water with 13,000 ppm NaCl

[0051] The water used had 13,000 ppm of NaCl. The temperature of the oven was 145 °F. The formulation of the present invention for the displacement test was a solution of 98 ml of diluent admixed with a previously mixed and homogenized mixture of 1 ml of tridecanol ethoxylated having 17 EO groups and 1 ml of ethanol.

[0052] Continuous flow was reached through the synthetic sand packed core saturated with oil to about 78% volume and a water saturation of about 22% by volume. The core was aged to reach an oil wet condition exposing it to pressure and temperature conditions of 1,150 psi and 145°F, which are typical of the Carabobo field of The Orinoco River Belt reservoirs, for about four weeks. Fluid flow was then reestablished by displacing oil until continuous flow was again reached. The stimulation system with diluent as a carrier fluid was then squeezed into the production area of the core and held at rest for a 24 hour time period. After that, oil was again allowed to flow, and an excellent lower differential pressure was observed for about three (3) pore volumes of oil produced in the collecting recipient. A second stimulation squeeze identical to the initial one was made and after 24 hours the flow was restarted, showing again improved properties to flow in two (2) porous media volumes of flow. A third cycle of stimulation was made observing the same results as the first cycle. Figure 6 shows a graph of the measured pressure during the several cycles of production and squeeze.

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[0053] ' ' The same test was run with the reservoir fluids as shown below:

OIL:

Saturated % : 8 wt

Aromatics % : 44 wt

Resins %: 35 wt

Asphaltenes % : 13 wt

Acidity: 3.90 mg KOH/g

Viscosidad CP 10,420 at 145 F

API: 12

% C wt 84.55

% H wt 11.12

Water with 2,500 ppm NaCl

[0054] Figure 7 shows the results in pressure behavior in the displacement system while producing an average of three porous volumes in between each stimulation injection.

Example 3

[0055] Two highly deviated Orinoco River Belt wells from the Cerro Negro area were selected for pilot testing. Main characteristics of the wells are:

Well name	Reservoir name	Completion Date	Rock properties				Production Method	Original pressure psi	Actual pressure psi	Lithology
			Porosity %	K Darcy	Vsh	Thickness ft				
CD 36	OFIM CNX9	04-1992	33	2.3	5.3	194	Mechanical pump & Gravel pack	1100	1095	sandstone
CD 37	OFIM CNX9	02-1993	32	5	7.0	192	PCP Gravel pack	1350	1000	sandstone

[0056] An amount of 270 barrels of diluent, which is a light crude oil of 23 API gravity, was admixed with a previously homogenized mix of 1.3 barrels of tridecyl alcohol of 12 EO groups and 1.3 barrels of methanol in a tank of a pumping truck. The admixture was recirculated in the tank for homogenization and pumped to well CD 36 through the annular space between the

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tubing and the casing. The stimulation fluid of the present invention contacted the gravel pack downhole and passed to about two feet penetration in the formation. The well was closed for a soaking period of 24 hours. The well was restarted thereafter and showed an increased production of about 200 bpd that has been stable for a period of 60 days.

[0057] Another amount of 133 barrels of diluent, a light crude oil of 23 API gravity was admixed with a previously homogenized mix of 0.7 barrels of tridecyl alcohol of 12 EO groups and 0.7 barrels of methanol in a tank of a pumping truck. The admixture was recirculated in the tank for homogenization and pumped to well CD 37 through the annular space between the tubing and the casing. The stimulation fluid of the present invention contacted the gravel pack downhole and passed to about two inches of penetration in the formation. The well was closed for a soaking period of 24 hours. The well was restarted thereafter and showed a production of 80 barrels net of oil per day and has been stable for a period of 60 days thereafter. The net oil production before the stimulation was 24 barrels of net oil.

[0058] These pilot tests establish that the stimulation fluid, or formulation, of the present invention is highly effective at improving hydrocarbon flow and production through porous media treated with fluid. The fluid is made from readily available constituents, and the method can be carried out using known equipment already available for injecting other well stimulation fluids.

[0059] It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modification of form, size, arrangement of parts and details of operation. The invention rather is intended to encompass all

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such modifications which are within its spirit and scope as defined by the claims

We Claim:

1. A combined injection and production method, comprising the steps of:
 - establishing a production well and an injection well into a hydrocarbon-bearing formation;
 - introducing a mixture of a surfactant, a co-surfactant and a carrier fluid into each of the production well and the injection well so that the mixture flows into porous media surrounding the production well and the injection well;
 - holding the mixture in the porous media in the presence of water for a period of time sufficient to form a water film on surfaces of the porous media; and
 - injecting an injection fluid into the injection well while producing from the production well, whereby hydrocarbons flow from the porous media around the injection well toward the production well.
2. The method of claim 1, wherein the surfaces of the porous media prior to treatment with the mixture have hydrocarbons adhered to them, and wherein the water film is formed over the surfaces and the hydrocarbon adhered to the surfaces.
3. The method of claim 1, wherein the porous media is a subterranean hydrocarbon bearing formation containing asphaltene and wherein the asphaltene is adhered to the surfaces of the porous media.
4. The method of claim 3, wherein the hydrocarbon has an API gravity of between 6 and 16.
5. The method of claim 3, wherein the hydrocarbon has an API gravity of between 6 and 12.

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6. The method of claim 1, wherein the surfactant is selected from the group consisting of cationic surfactants, nonionic surfactants, amphoteric surfactants and combinations thereof.

7. The method of claim 1, wherein the co-surfactant is an alcohol co-surfactant.

8. The method of claim 7, wherein the alcohol co-surfactant is selected from the group consisting of methanol, ethanol, propanol, butanol, pentanol, isopropanol, and combinations thereof.

9. The method of claim 1, wherein the carrier fluid is selected from the group consisting of organic solvents, light hydrocarbons, diluents, light crude oil, and combinations thereof, and water.

10. The method of claim 1, wherein the carrier fluid is a light crude oil with an API gravity between 20 to 25.

11. The method of claim 1, wherein the surfactant is an ethoxylated fatty alcohol having between 4 and 60 ethoxylated groups, and wherein the co-surfactant is methanol and/or ethanol.

12. The method of claim 11, wherein the mixture contains substantially equal amounts by volume of surfactant and co surfactant.

13. The method of claim 11, wherein the mixture contains each of the surfactant and the co-surfactant at a concentration of between 0.5 and 10% wt.

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, , , ,

14. The method of claim 11, wherein the mixture contains each of the surfactant and the co-surfactant at a concentration of between 1 and 4% wt.

15. The method of claim 1, wherein the surfaces of the porous media define pore space for the hydrocarbon, and wherein the surfaces are defined by a material selected from quartz, feldspar, siliceous mineral, carbonaceous mineral, clays, and combinations thereof.

ABSTRACT

A combined injection and production method, comprising the steps of: establishing a production well and an injection well into a hydrocarbon-bearing formation; introducing a mixture of a surfactant, a co-surfactant and a carrier fluid into each of the production well and the injection well so that the mixture flows into porous media surrounding the production well and the injection well; holding the mixture in the porous media in the presence of water for a period of time sufficient to form a water film on surfaces of the porous media; and injecting an injection fluid into the injection well while producing from the production well, whereby hydrocarbons flow from the porous media around the injection well toward the production well.

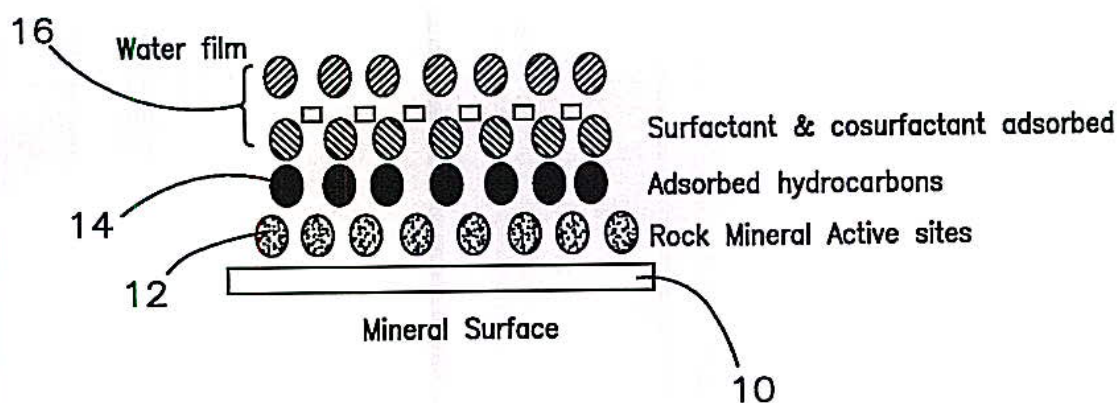


FIG. 1

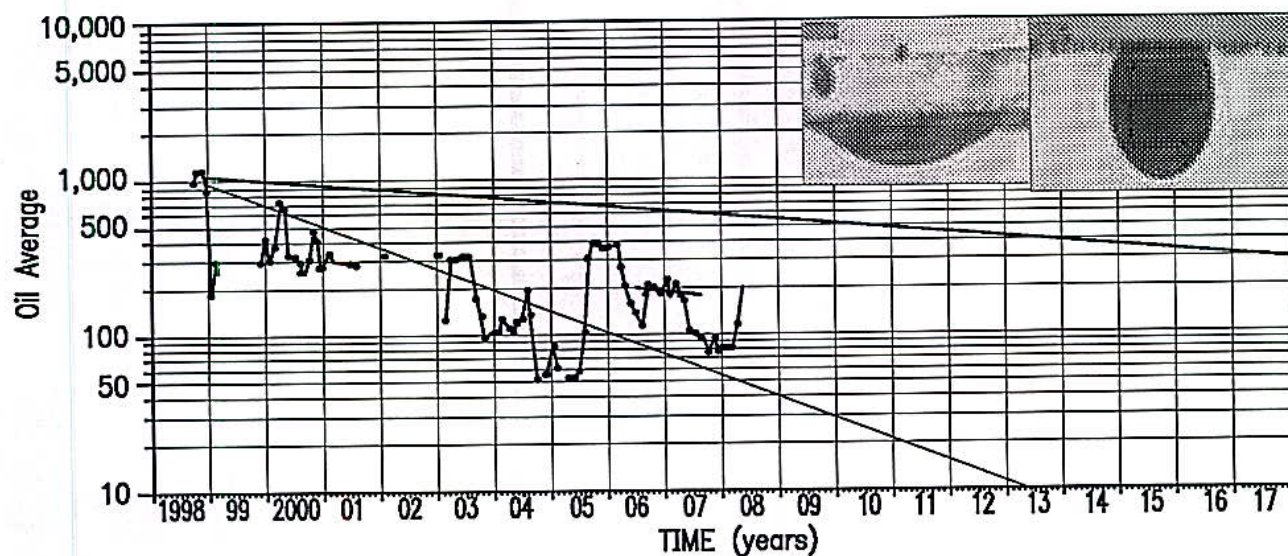


FIG. 2

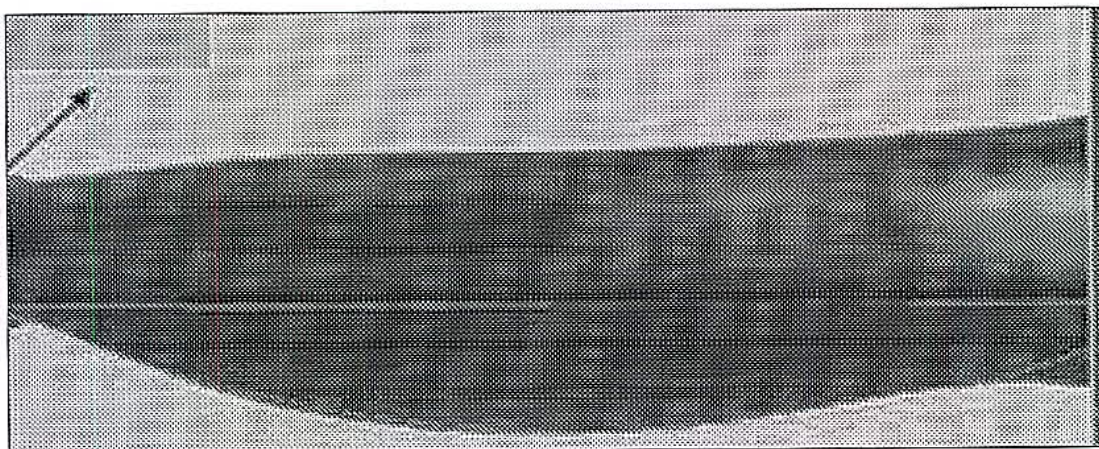


FIG. 3

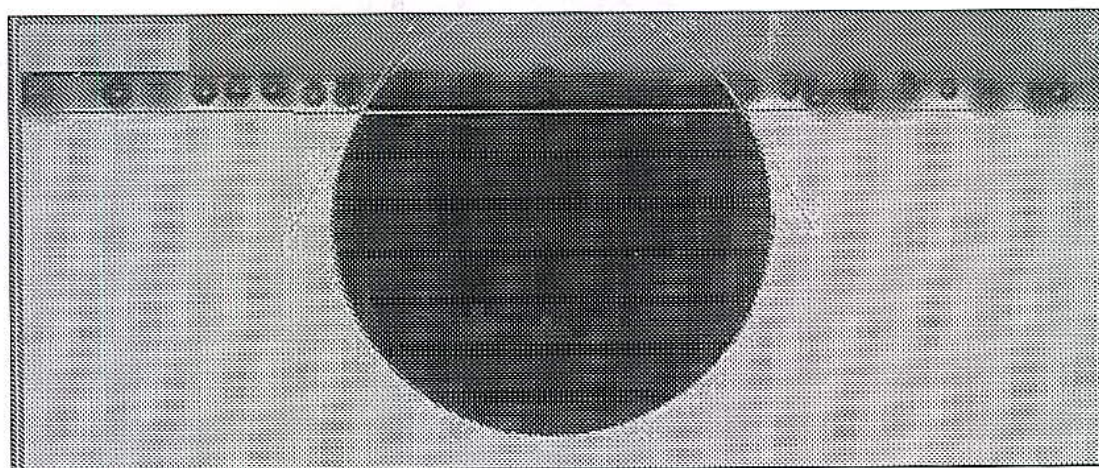


FIG. 4

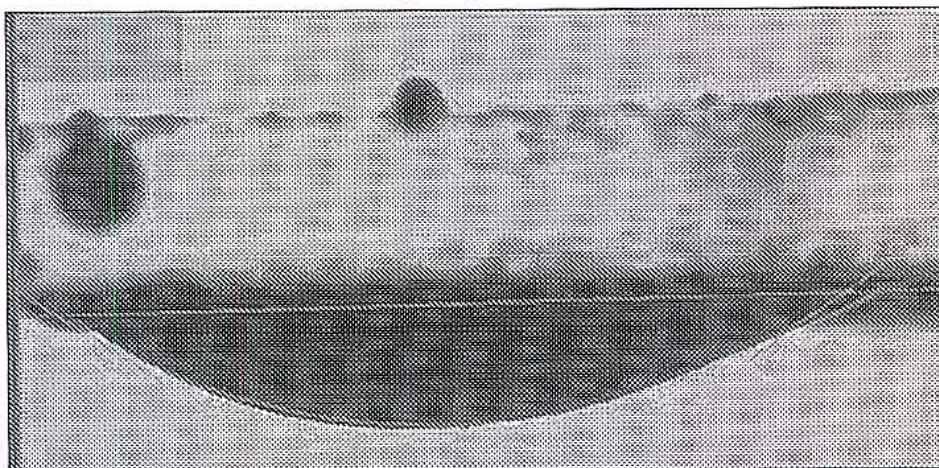


FIG. 5

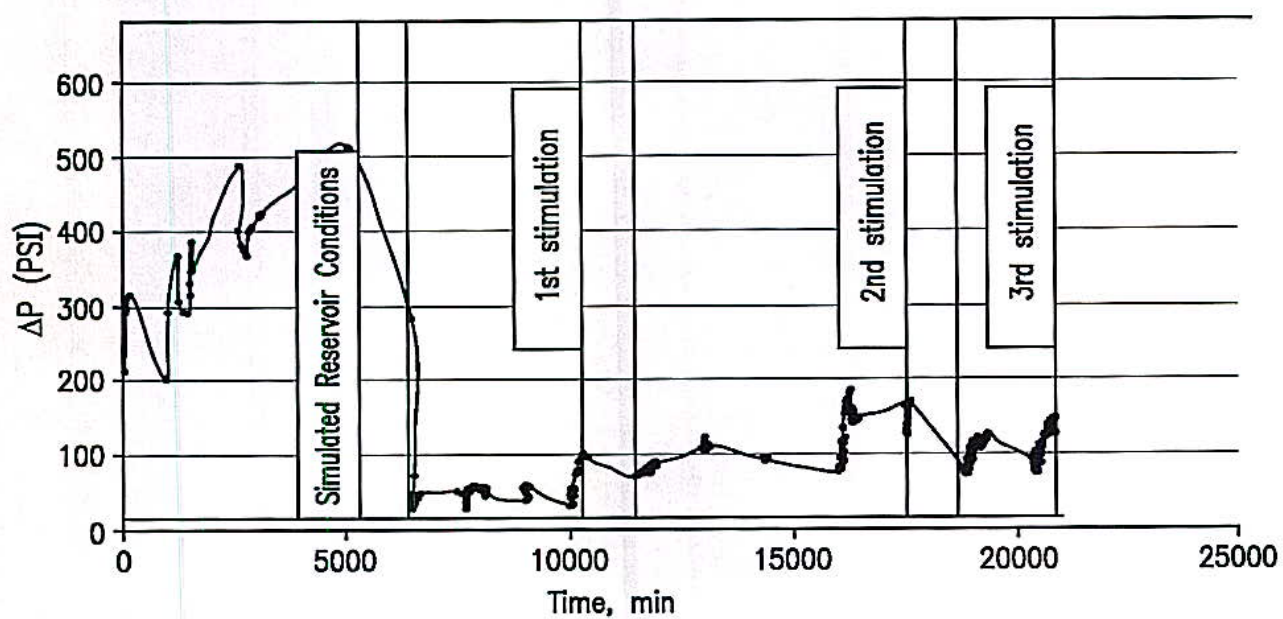


FIG. 6

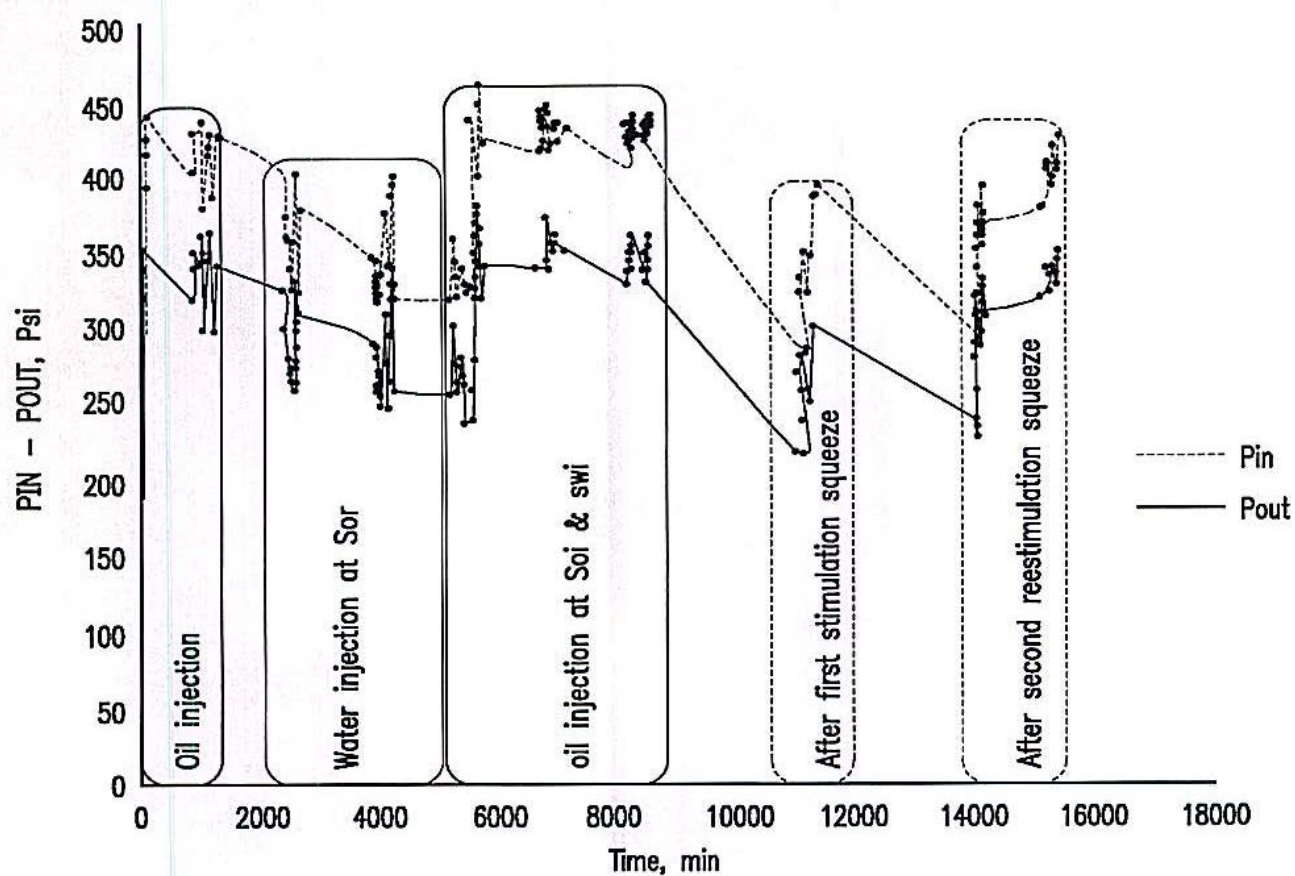


FIG. 7

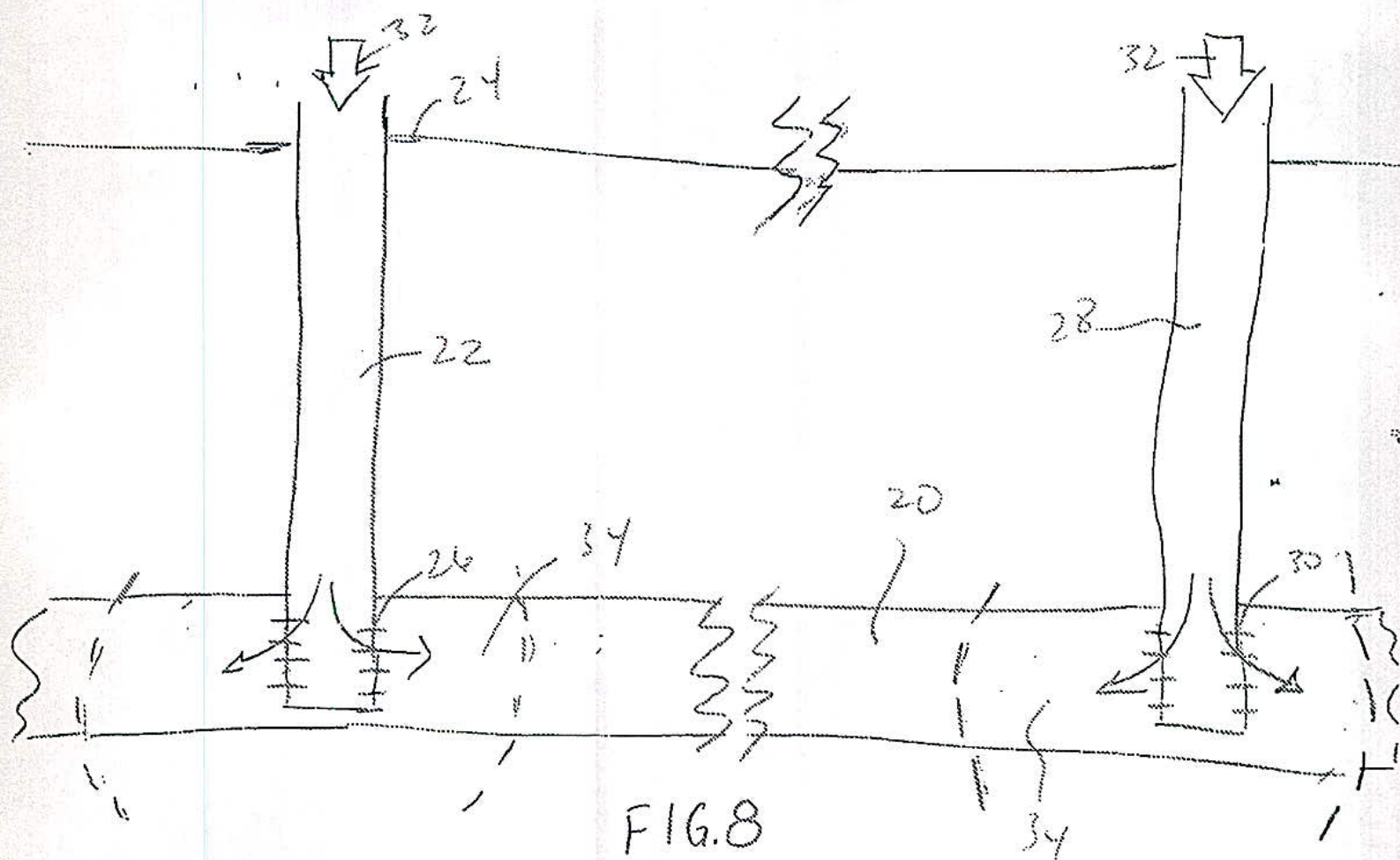


FIG. 8

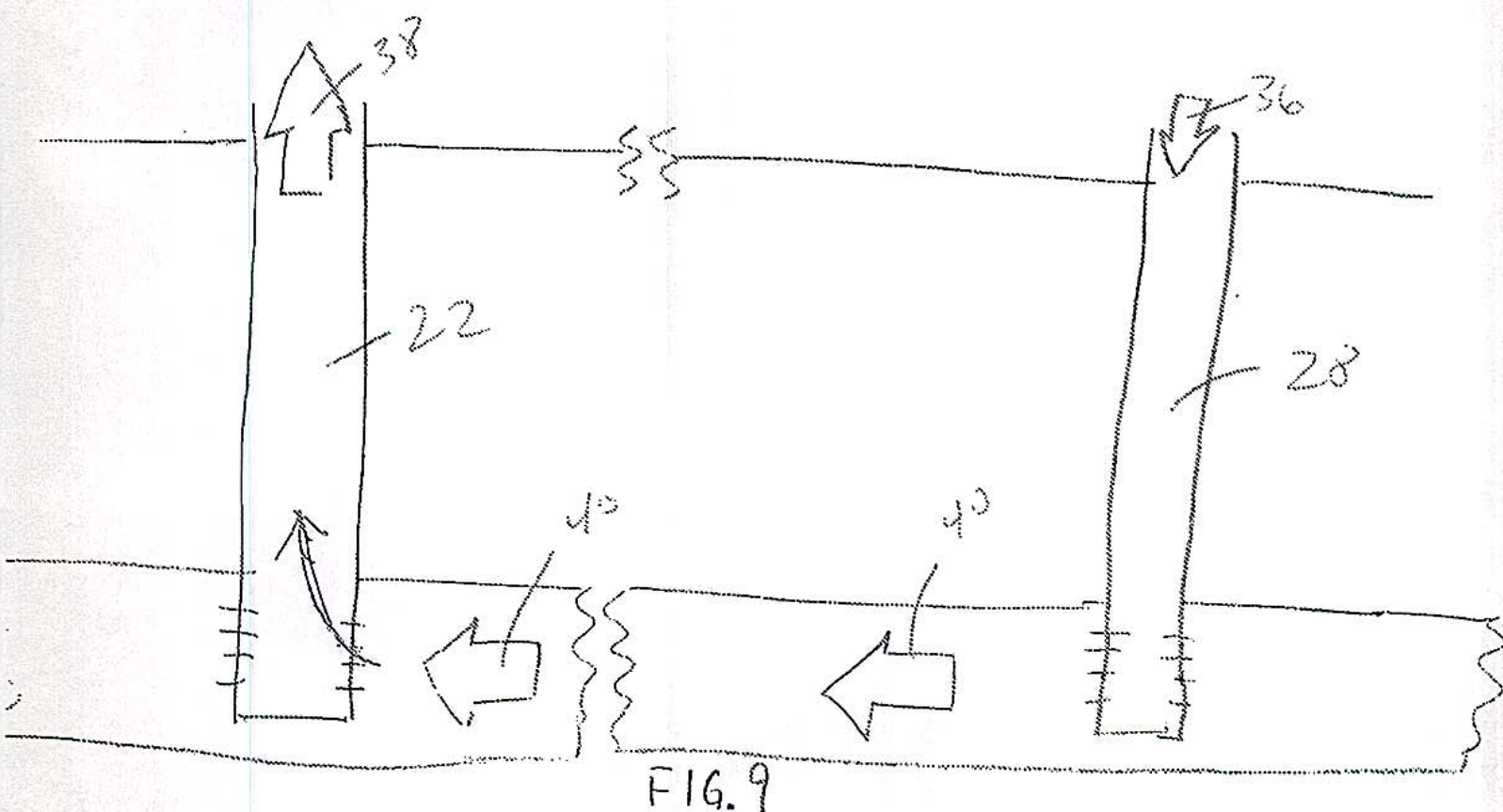


FIG. 9

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11-193
		Application Number	
Title of Invention	FORMULATION AND METHOD OF USE FOR EXPLOITATION OF HEAVY AND EXTRA HEAVY OIL WELLS		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1					Remove
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Prefix	Given Name	Middle Name	Family Name	Suffix	
	Pablo		Manrique		
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service					
City	Caracas	Country Of Residenceⁱ	VE		
Citizenship under 37 CFR 1.41(b) ⁱ		VE			
Mailing Address of Applicant:					
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Address 2		Parque Central			
City	Caracas	State/Province			
Postal Code		Countryⁱ	VE		
					Remove
Applicant 2					
Applicant Authority ☒ Inventor		☐ Legal Representative under 35 U.S.C. 117		☐ Party of Interest under 35 U.S.C. 118	
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	Franklin		Archer		
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service					
City	Caracas	Country Of Residenceⁱ	VE		
Citizenship under 37 CFR 1.41(b) ⁱ		VE			
Mailing Address of Applicant:					
Address 1		Edificio Lagunillas Apto. 9C2, El Valle			
Address 2					
City	Caracas	State/Province			
Postal Code		Countryⁱ	VE		
					Remove
Applicant 3					
Applicant Authority ☒ Inventor		☐ Legal Representative under 35 U.S.C. 117		☐ Party of Interest under 35 U.S.C. 118	
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Maria	Gracia	Araujo		
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service					
City	Barinas	Country Of Residenceⁱ	VE		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11-193	
		Application Number		
Title of Invention	FORMULATION AND METHOD OF USE FOR EXPLOITATION OF HEAVY AND EXTRA HEAVY OIL WELLS			
Citizenship under 37 CFR 1.41(b) i		VE		
Mailing Address of Applicant:				
Address 1		Urb. Raul Leoni, Sector 5 Vereda 23		
Address 2		Casa Nro. 11		
City	Barinas	State/Province		
Postal Code		Countryi	VE	
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add				

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence Information of this application.			
Customer Number	34704		
Email Address	doctet@bachlap.com	Add Email	Remove Email

Application Information:

Title of the Invention	FORMULATION AND METHOD OF USE FOR EXPLOITATION OF HEAVY AND EXTRA HEAVY OIL WELLS		
Attorney Docket Number	11-193	Small Entity Status Claimed	☐
Application Type	Provisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	5	Suggested Figure for Publication (if any)	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ Request Not to Publish. I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11-193
		Application Number	
Title of Invention	FORMULATION AND METHOD OF USE FOR EXPLOITATION OF HEAVY AND EXTRA HEAVY OIL WELLS		
Customer Number	34704		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

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Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

			Remove
Application Number	Country ⁱ	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			☒ Yes ☐ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1		Remove
If the Assignee is an Organization check here. ☒		
Organization Name	Intevep, S.A.	

Mailing Address Information:

Address 1	Apartado 76343		
Address 2			
City	Caracas	State/Province	
Country ⁱ	VE	Postal Code	1070A
Phone Number		Fax Number	
Email Address			

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Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

36

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11-193		
		Application Number			
Title of Invention		FORMULATION AND METHOD OF USE FOR EXPLOITATION OF HEAVY AND EXTRA HEAVY OIL WELLS			
Signature	/george a. coury/			Date (YYYY-MM-DD)	2011-10-20
First Name	George	Last Name	Coury	Registration Number	34309

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



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Enero 10, 2013

LA PRESENTE ES PARA CERTIFICAR QUE ADJUNTO HAY UNA COPIA FIEL DE LOS REGISTROS DE LA OFICINA DE MARCAS Y PATENTES DE AQUELLOS DOCUMENTOS DE LA SOLICITUD DE PATENTE IDENTIFICADA ADELANTE QUE CUMPLE CON LOS REQUERIMIENTOS PARA QUE SE LES OTORQUE UNA FECHA DE PRESENTACIÓN DE CONFORMIDAD CON EL 35 US 111.

NÚMERO DE SOLICITUD:

61/549,631

FECHA DE PRESENTACIÓN:

Octubre 20, 2011

EL CÓDIGO Y NÚMERO DE PAÍS DE SU SOLICITUD DE PRIORIDAD, QUE SE VA A UTILIZAR PARA PRESENTACIÓN EN EL EXTRANJERO DE CONFORMIDAD CON LA CONVENCION DE PARIS, ES US61/549,631



Por la Autoridad del
De conformidad con la Secretaría de
Comercio para la Propiedad Intelectual y el
Director de la Oficina de Marcas y Patentes
de los Estados Unidos

(Aparece firma ilegible)

M. TARVER

Funcionario Certificador

Reivindicamos:

1. Un método de producción e inyección combinados, que comprende las etapas de:

Establecer un pozo de producción y un pozo de inyección en una formación que tiene hidrocarburos;

Introducir una mezcla de un tensoactivo, un cotensoactivo y un fluido portador dentro de cada pozo de producción y pozo de inyección de tal manera que la mezcla fluye en un medio poroso que rodea el pozo de producción y el pozo de inyección;

Mantener la mezcla en el medio poroso en la presencia de agua durante un tiempo suficiente para formar una película de agua sobre las superficies de, medio poroso; e

Inyectar un fluido de inyección en un pozo de inyección mientras hay producción del pozo de producción, con lo cual los hidrocarburos fluyen desde el medio poroso alrededor del pozo de inyección hacia el pozo de producción.

2. El método de la reivindicación 1, en donde las superficies del medio poroso antes de tratamiento con la mezcla que tiene hidrocarburos adheridos a ellos, y en donde la película de agua se forma sobre las superficies y el hidrocarburo adherido a las superficies.

3. El método de la reivindicación 1, en donde el medio poroso es un hidrocarburo subterráneo que tiene la formación que contiene asfalteno y en donde el asfalteno se adhiere a las superficies del medio poroso.
4. El método de la reivindicación 3, en donde los hidrocarburos tienen una gravedad API de entre 6 y 16.
5. El método de la reivindicación 3, en donde los hidrocarburos tienen una gravedad API de entre 6 y 12.
6. El método de la reivindicación 1, en donde el tensoactivo se selecciona del grupo que consiste de tensoactivos catiónicos, tensoactivos no iónicos, tensoactivos anfotéricos y combinaciones de los mismos.
7. El método de la reivindicación 1, en donde el cotensoactivo es un cotensoactivo alcohol.
8. El método de la reivindicación 7, en donde el cotensoactivo alcohol se selecciona del grupo que consiste de metanol, etanol, propanol, butanol, pentanol, isopropanol, y combinaciones de los mismos.
9. El método de la reivindicación 1, en donde el fluido portador se selecciona del grupo que consiste de solventes orgánicos, hidrocarburos livianos, diluyentes, petróleo crudo ligero, y combinaciones de los mismos, y agua.

- 4/
10. El método de la reivindicación 1, en donde el fluido portador es un petróleo crudo ligero con una gravedad API de entre 20 a 25.
 11. El método de la reivindicación 1, en donde el tensoactivo es un alcohol graso etoxilado que tiene entre 4 y 60 grupos etoxilados, y en donde el cotensoactivo es metanol y/o etanol.
 12. El método de la reivindicación 11, en donde la mezcla contiene cantidades sustancialmente iguales por volumen de tensoactivo y cotensoactivo.
 13. El método de la reivindicación 11, en donde la mezcla contiene cada uno de tensoactivo y cotensoactivo en una concentración de entre 0.5 y 10% en peso.
 14. El método de la reivindicación 11, en donde la mezcla contiene cada uno del tensoactivo y cotensoactivo de una concentración de entre 1 y 4%.
 15. El método de la reivindicación 1, en donde los tensoactivos del medio poroso definen un espacio de poro para el hidrocarburo, y en donde las superficies se definen por el material seleccionado de cuarzo, feldespatos, minerales silíceos, mineral carbonáceo, arcillas y combinaciones de los mismos.