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(54) Title: Y-GRADE NGL STEAM ASSISTED GRAVITY DRAINAGE

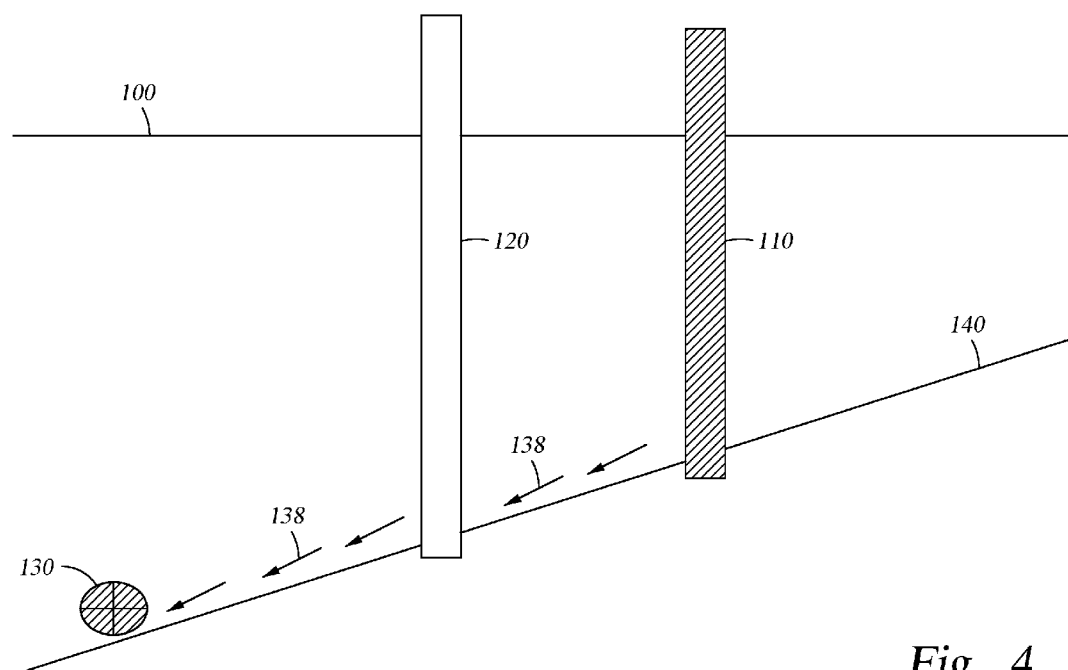


Fig. 4

(57) Abstract: A method of recovering hydrocarbons from a (non-bitumen) heavy crude oil bearing reservoir with structural relief uses the combination of Y-Grade NGL and steam assisted gravity drainage. The method includes injecting steam and Y-Grade NGL into the reservoir through a vertical injection wellbore (110,120), displacing hydrocarbons within the reservoir using a combination of the steam, the unfractionated hydrocarbon mixture, and gravity drainage, and then producing the displaced hydrocarbons from the reservoir through a horizontal production wellbore (130) that is positioned structurally lower than and offset from the vertical injection wellbore (110,120).



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MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
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Y-GRADE NGL STEAM ASSISTED GRAVITY DRAINAGE

BACKGROUND

FIELD

[0001] Embodiments of the disclosure relate to thermally-enhanced primary, secondary, and tertiary oil recovery methods by combining steam assisted gravity drainage (SAGD) technology with solvent extraction and dilution utilizing an unfractionated hydrocarbon mixture in heavy crude oil bearing reservoirs.

DESCRIPTION OF THE RELATED ART

[0002] Hydrocarbon recovery can be enhanced in certain heavy crude oil bearing reservoirs by drilling closely spaced vertical wellbores and injecting steam into the reservoir. The steam causes the hydrocarbons to become mobile due to the reduction of their in-situ viscosity, which can then be produced through the same vertical wellbores. Although hydrocarbon recovery is much improved using conventional enhanced recovery techniques, large portions of hydrocarbons still remain in the reservoirs.

[0003] There is a need for economically valuable methods to recover heavy crude oil from non-bitumen, hydrocarbon bearing reservoirs with structural relief.

SUMMARY

[0004] In one embodiment, a method of recovering hydrocarbons from a non-bitumen, hydrocarbon bearing reservoir with structural relief comprises injecting steam and an unfractionated hydrocarbon mixture through a vertical injection wellbore and into the reservoir to form a steam chamber; displacing hydrocarbons within the reservoir using a combination of the steam, the unfractionated hydrocarbon mixture, and gravity drainage; and producing the displaced hydrocarbons from the reservoir through a horizontal production wellbore that is positioned structurally lower than and offset from the vertical injection wellbore.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 is a graph illustrating the relationship between viscosity and temperature for a heavy crude oil.

[0006] Figure 2 is a graph illustrating the relationship between molecular weight, mean average boiling point, and API gravity for heavy crude oil and bitumen.

[0007] Figure 3 is a schematic illustration of a vertical section (end view) of a steam chamber and mobilization of hydrocarbons via gravity drainage with horizontal injection and production wellbores.

[0008] Figure 4 is a schematic illustration of a vertical section (end view) of an array of offset vertical injection and horizontal production wellbores.

[0009] Figure 5 is a schematic illustration of a plan section (top view) of the array of offset vertical injection wellbores and horizontal production wellbores shown in Figure 4.

[0010] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements disclosed in one embodiment may be beneficially utilized on other embodiments without specific recitation.

DETAILED DESCRIPTION

[0011] Embodiments of the disclosure include a method for exploiting shallow (e.g. at a depth that can be mined), non-bitumen, hydrocarbon bearing reservoirs with structural relief (e.g. having a dip or an angle) under primary, secondary, and/or tertiary recovery by injecting high quality steam and an unfractionated hydrocarbon mixture into the hydrocarbon bearing reservoirs to mobilize in-situ heavy crude oil hydrocarbons via gravity drainage, solvent extraction, and/or dilution.

[0012] Y-Grade natural gas liquids (herein after referred to as Y-Grade NGL) is an un-fractionated hydrocarbon mixture comprising ethane, propane, butane,

isobutane, and pentane plus. Pentane plus comprises pentane, isopentane, and/or heavier weight hydrocarbons, for example hydrocarbon compounds containing at least one of C5 through C8+. Pentane plus may include natural gasoline for example.

[0013] Typically, Y-Grade NGL is a by-product of de-methanized hydrocarbon streams that are produced from shale wells and transported to a centralized facility. Y-Grade NGL can be locally sourced from a splitter facility, a gas plant, and/or a refinery and transported by truck or pipeline to a point of use. In its un-fractionated or natural state (under certain pressures and temperatures, for example within a range of 250-600 psig and at wellhead or ambient temperature), Y-Grade NGL has no dedicated market or known use. Y-Grade NGL must undergo processing before its true value is proven.

[0014] The Y-Grade NGL composition can be customized for handling as a liquid under various conditions. Since the ethane content of Y-Grade NGL affects the vapor pressure, the ethane content can be adjusted as necessary. According to one example, Y-Grade NGL may be processed to have a low ethane content, such as an ethane content within a range of 3-12 percent, to allow the Y-Grade NGL to be transported as a liquid in low pressure storage vessels. According to another example, Y-Grade NGL may be processed to have a high ethane content, such as an ethane content within a range of 38-60 percent, to allow the Y-Grade NGL to be transported as a liquid in high pressure pipelines.

[0015] Y-Grade NGL differs from liquefied petroleum gas ("LPG"). One difference is that LPG is a fractionated product comprised of primarily propane, or a mixture of fractionated products comprised of propane and butane. Another difference is that LPG is a fractionated hydrocarbon mixture, whereas Y-Grade NGL is an unfractionated hydrocarbon mixture. Another difference is that LPG is produced in a fractionation facility via a fractionation train, whereas Y-Grade NGL can be obtained from a splitter facility, a gas plant, and/or a refinery. A further difference is that LPG is a pure product with the exact same composition, whereas Y-Grade NGL can have a variable composition.

[0016] In its unfractionated state, Y-Grade NGL is not an NGL purity product and is not a mixture formed by combining one or more NGL purity products. An NGL purity product is defined as an NGL stream having at least 90% of one type of carbon molecule. The five recognized NGL purity products are ethane (C2), propane (C3), normal butane (NC4), isobutane (IC4) and natural gasoline (C5+). The unfractionated hydrocarbon mixture must be sent to a fractionation facility, where it is cryogenically cooled and passed through a fractionation train that consists of a series of distillation towers, referred to as deethanizers, depropanizers, and debutanizers, to fractionate out NGL purity products from the unfractionated hydrocarbon mixture. Each distillation tower generates an NGL purity product. Liquefied petroleum gas is an NGL purity product comprising only propane, or a mixture of two or more NGL purity products, such as propane and butane. Liquefied petroleum gas is therefore a fractionated hydrocarbon or a fractionated hydrocarbon mixture.

[0017] In one embodiment, Y-Grade NGL comprises 30-80%, such as 40-60%, for example 43%, ethane, 15-45%, such as 20-35%, for example 27%, propane, 5-10%, for example 7%, normal butane, 5-40%, such as 10-25%, for example 10%, isobutane, and 5-25%, such as 10-20%, for example 13%, pentane plus. Methane is typically less than 1%, such as less than 0.5% by liquid volume.

[0018] In one embodiment, Y-Grade NGL comprises dehydrated, desulfurized wellhead gas condensed components that have a vapor pressure of not more than about 600 psig at 100 degrees Fahrenheit (°F), with aromatics below about 1 weight percent, and olefins below about 1% by liquid volume. Materials and streams useful for the embodiments described herein typically include hydrocarbons with melting points below about 0 degrees Fahrenheit (°F).

[0019] Heavy crude oil is defined as hydrocarbons having an API gravity less than about 22.3 degrees but greater than about 10 degrees. Heavy crude oil contains heavy molecular components such as asphaltenes and aromatics due to the selective removal of lighter compounds during the degradation process. Heavy crude oil is also defined as hydrocarbons having a viscosity within a range of about

50 centipoise to about 10,000 centipoise at standard (e.g. atmospheric) conditions. As viscosity increases above 1,000 centipoise, hydrocarbons become nearly immobile.

[0020] Bitumen is an immobile, sticky and tar-like form of petroleum which is so thick and heavy that it must be heated or diluted before it will flow. At room temperature, it is much like cold molasses. Bitumen is typically defined as having an API gravity of less than 10 degrees and a viscosity greater than 100,000 centipoise. Refined bitumen is the residual (or bottom) fraction obtained by fractional distillation of crude oil. Refined bitumen is the heaviest fraction of crude oil and has the highest boiling point, e.g. a boiling point at about 525 degrees Celsius (about 977 degrees Fahrenheit). Most bitumen contains sulfur and several heavy metals such as nickel, vanadium, lead, chromium, mercury, arsenic, selenium, and other toxic elements. Bitumen is the prime feed stock for petroleum production from tar sands currently under development in Canada.

[0021] Outside of Canada, a different form of enhanced oil recovery can be employed to extract non-bitumen deposits according to embodiments of this disclosure. Heavy crude oils are known to exist in certain hydrocarbon bearing reservoirs with structural relief, such as in California, Indonesia, Venezuela, and other locations. A combination of closely spaced up dip vertical steam injection wellbores offset by down dip horizontal production wellbores can be used to build upon the natural gravity drainage that occurs in reservoirs with structural relief.

[0022] The benefits of steam assisted gravity drainage over conventional vertical thermal processes are as follows:

[0023] Higher oil productivity relative to the number of wellbores employed. A horizontal wellbore has a substantially larger cross-sectional area open to flow as compared to a vertical wellbore and therefore a higher productivity rate may be achieved. In addition, as a consequence of the oil being steadily produced at essentially steam temperature, high oil mobility is maintained. This is contrasted to

vertical wellbores, where oil temperature decreases with distance, causing a decrease in mobility over time.

[0024] Higher volumes of oil produced per volumes of steam injected. The concentration of production within the steam chamber minimizes heat losses to the overlying and underlying strata. In addition, the concentration of heat applies to the entire oil column. In a vertical wellbore process, there is a tendency for heat to be more widely diffused in the oil zone, diminishing possible oil production temperatures.

[0025] Higher ultimate recovery of oil-in-place. The steam assisted gravity drainage process establishes high areal and vertical conformance via the high surface area of the horizontal wellbores in contact with the reservoir and via the superior recovery of oil through the gravity drainage mechanism.

[0026] Minimization of both wellbore interference and early linkup between wellbores. Vertical wellbore systems, displacement processes, and the multi-wellbore cyclic steam stimulation process can all create poor conformance because of the high mobility contrast between oil and steam. Undesirable steam production from the production wellbore is a common result. The steam assisted gravity drainage process balances the injection of steam with the production of liquids over a localized region of the reservoir. As a consequence, pressure and temperature transients are minimized, as is the interference between wellbores.

[0027] Reduced sand production. Due to the large surface area open to flow in the horizontal production wellbore, the fluid velocities in the near-wellbore region are reduced as compared to a vertical production wellbore.

[0028] Steam assisted gravity drainage is a thermal recovery process normally used for immobile oil from bitumen deposits. Typically, two horizontally drilled wellbores are placed in close proximity and directly overlying each other, one for injection of heated fluid and one for production of liquids (as shown in Figure 3 described below). Thermal communication is established between the horizontal wellbores and they are operated to ensure that heated mobilized oil and steam flow

without substantially mixing. Oil drains continuously by gravity to the horizontal production well where it is recovered. This method of steam assisted gravity drainage is most appropriate for bitumen reservoirs.

[0029] Heavy crude oil bearing reservoirs with structural relief were originally developed with vertical wellbores operating under cyclic steaming operations. However, according to the embodiments of this disclosure, steam assisted gravity drainage can be established in these heavy crude oil bearing reservoirs with structural relief by drilling horizontal production wellbores that are offset from and down dip to the existing vertical injection wellbores, which are converted to continuous steam injection wellbores (as shown in Figures 4 and 5). Heavy crude oil that is mobilized by the heated fluid flows down dip under the effect of gravity drainage toward the horizontal production wellbore, which is placed near the base of the heavy crude oil bearing reservoir. This method of steam assisted gravity drainage and vertical/horizontal wellbore placement is not appropriate for bitumen reservoirs.

[0030] Figure 1 is a graph that shows the relationship between viscosity and temperature for a heavy crude oil having an API gravity of about 18 degrees. The processes described in Figure 4 and Figure 5 apply to heavy crude oil with in-situ viscosities that can be reduced to less than about 300 centipoise (or less than about 150 centipoise) using a combination of steam assisted gravity drainage and an unfractionated hydrocarbon mixture, such as Y-Grade NGL.

[0031] Figure 2 is a graph that shows the relationship between molecular weight (MW), mean average boiling point (Mean Avg. B.P.), and API gravity. The cross hatched area 210 is the Mean Avg. B.P. range for bitumen, which has an API gravity less than about 10 degrees. The cross hatched area 220 is the Mean Avg. B.P. range for heavy crude oil, which has an API gravity greater than about 10 degrees, and in particular within a range of about 25 degrees to about 10 degrees.

[0032] Figure 3 is a schematic illustration of a vertical section (end view) of a bitumen reservoir 10 without any structural relief through which a horizontal injection

wellbore 20 and a horizontal production wellbore 30 are disposed. The horizontal production wellbore 30 is located under and in close proximity to the horizontal injection wellbore 20. Steam from the surface is injected through the horizontal injection wellbore 20 into the bitumen reservoir 10 where the steam expands upward and outward to form a steam chamber 35. The ceiling of the bitumen reservoir 10 acts as a partial flow boundary to heat flow. The expanding steam chamber 35 mobilizes adjacent bitumen at the ceiling of the bitumen reservoir 10 and causes the bitumen and steam to condense along a wall 36 of the steam chamber 35. Gravity drainage causes the condensed mixture of bitumen and water (identified by reference arrows 38) to flow downward to the base of the bitumen reservoir 10 where it is recovered from the horizontal production wellbore 30 that is located near the base 40 of the bitumen reservoir 10.

[0033] Figure 4 is a schematic illustration of a vertical section (end view) of a (non-bitumen) heavy crude oil bearing reservoir 100 with a structural relief 140 and having an array of offset vertical injection wellbores 110, 120 and a horizontal production wellbore 130 that is located structurally lower than and offset from the vertical injection wellbores 110, 120. Although only one horizontal production wellbore 130 is shown, the embodiments described herein may include an array of horizontal production wellbores 130 located structurally lower than and offset from the vertical injection wellbores 110, 120.

[0034] In one embodiment, the average permeability of the reservoir 100 is greater than about 50 millidarcies. In one embodiment, the reservoir 100 has a thickness greater than 30 feet. In one embodiment, the reservoir 100 may be located at a depth that can be mined from the surface.

[0035] High quality steam and an unfractionated hydrocarbon mixture from the surface are injected through the vertical injection wellbores 110, 120 and into the heavy crude oil bearing reservoir 100. The steam and the unfractionated hydrocarbon mixture are simultaneously and continuously co-injected into the reservoir 100. In one embodiment, the unfractionated hydrocarbon mixture may be periodically injected into the reservoir 100 with the steam or alternately injected into

the reservoir 100 with the steam. In one embodiment, carbon dioxide and/or nitrogen may be simultaneously, periodically, and/or alternately injected into the reservoir 100 with at least one of the unfractionated hydrocarbon mixture and the steam.

[0036] The steam and unfractionated hydrocarbon mixture rise vertically toward the top of the reservoir 100 to form a steam chamber (similar to steam chamber 35 shown in Figure 2). The vertical injection wellbores 110, 120 are located at an upper portion of a dip of the structural relief 140 relative to the horizontal production wellbore 130 to minimize the possibility of accidentally coning steam downward. Accidental steam breakthrough into the horizontal production wellbore 130 can reduce the recovery from the reservoir 100 and lead to the increase of thermal recovery operating costs. In one embodiment, the dip of the structural relief 140 may have an angle within a range of about 5 degrees to about 20 degrees or more.

[0037] Mobilized hydrocarbons, the steam, and/or the unfractionated hydrocarbon mixture condense along the steam chamber walls, flow downward along the steam chamber walls, and collect near the base of and/or below the vertical injection wellbores 110, 120. The condensed mixture (identified by reference arrows 138) flows down along the structural relief 140 toward the horizontal production wellbore 130 due to the effect of gravity drainage, solvent extraction, and/or dilution and is recovered through the horizontal production wellbore 130. The horizontal production wellbore 130 is located as close to the base of the structural relief 140 of the reservoir 100 as is practical to maximize the recovery of hydrocarbons. The production of hydrocarbons from the horizontal production wellbore 130 may be monitored so that the injection rate of at least one of the steam and the unfractionated hydrocarbon mixture into the reservoir 100 can be adjusted as necessary to optimize hydrocarbon production.

[0038] Figure 5 is a schematic illustration of a plan view of the (non-bitumen) heavy crude oil bearing reservoir 100 having the array of offset vertical injection wellbores 110, 120 and the horizontal production wellbore 130. The condensed mixture (identified by reference arrows 138) flows downward along the structural

relief 140 due to the effect of gravity drainage, solvent extraction, and/or dilution toward the horizontal production wellbore 130 where it is recovered to the surface. The steam and/or the unfractionated hydrocarbon mixture reduce the viscosity of the heavy crude oil in the reservoir 100 (for example, to less than about 300 centipoise or less than about 150 centipoise, at reservoir conditions) so that it can flow down the structural relief 140 toward the horizontal production wellbore 130. The steam and/or the unfractionated hydrocarbon mixture increase the API gravity of the heavy crude oil in the reservoir 100 so that it can flow down the structural relief 140 toward the horizontal production wellbore 130.

[0039] In one embodiment, the unfractionated hydrocarbon mixture is continuously co-injected with steam through vertical injection wellbores 110, 120 into the reservoir 100 having the structural relief 140 to maintain or increase reservoir pressure, strip lighter ends from the heavy crude oil, act as a solvent and diluent, supply additional reservoir energy, and/or help to reduce steam temperature loss to the overburden formation. The unfractionated hydrocarbon mixture may also provide gas drive to flush the diluted hydrocarbons out through the horizontal production wellbore 130 located down dip of the vertical injection wellbores 110, 120.

[0040] When the unfractionated hydrocarbon mixture is co-injected with steam into the (non-bitumen) heavy crude oil bearing reservoir with structural relief, the unfractionated hydrocarbon mixture acts as a solvent and condenses with steam at the boundary of the steam chamber. As the solvent condenses, the viscosity of the hydrocarbons at the steam-hydrocarbon interface decrease. As the steam front advances, further heating the reservoir, the condensed solvent evaporates and the condensation-evaporation mechanism provides an additional driving force due to the expanded volume of the solvent as a result of the phase change. The combination of reduced viscosity and the condensation-evaporation driving force increase mobility of the hydrocarbons to the down dip of the structural relief to the horizontal production wellbore.

[0041] The condensed solvent dilutes the heavy crude oil and reduces its viscosity in conjunction with heat from the condensed steam. This process offers higher hydrocarbon production rates and recovery with less energy and water consumption than a steam assisted gravity drainage process alone. This process also uses less amounts of solvent than a vapor extraction (VAPEX) process, which does not use steam and relies on pure solvent injection. This process, which combines solvent dilution and heat, reduces heavy crude oil viscosity much more effectively than using heat alone.

[0042] An additional benefit of the unfractionated hydrocarbon mixture and steam co-injection is that the gaseous phase accumulates up dip at the top of the steam chamber creating an insulating effect by reducing the partial pressure of the steam and associated temperature of the steam chamber. The drop in temperature at the top of the steam chamber reduces the temperature difference between the steam chamber and the overburden, which reduces the volume of steam that condenses against the overburden and minimizes the heat lost to the non-oil bearing rock, thereby reducing the steam to oil (SOR) within the reservoir.

[0043] Additional benefits of the unfractionated hydrocarbon mixture and steam co-injection is gas transportation toward the horizontal production wellbore, which results in dissolution of gas within the draining hydrocarbons and condensed steam; a drag force on the gas from hydrocarbons draining down the walls of the steam chamber; and gas moving within the steam chamber from higher-pressure to lower pressure regions or gas sweep.

[0044] While the foregoing is directed to certain embodiments, other and further embodiments may be devised without departing from the basic scope of this disclosure.

We claim:

1. A method of recovering hydrocarbons from a non-bitumen, hydrocarbon bearing reservoir with structural relief, comprising:
 - injecting steam and an unfractionated hydrocarbon mixture through a vertical injection wellbore and into the reservoir to form a steam chamber;
 - displacing hydrocarbons within the reservoir using a combination of the steam, the unfractionated hydrocarbon mixture, and gravity drainage; and
 - producing the displaced hydrocarbons from the reservoir through a horizontal production wellbore that is positioned structurally lower than and offset from the vertical injection wellbore.
2. The method of claim 1, wherein the hydrocarbons within the reservoir comprise heavy crude oil.
3. The method of claim 1, wherein the reservoir has a thickness greater than 30 feet.
4. The method of claim 1, further comprising displacing the hydrocarbons by reducing the viscosity of the hydrocarbons to less than about 300 centipoise at reservoir conditions.
5. The method of claim 1, wherein the average permeability of the reservoir is greater than about 50 millidarcies.
6. The method of claim 1, wherein the unfractionated hydrocarbon mixture comprises Y-Grade NGL.
7. The method of claim 1, wherein the unfractionated hydrocarbon mixture is injected periodically into the reservoir with steam.

8. The method of claim 1, wherein the unfractionated hydrocarbon mixture is injected simultaneously into the reservoir with steam.
9. The method of claim 1, further comprising increasing pressure within the reservoir by the injection of the steam and the unfractionated hydrocarbon mixture.
10. The method of claim 1, further comprising increasing the API gravity of the hydrocarbons within the reservoir by the injection of the steam and the unfractionated hydrocarbon mixture.
11. The method of claim 1, further comprising reducing the viscosity of the hydrocarbons within the reservoir by the injection of the steam and the unfractionated hydrocarbon mixture.
12. The method of claim 1, further comprising reducing the steam to oil ratio (SOR) within the reservoir by the injection of the steam and the unfractionated hydrocarbon mixture.
13. The method of claim 1, further comprising injecting carbon dioxide with the unfractionated hydrocarbon mixture through the vertical injection wellbore and into the reservoir.
14. The method of claim 1, further comprising injecting nitrogen with the unfractionated hydrocarbon mixture through the vertical injection wellbore and into the reservoir.
15. The method of claim 1, further comprising monitoring the production of hydrocarbons from the horizontal production wellbore and adjusting the injection rate of at least one of the steam and the unfractionated hydrocarbon mixture into the reservoir to optimize hydrocarbon production.

16. The method of claim 1, wherein the hydrocarbons within the reservoir have an API gravity within a range of about 25 degrees to about 10 degrees.

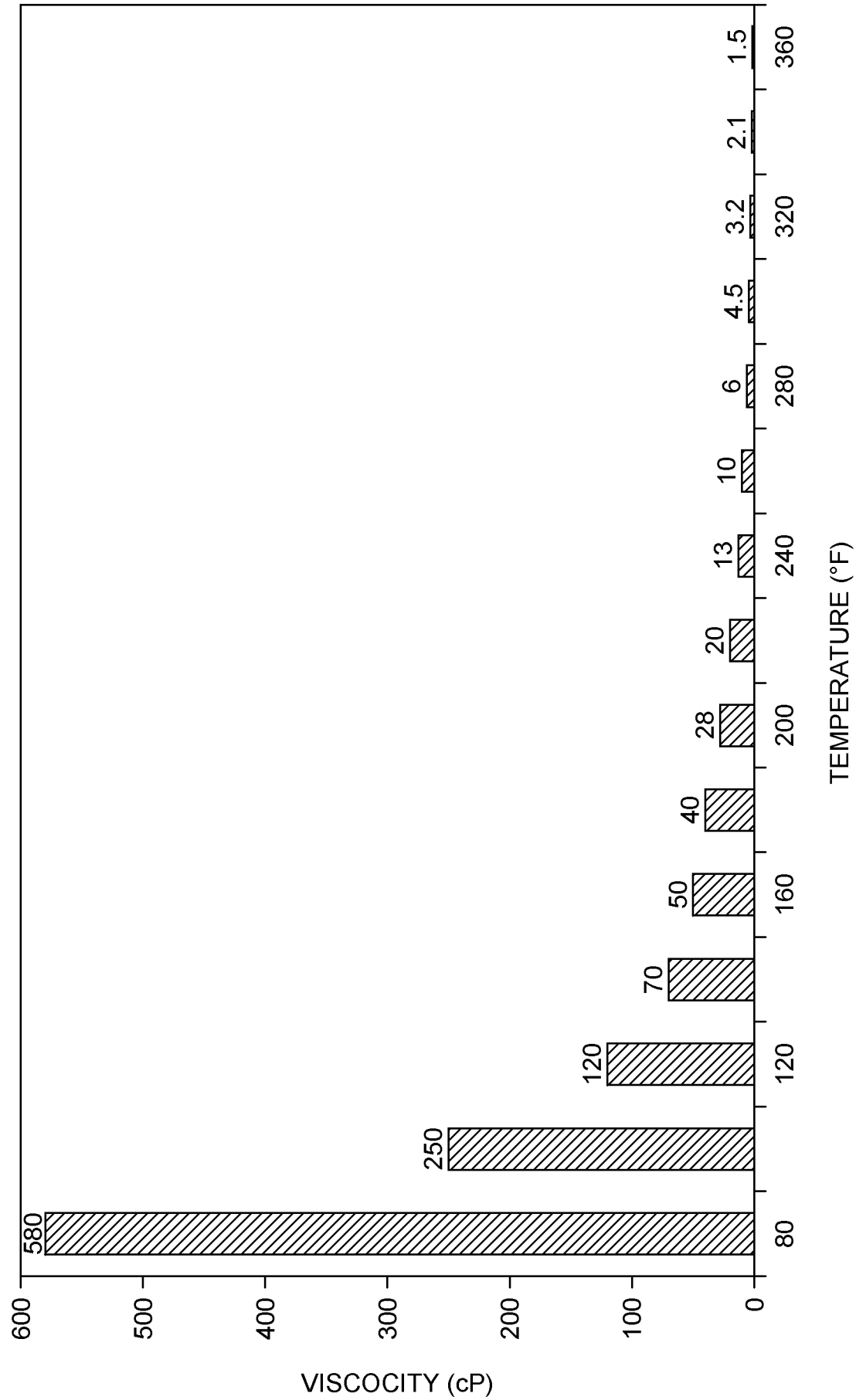


Fig. 1

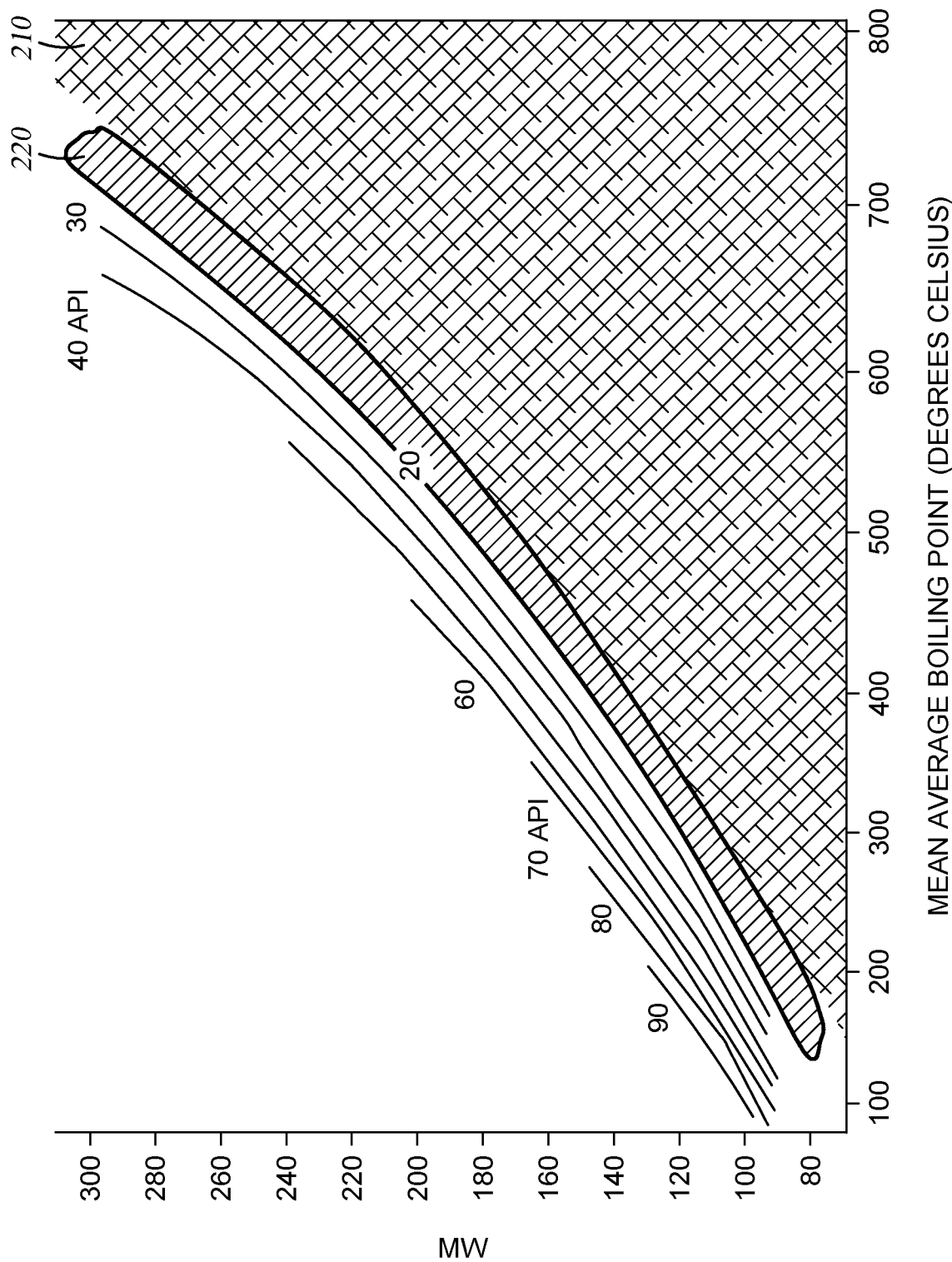


Fig. 2

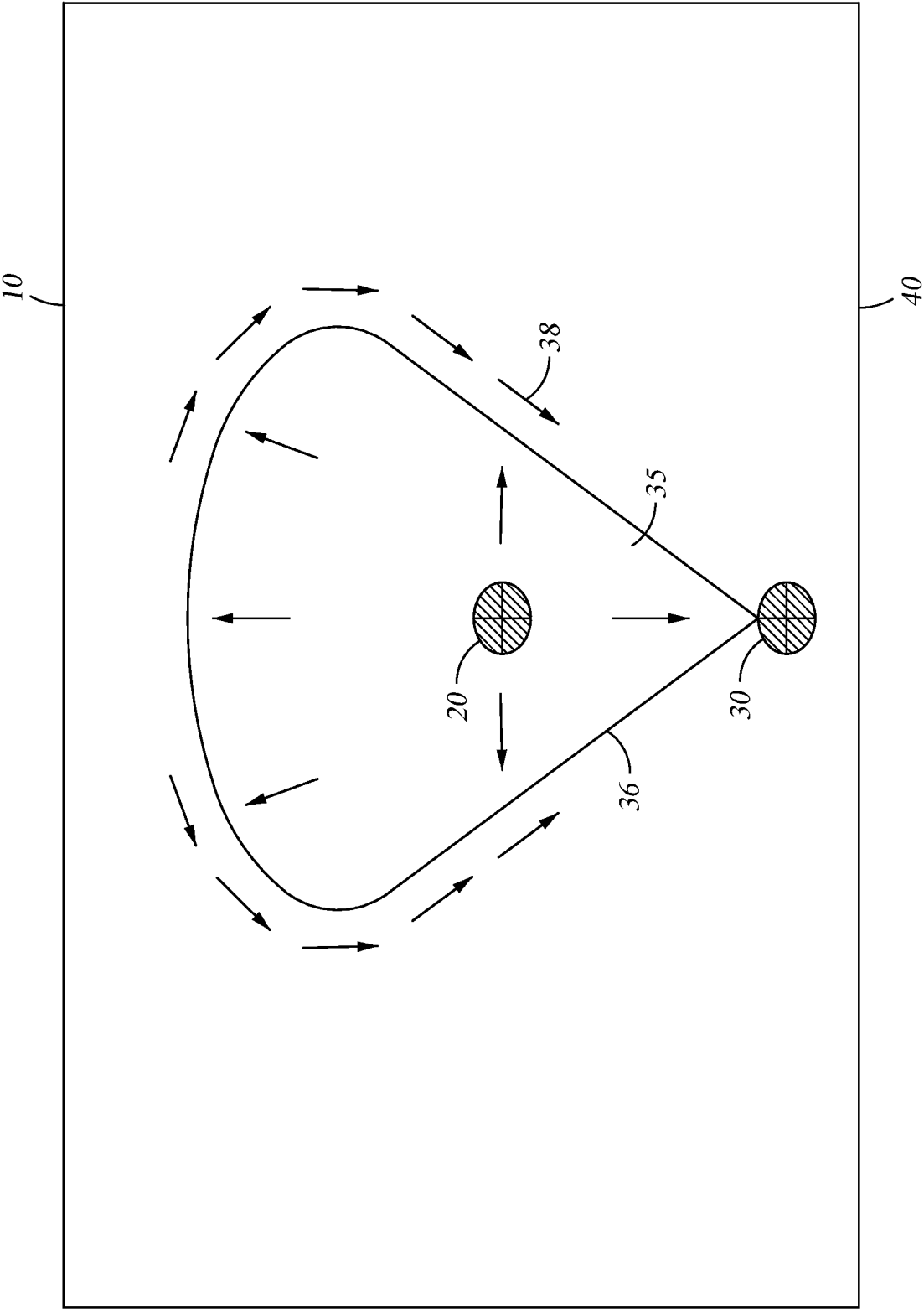


Fig. 3

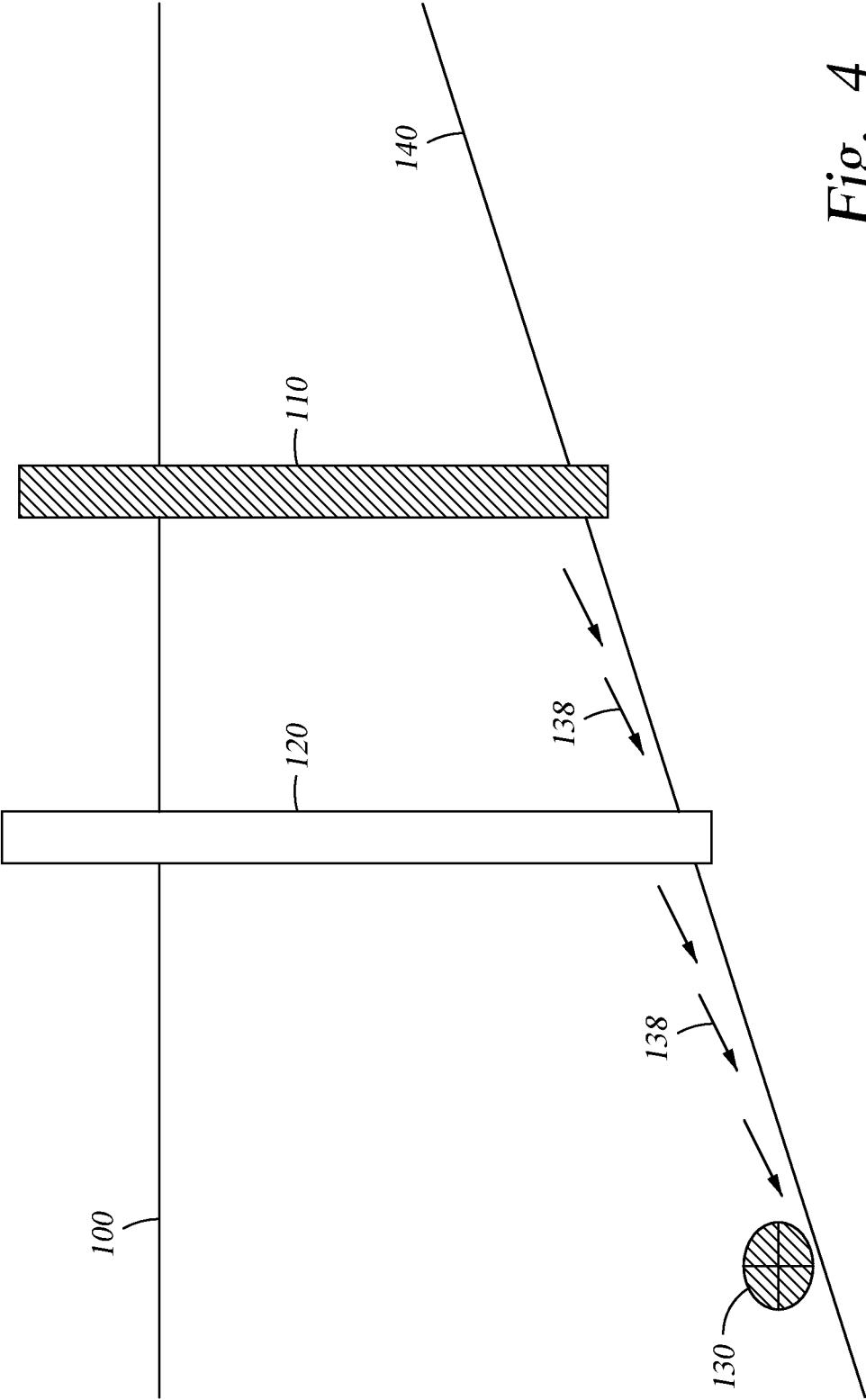


Fig. 4

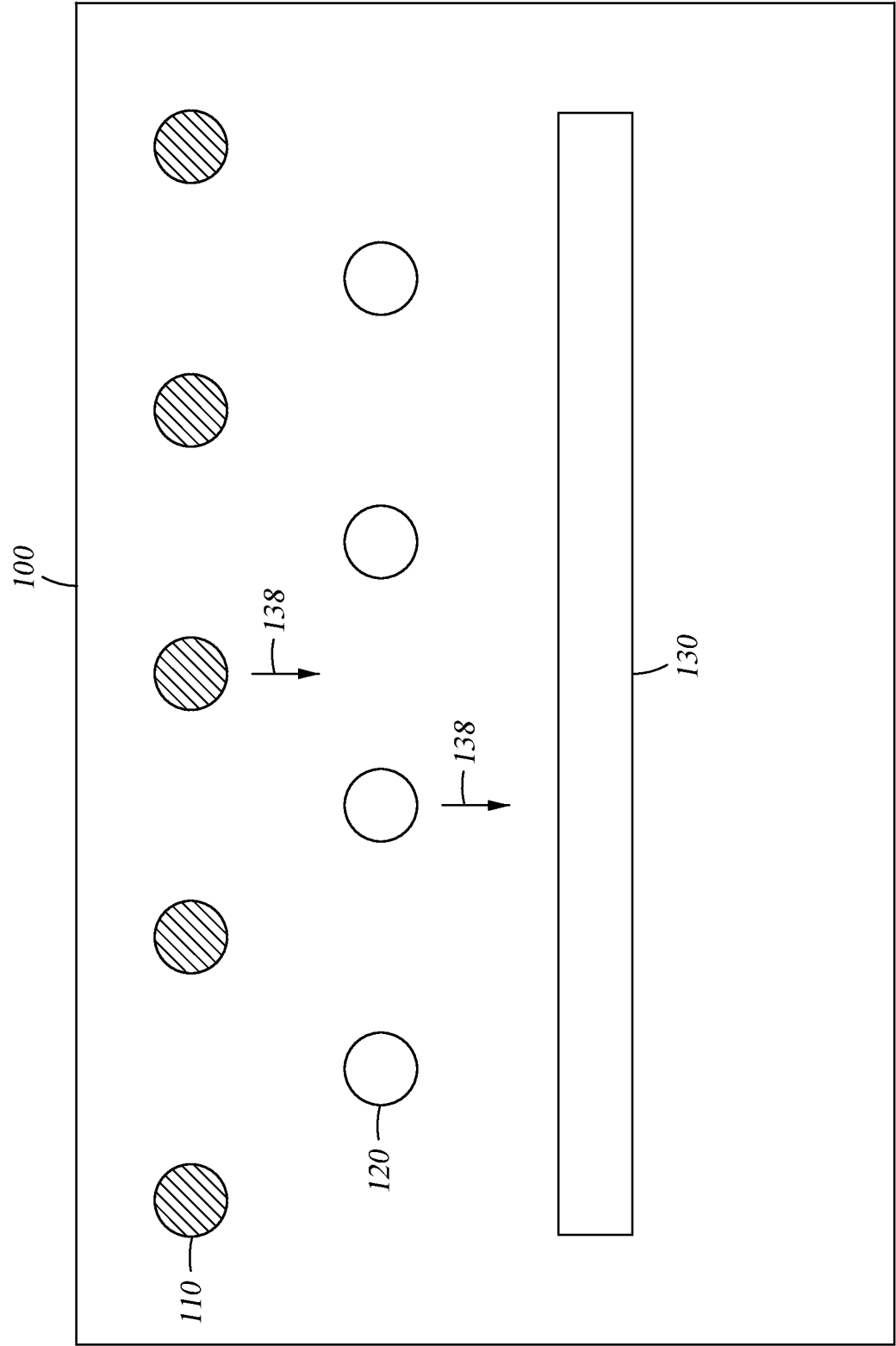


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/014696

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/24
ADD.

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

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016/069171 A1 (STANCLIFFE RUSSELL PETER WARREN [CA] ET AL) 10 March 2016 (2016-03-10) paragraphs [0055], [0063]; figure 6 -----	1-16
A	US 7 527 096 B2 (NEXEN INC [CA]) 5 May 2009 (2009-05-05) column 4, line 59 - column 5, line 13 column 6, line 21 - line 43 -----	1-16
A	WO 98/04807 A1 (AMOCO CORP [US]) 5 February 1998 (1998-02-05) page 6, line 18 - line 34 -----	1-16

☐

Further documents are listed in the continuation of Box C.

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See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"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

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Date of the actual completion of the international search

11 September 2017

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21/09/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Schneiderbauer, K

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/014696

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016069171 A1	10-03-2016	NONE	

US 7527096 B2	05-05-2009	CA 2494391 A1	26-07-2006
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