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- (71) **Applicant:** STATOIL PETROLEUM AS [NO/NO]; N-4035 Stavanger (NO).
- (72) **Inventors:** VINDSTAD, Jens Emil; Lade allé 18c, N-7041 Trondheim (NO). GRISLINGÅS, Arne; Ole Nordgaardsv. 36B, N-7049 Trondheim (NO). BORCH, Jan Henrik; Høilivegen 14, N-7052 Trondheim (NO). MEDIAAS, Heidi; Perslia 47A, N-7088 Heimdal (NO). MEYER, Trygve; Solliveien 8c, N-4020 Stavanger (NO).
- (74) **Agent:** MITCHELL, Matthew; Fletcher House (2nd Floor), Heatley Road, The Oxford Science Park, Oxford Oxfordshire OX4 4GE (GB).
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(54) **Title:** INCREASING HYDROCARBON PRODUCTION FROM RESERVOIRS

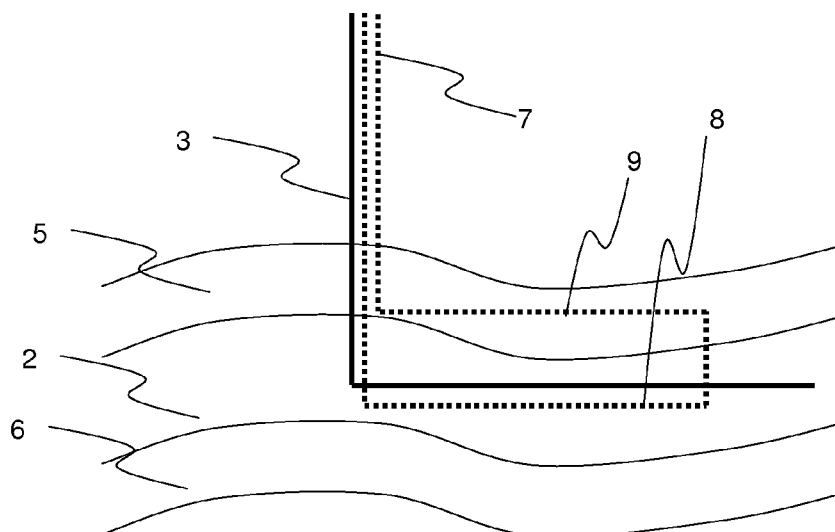


Figure 3

(57) **Abstract:** A system and method for increasing hydrocarbon production from a subsurface reservoir (2). A production well is provided in the subsurface reservoir. A heat treatment is performed on a region of the subsurface reservoir and/or a region adjacent to the subsurface reservoir. Hydrocarbons are then produced via the production well. The heat treatment may induce thermal fractures, increase the mobility of fluid hydrocarbons, and pyrolyze kerogen to generate recoverable fluid hydrocarbons.



Increasing Hydrocarbon Production from Reservoirs

TECHNICAL FIELD

- 5 The invention relates to the field of increasing hydrocarbon production from reservoirs, and in particular shale reservoirs and tight oil reservoirs.

BACKGROUND

- 10 Shale reservoirs are hydrocarbon reservoirs formed in a shale formation. It can be difficult to extract the hydrocarbons from shale reservoirs because the shale formation is of low porosity and low permeability. This means that when a well is drilled into the formation, only those fluid hydrocarbons in proximity to the well are produced, as the other hydrocarbons further away from the well have no easy path to the well through
15 the relatively impermeable rock formation.

- A typical production system is illustrated in Figure 1, in which a subsurface shale formation 1 is exploited. A reservoir of liquid hydrocarbons is at a certain depth 2. These are exploited by drilling a horizontal well 3 from a production facility 4 located at
20 the surface. A horizontal well 3 allows a greater length the well to be in contact with the reservoir 2. Note also that substantially vertical wells may be used.

- In order to further improve hydrocarbon recovery from shale reservoirs, the shale around the well 3 is often hydraulically fractured. This involves propagating fractures
25 through the shale formation using a pressurized fluid. These fractures create conduits in the impermeable shale formation. Hydrocarbon fluids can then migrate through the conduits toward the well 3. In this way, recovery of hydrocarbons from the reservoir is improved because hydrocarbons that would not previously be able to reach the well now have a path to the well and can be produced.

- 30 Hydraulic fracturing leads to a high initial oil production of hydrocarbons trapped in the shale reservoir. However, this high initial production quickly tails off to a value of typically between 10 and 20% of the initial production rate. Over the lifetime of a shale reservoir well, the well may produce an average of 400-500 BOE (barrels of oil
35 equivalent) per day, peaking in the initial stages at around 1,500 BOE per day.

Furthermore, hydraulic fracturing only leads to a part of the hydrocarbons trapped in the shale being produced. This is because the pattern of the fractures created during the hydraulic fracturing process does not provide access to the entire pore space of the shale formation. Some regions of the shale reservoir are therefore out of reach by the production well 3 due to the low permeability of the shale formation.

SUMMARY

It is an object to improve the production of hydrocarbons trapped in reservoirs in low permeability formations such as shale. This is done in part by heating a region of the reservoir or a region adjacent to the reservoir.

According to a first aspect, there is provided a method of increasing hydrocarbon production from a subsurface reservoir. A production well is provided in the subsurface reservoir. A heat treatment is performed on a region of the subsurface reservoir and/or a region adjacent to the subsurface reservoir. Hydrocarbons are then produced via the production well.

The subsurface reservoir is optionally any of a low permeability reservoir and a low porosity reservoir. It may comprise any of shale oil and tight oil.

As an option, the method further comprises producing both hydrocarbons in the subsurface reservoir and further hydrocarbons generated through kerogen pyrolysis in or adjacent to the subsurface reservoir. Kerogen requires pyrolysis to convert it to fluid hydrocarbons that can be recovered. The method therefore allows both the recovery of existing fluid hydrocarbons and the recovery of hydrocarbons generated from the pyrolysis of kerogen. In this case, a heat treatment temperature may be selected that is suitable to pyrolyze the kerogen. An example of such a heat treatment is a temperature in the range of 250°C to 450°C. The heat treatment temperature may be determined by first determining the maturity of the kerogen and selecting the heat treatment temperature on the basis of the maturity.

A hydraulic fracturing operation is optionally performed on or adjacent to the subsurface reservoir.

Exemplary ways of providing the heat treatment include a pipe heated by a circulating hot fluid, an electric heater, a radio wave heater, a microwave heater, an inductive heater, and a hot fluid injector injecting hot fluids into the subsurface reservoir or adjacent regions.

As an option, the method includes performing a first heat treatment on the region of the subsurface reservoir and/or the region adjacent to the subsurface reservoir at a first time and temperature, and subsequently performing a second heat treatment on the region of the subsurface reservoir and/or the region adjacent to the subsurface reservoir at a second time and temperature. As an example, the first heat treatment is selected to pyrolyze kerogen and the second heat treatment is selected to mobilise viscous hydrocarbons. This allows recovery of existing fluid hydrocarbons and also fluid hydrocarbons generated from the pyrolysis of kerogen.

As an option, a heat treatment may be selected so as to induce thermal fracturing in a formation around the subsurface reservoir. This maximizes the recovery of fluid hydrocarbons in low permeability formations. The induced thermal fracturing may increase the size of existing hydraulic fractures.

As an option, the heat treatment is selected to reduce a viscosity of liquid hydrocarbons in the subsurface reservoir.

According to a second aspect, there is provided a system for hydrocarbon recovery from a subsurface reservoir, the system comprising a production well located in the subsurface reservoir and a source of heat located in any of the subsurface reservoir and a region adjacent to the subsurface reservoir.

As an option, the subsurface reservoir is any of a low permeability reservoir and a low porosity reservoir.

The production well is optionally located a subsurface reservoir that comprises any of shale oil and tight oil.

The production well is optionally arranged to produce both hydrocarbons in the subsurface reservoir and further hydrocarbons generated through kerogen pyrolysis in or adjacent to the subsurface reservoir.

- 5 The source of heat is optionally arranged to provide a heat treatment temperature suitable to pyrolyze the kerogen.

An exemplary temperature range provided by the source if heat is in the range of 250 °C to 450 °C.

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The system optionally further comprises apparatus for performing a hydraulic fracturing operation on the formation bearing the subsurface reservoir.

- 15 The source of heat is optionally selected from any of a pipe heated by a circulating hot fluid, an electric heater, a radio wave heater, a microwave heater, an inductive heater, and a hot fluid injector injecting hot fluids into the subsurface reservoir or adjacent regions.

- 20 The system is optionally provided with a plurality of sources of heat, each source of heat of the plurality of sources of heat being located in an of the subsurface reservoir, a kerogen bearing region above the subsurface reservoir, and a kerogen bearing region below the subsurface reservoir.

BRIEF DESCRIPTION OF DRAWINGS

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Figure 1 illustrates schematically a cross-section of a shale reservoir in a shale formation;

- 30 Figure 2 illustrates schematically a cross-section of a shale reservoir and surrounding kerogen-bearing regions;

Figure 3 illustrates schematically a subsurface formation including a shale reservoir and exemplary production equipment;

Figure 4 illustrates schematically a subsurface formation including a shale reservoir and alternative exemplary production equipment;

5 Figure 5 illustrates schematically a subsurface formation including a shale reservoir and further alternative exemplary production equipment;

Figure 6 is a graph showing hydrocarbon generation with increasing thermal maturity of a shale formation; and

10 Figure 7 is a flow diagram showing steps of production.

DETAILED DESCRIPTION

15 It has been realised that providing heating to regions of, or around, a shale reservoir will increase production of hydrocarbons. Turning to Figure 2, a production facility 4 has drilled a well 3 into a shale reservoir 2. The shale reservoir 2 may contain kerogen. Furthermore, kerogen may be found in areas of the formation above 5 or below 6 the reservoir 2. The term "shale reservoir" is used herein to denote a hydrocarbon bearing region of a shale formation in which the hydrocarbons are present
20 in a fluid form and can be produced. It is also used to refer to tight oil plays and plays where hydrocarbons are present in other sequences (such as sandstone or carbonates) within the shale.

25 Heating low permeability and/or porosity reservoirs improves production for several reasons. Heating regions of the reservoir or around the reservoir, before, during or after hydraulic fracturing, puts additional thermal stress on the fractures caused by hydraulic fracturing. This can increase the size of the fractures. Furthermore, heating reduces the viscosity of liquid hydrocarbons, making them more mobile and more likely to find a path through the low-permeability formation towards the well. An additional
30 effect is that any non-liquid hydrocarbons in the form of kerogen may start to mature and crack into smaller, mobile molecules (oil and gas), thus increasing the total producible resource. The oil and gas thus generated migrates towards the production well owing to pressure differences between the hot zone where the cracking takes place and the production well which operates at a pressure lower than the natural
35 pressure in the shale. During this migration, generated gas and/or water in the

formation pushes oil trapped in pores and fractures in the same direction towards the production well (this is termed the “sweep effect”). The relative contributions of these four different effects will vary from site to site, and potentially also within the same geologic formation.

5

Kerogen is a mixture of organic compounds, most of which have a very high molecular weight. The high molecular weight makes kerogen insoluble in most organic solvents in a subsurface hydrocarbon reservoir, and so the kerogen is present in solid form. Under normal conditions of producing a shale reservoir, kerogen does not contribute to the produced hydrocarbon. However, depending on the maturity level of the shale formation, kerogen may, for some shale types, include more potential hydrocarbons than the oil trapped in accessible pores of the shale formation. It would therefore be of great benefit to be able to produce usable hydrocarbons from the kerogen in addition to producing hydrocarbons from the reservoir in the shale formation.

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Turning now to Figure 3 there is illustrated a subsurface formation and exemplary production equipment. In this example, the well 3 has a horizontal portion extending through shale reservoir 2 in the shale formation. In addition, a heating well 7 is provided from the surface production facility 4. There are various ways in which heating can be applied, discussed in more detail below. In this case, the heating well 7 operates by passing a hot fluid through the heating well 7.

20

In the example of Figure 3, a first portion 8 of the heating well 7 passes through the shale reservoir 2 below the production well 3. A second portion 9 of the heating well 7 passes through a region 5 above the reservoir 2 that contains kerogen.

25

The first portion 8 of the heating well 7 extends through the reservoir 2 and is used to heat the part of the shale formation constituting or containing the reservoir for the oil already present in the shale. The heat increases thermal stresses on the shale formation. If hydraulic fracture has not yet been started, the additional thermal stress will make the hydraulic fracture process more efficient and cause larger fractures and in some cases more fractures to open up. If hydraulic fracturing has already taken place, the thermal stresses on the fractures can cause the fractures to increase in size and length. This will increase the effective volume of the shale reservoir that can be used to produce hydrocarbons. The time and temperature of heating varies according

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to the geological conditions. Time can be of the order of months to years. A further important parameter when selecting a heating time and temperature regime for improving the effectiveness of a hydraulic fracturing operation is the temperature gradient (heating rate).

5

Furthermore, the heating of the shale formation reduces the viscosity of fluid hydrocarbons trapped in the shale formation, making it more mobile. Fluid hydrocarbons can then migrate more easily through fractures thereby increasing the amount of fluid hydrocarbons that can be produced from the shale reservoir.

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A further effect of the heating is to at least partially crack and liquefy any kerogen that is present in the shale reservoir. The heating of kerogen releases fluid hydrocarbons by a pyrolysis reaction. The evolved fluid hydrocarbon can move through the formation and be produced by the well 3, leading to increased hydrocarbon recovery from the well 3.

15

The second portion 9 of the heating well 7 extends through a portion of the formation adjacent to the fluid hydrocarbon-bearing formation. This portion of the formation contains kerogen. The heating starts to liquefy this kerogen which in turn migrates towards the well 3 and can be produced.

20

A secondary effect of liquefying the kerogen in regions adjacent to the reservoir is that heated hydrocarbons evolved from the kerogen "sweep" through the shale reservoir 2 and further heat fluid hydrocarbons in the shale reservoir and push them towards the production well 3. This increases the mobility of existing fluid hydrocarbons, increasing production from the shale reservoir 2. A similar effect may be caused by heating water trapped in the formation, which can also push hydrocarbons towards the production well 3.

25

The heating of the shale reservoir or regions adjacent to the shale reservoir can be used for shale formations at all maturity stages from low to high maturity within a hydrocarbon generating window.

30

Note that the most suitable heating regime for increasing the size of fractures induced by hydraulic fracturing may be different to the most suitable heating regime for cracking

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and liquefying kerogen. It is an option to perform two separate heating operations. For example, a first heating operation could be performed at a time and temperature suitable for increasing the size of fractures, and a subsequent heating operation can be performed at a time and temperature suitable for cracking and liquefying kerogen.

5

Note also that the heating well 7 in Figure 3 has a first portion 8 extending through the shale reservoir 2 and a second portion 9 extending through a kerogen containing region 5 above the shale reservoir 2. It will be appreciated that the heating well could be located in any regions suitable for exploiting, including the kerogen-containing region 6 below the shale reservoir 2.

10

Figure 4 shows a production system that operates on the same principle of heating the shale reservoir 2 as that illustrated in Figure 3. However, in this case, heaters 10, 11 are disposed on the production well 3 to effect heating of the shale reservoir. These have the same effect on the shale reservoir 2 as the first portion 8 of the heating well 7 shown in Figure 3. Note that it is possible to combine the embodiment of Figures 3 and 4 to provide both a heating well 7 and heaters 10, 11.

15

As mentioned above, there are a variety of ways in which heating can be applied to the shale reservoir 2 or regions 5, 6 adjacent to the shale reservoir 2. One way is to pipe a hot fluid such as superheated steam through the region to be heated. A further way is to inject hot fluids directly into the shale formation. Furthermore, heating elements such as electric heating elements, induction heating elements, radio wave heating elements or microwave heating elements may be disposed on the production well 3, in a heating well 7, or at other points in the region of the shale formation to be heated.

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25

It will be appreciated that any suitable form of heating, or combination of suitable forms of heating may be provided in order to most efficiently heat the required region of the shale formation. By way of example, Figure 5 shows a heating well 7 that transports hot fluid and is additionally provided with heaters 12, 13, 14, 15. Two sets of heaters 12, 13 are disposed in the shale reservoir 2 itself, and two sets of heaters 14, 15 are disposed in a kerogen containing region 6 located below the shale reservoir 2.

30

Heating of the shale reservoir 2 or regions around the shale reservoir 5, 6 can be performed over a period of several years to maximize the evolution of fluid

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hydrocarbons from kerogen. A typical heat treatment may be in the temperature range of 100-450 °C. If the heat treatment is primarily for the purpose of improving the size of fractures and/or lowering the viscosity of hydrocarbons, then temperatures need not be significantly higher than 100 °C. If the heat treatment is primarily for the purpose of maturing kerogen by cracking and liquefying it, then the higher temperatures (between 250 °C and 450 °C) are most suitable. As mentioned above, the heat treatment time and temperature can be changed during the lifetime of the well to maximize certain effects such as lowering viscosity or maturing kerogen. Note also that different heat treatments can be applied at the same time to different parts of the reservoir. For example, one part of the reservoir may benefit from a heat treatment to reduce viscosity of hydrocarbons in the reservoir, while another part of the reservoir may be richer in kerogens and so benefit from a different heat treatment to crack and liquefy kerogen.

Turning now to Figure 6, there is illustrated a graph showing typical hydrocarbon generation history of a source rock represented by the Rock-Eval S_1 , S_2 and T_{max} parameters.

Hydrocarbon source rock can be classified according to organic content (richness) using total organic carbon (TOC) in wt% of a rock sample after treatment to remove all presence of carbonate in the sample.

The petroleum potential and chemical classification of kerogen can be measured by Rock-Eval (or using R-E thermal extraction/pyrolysis equipment). The principle of hydrocarbon generation history with increasing thermal maturity of the shale formation is shown in Figure 6.

Five traces are shown, denoted A to E. Trace A represents the least mature kerogen and trace E denotes the most mature kerogen. The S_1 peak represents the quantity of free hydrocarbons retained in the shale and released during heating at 300 °C. The S_2 peak represents the quantity of hydrocarbons released during temperature programmed pyrolysis of the shale (hydrocarbon source rocks) from 300 to 550 °C.

T_{max} represents the temperature of maximum hydrocarbon generation during the pyrolysis, and increases with increasing source rock (kerogen) maturity with respect to

hydrocarbon generation. Thus, in the widest sense $T_{\max}$ for an immature kerogen is between 400 and 430°C. The hydrocarbon-generating “window” is similarly represented by a $T_{\max}$ between 430 - 460°C, and an “over-mature” kerogen with almost no hydrocarbon potential is represented by a $T_{\max} > 460^\circ\text{C}$.

5

A shale with an immature kerogen (denoted ‘A’) has almost no S_1 , and the S_2 peak is large and in accordance with the total source rock (kerogen) potential. With increasing kerogen maturity, S_1 increases simultaneously and at the cost of S_2 . In other words, heating to artificially mature kerogen means that more hydrocarbons can be generated from less mature kerogen by the heating process described above.

10

The techniques described above can be used on shale formations at all maturity stages from low (early oil generating window: low S_1 and high S_2) to high (upper end of oil generating window: high S_1 and low S_2).

15

The techniques described herein provide increased hydrocarbon recovery from shale reservoirs compared to techniques currently used. Figure 7 is a flow diagram showing steps of embodiments described above. The following numbering corresponds to that of Figure 7:

20

S1. A production well for producing hydrocarbons is located in a low porosity formation that bears a subsurface reservoir 2, such as a shale formation.

25

S2. If required, a hydraulic fracturing operation is performed. This step may occur at any point after step S1.

30

S3. A region to be heated is determined. The region may be the subsurface reservoir itself (which will improve the effectiveness of any hydraulic fracturing operation or help to pyrolyze any kerogen located in the subsurface reservoir 2), or a region adjacent to the subsurface reservoir 2 that contains kerogen. As described above, more than one region may be heated.

S4. The heat source is located in the region to be heated. As described above, this may be effected by drilling a heating well (as illustrated in Figures 3 and 5), or the heat

source may be co-located with the production well 3 (as illustrated in Figure 4). Various types of heat sources or combinations of heat sources may be used.

5 S5. A heat treatment time and temperature is determined. This may be on the basis of a heat treatment regime necessary to pyrolyze kerogen, and may depend on the maturity of the kerogen. It may be on the basis of a heat treatment regime required to improve the effectiveness of a hydraulic fracturing operation. It may be a combination of the two factors.

10 S6. The heat treatment is performed on the region.

S7. Hydrocarbons in the reservoir are produced. Initially existing fluid hydrocarbons in the shale reservoir are produced, and this may happen concurrently with steps S2 to S6. Once the heat treatment is applied, hydrocarbon production increases owing to
15 pyrolysis of kerogen, improved mobility of existing fluid hydrocarbons, a sweep effect of evolved hydrocarbons from pyrolysis of kerogen, and enhanced hydraulic fracturing owing to induced thermal stress in the formation.

Note that many of the steps described above may occur in a different order.
20 Furthermore, the heat treatment regime may change over the lifetime of the well. This may be, for example, to account for kerogens of different maturities or to enhance subsequent hydraulic fracturing operations.

It should be noted that the above description refers to shale formations and shale
25 reservoirs. However, it should be noted that the techniques can be used to enhance oil recovery from reservoirs formed in any type of low permeability/low porosity rock formations, particularly where kerogen reserves are also present and/or where hydrocarbon recovery from the reservoir is enhanced using the technique of hydraulic fracturing.

30 It will be appreciated by a person of skill in the art that various modifications may be made to the embodiments described above without departing from the scope of the present disclosure.

The following abbreviations have been used in the above description:

BOE barrels of oil equivalent

TOC total organic carbon

CLAIMS:

1. A method of increasing hydrocarbon production from a subsurface reservoir, the method comprising providing a production well in the subsurface reservoir, heat
5 treating any of a region of the subsurface reservoir and / or a region adjacent to the subsurface reservoir, and producing hydrocarbons via the production well.
2. The method according to claim 1, wherein the subsurface reservoir is any of a low permeability reservoir and a low porosity reservoir.
10
3. The method according to claim 1 or 2, wherein the subsurface reservoir comprises any of shale oil and tight oil.
4. The method according to any of claims 1, 2 or 3, wherein the method further
15 comprises producing both hydrocarbons in the subsurface reservoir and further hydrocarbons generated through kerogen pyrolysis in or adjacent to the subsurface reservoir.
5. The method according to claim 4, further comprising selecting a heat treatment
20 temperature suitable to pyrolyze the kerogen.
6. The method according to claim 5, wherein the heat treatment temperature is in the range of 250 °C to 450 °C.
- 25 7. The method according to claim 5 or claim 6, further comprising determining a maturity of the kerogen and selecting the heat treatment temperature on the basis of the determined maturity.
8. The method according to any one of claims 1 to 7, further comprising
30 performing a hydraulic fracturing operation on or adjacent to the subsurface reservoir.
9. The method according to any one of claims 1 to 8, wherein the heat treatment is provided by any of:
a pipe heated by a circulating hot fluid;
35 an electric heater;

a radio wave heater;
a microwave heater;
an inductive heater; and
a hot fluid injector injecting hot fluids into the subsurface reservoir or adjacent
5 regions.

10. The method according to any of claims 1 to 9, further comprising performing a first heat treatment on the region of the subsurface reservoir and/or the region adjacent to the subsurface reservoir at a first time and temperature, and subsequently
10 performing a second heat treatment on the region of the subsurface reservoir and/or the region adjacent to the subsurface reservoir at a second time and temperature.

11. The method according to claim 10, wherein the first heat treatment is selected to pyrolyze kerogen and the second heat treatment is selected to mobilise viscous
15 hydrocarbons.

12. The method according to any of claims 1 to 11, further comprising selecting a heat treatment to induce thermal fracturing in a formation around the subsurface reservoir.
20

13. The method according to claim 12, wherein the induced thermal fracturing increases a size of existing hydraulic fractures.

14. The method according to any one of claims 1 to 13, further comprising selecting
25 a heat treatment to reduce a viscosity of liquid hydrocarbons in the subsurface reservoir.

15. A system for hydrocarbon recovery from a subsurface reservoir, the system comprising:
30 a production well located in the subsurface reservoir; and
a source of heat located in any of the subsurface reservoir and a region adjacent to the subsurface reservoir.

16. The system according to claim 15, wherein the subsurface reservoir is any of a
35 low permeability reservoir and a low porosity reservoir.

17. The system according to claim 15 or 16, wherein the production well is located a subsurface reservoir that comprises any of shale oil and tight oil.

5 18. The system according to any one of claims 15, 16 or 17, wherein the production well is arranged to produce both hydrocarbons in the subsurface reservoir and further hydrocarbons generated through kerogen pyrolysis in or adjacent to the subsurface reservoir.

10 19. The system according to claim 18, wherein the source of heat is arranged to provide a heat treatment temperature suitable to pyrolyze the kerogen.

20. The system according to claim 18 or 19, wherein the source of heat is arranged to provide a heat treatment temperature in the range of 250 °C to 450 °C.

15

21. The system according to any one of claims 16 to 20, further comprising apparatus for performing a hydraulic fracturing operation on the formation bearing the subsurface reservoir.

20 22. The system according to any one of claims 15 to 21, wherein the source of heat comprises any of:

a pipe heated by a circulating hot fluid;

an electric heater;

a radio wave heater;

25 a microwave heater;

an inductive heater; and

a hot fluid injector injecting hot fluids into the subsurface reservoir or adjacent regions.

30 23. The system according to any one of claims 15 to 22, further comprising a plurality of sources of heat, each source of heat of the plurality of sources of heat being located in an of the subsurface reservoir, a kerogen bearing region above the subsurface reservoir, and a kerogen bearing region below the subsurface reservoir.

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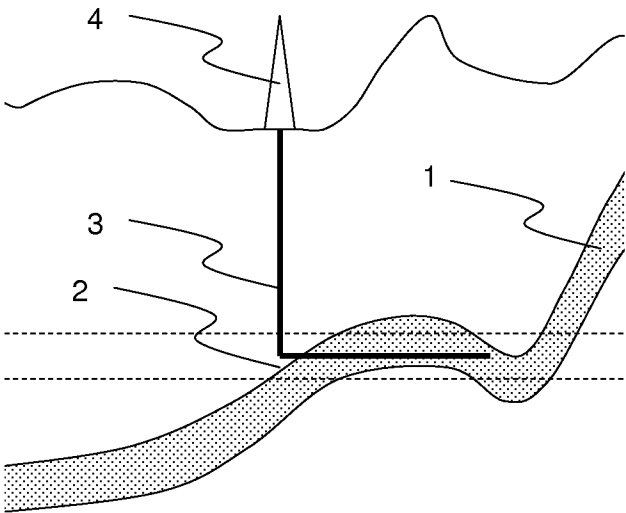


Figure 1 (prior art)

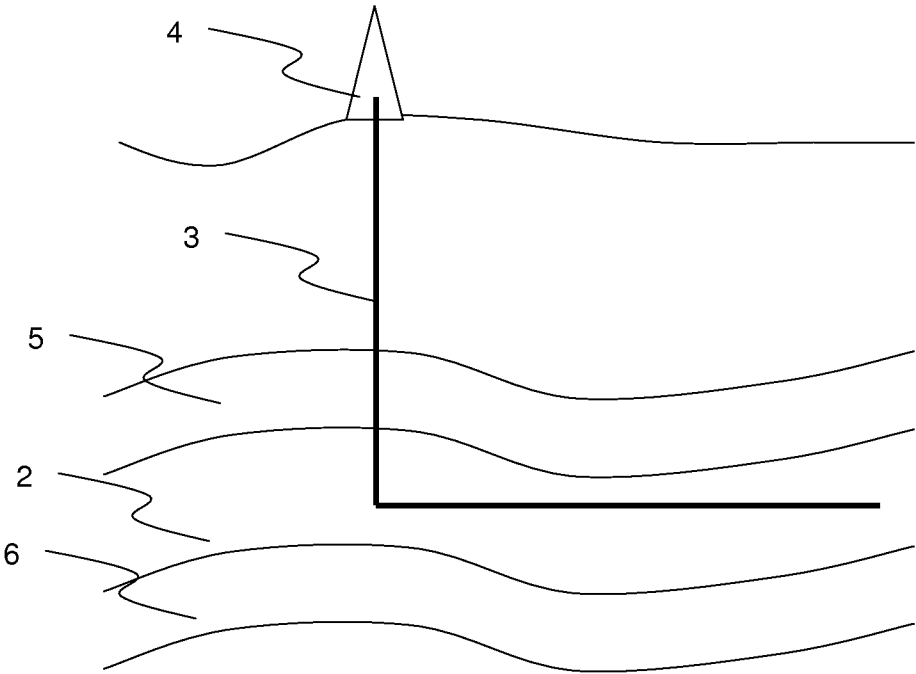


Figure 2 (prior art)

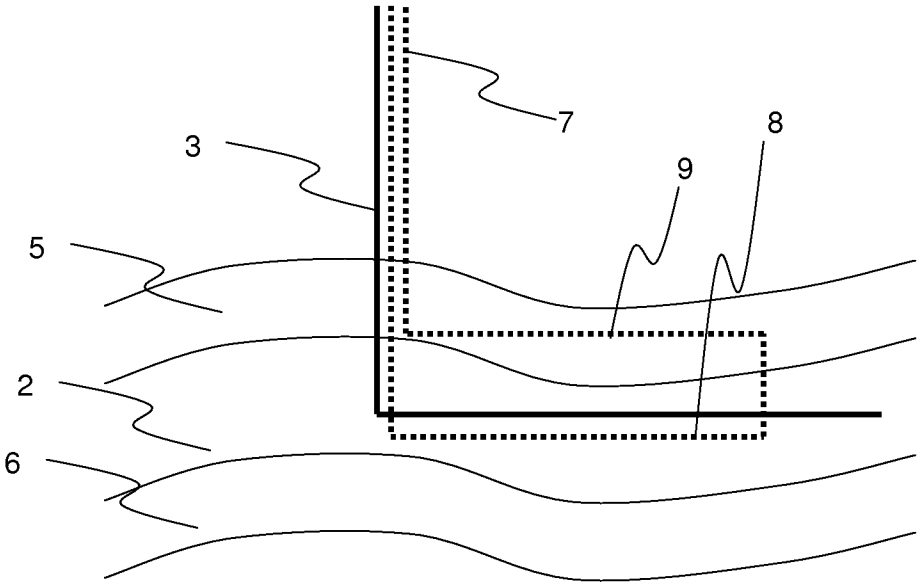


Figure 3

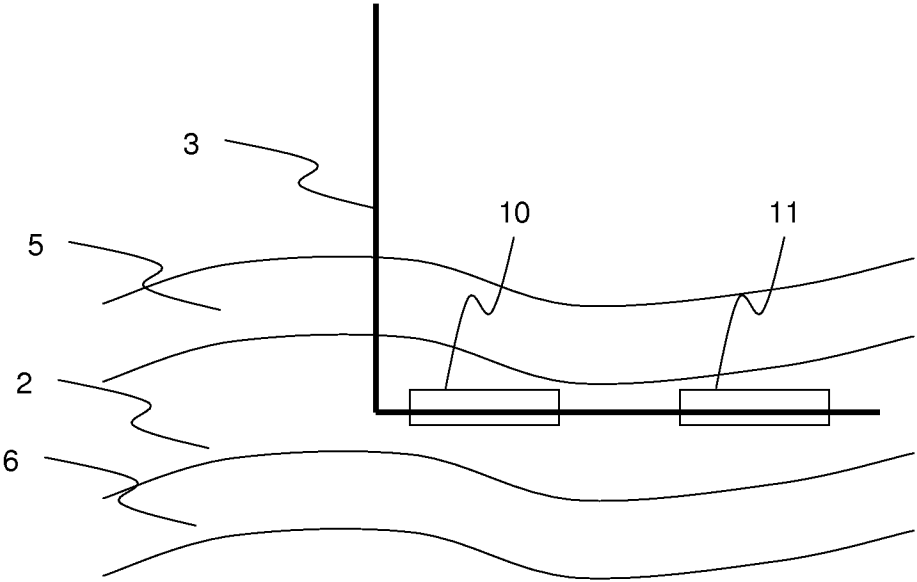


Figure 4

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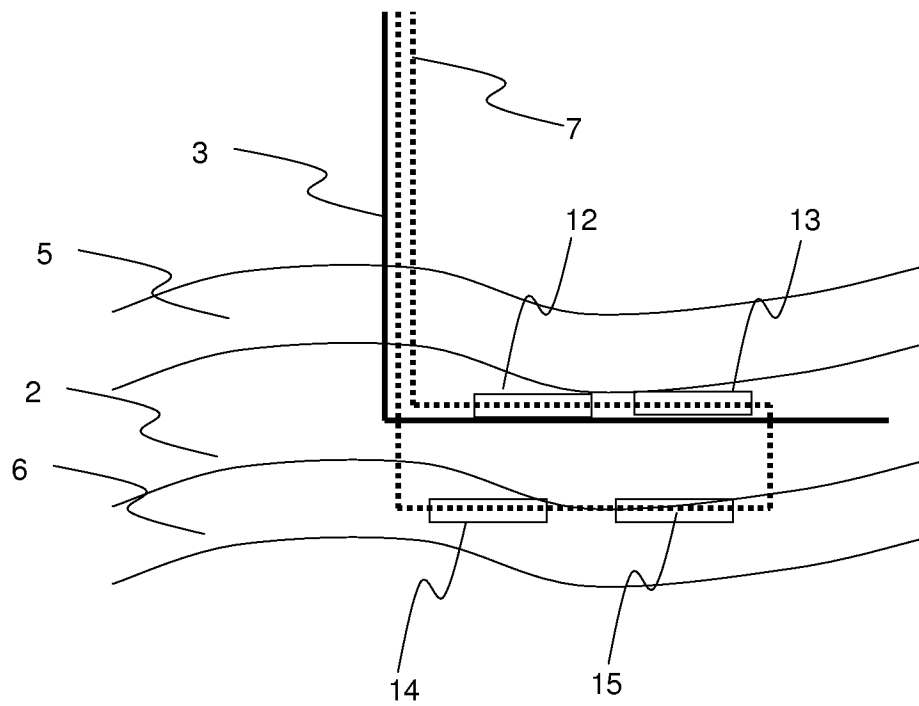


Figure 5

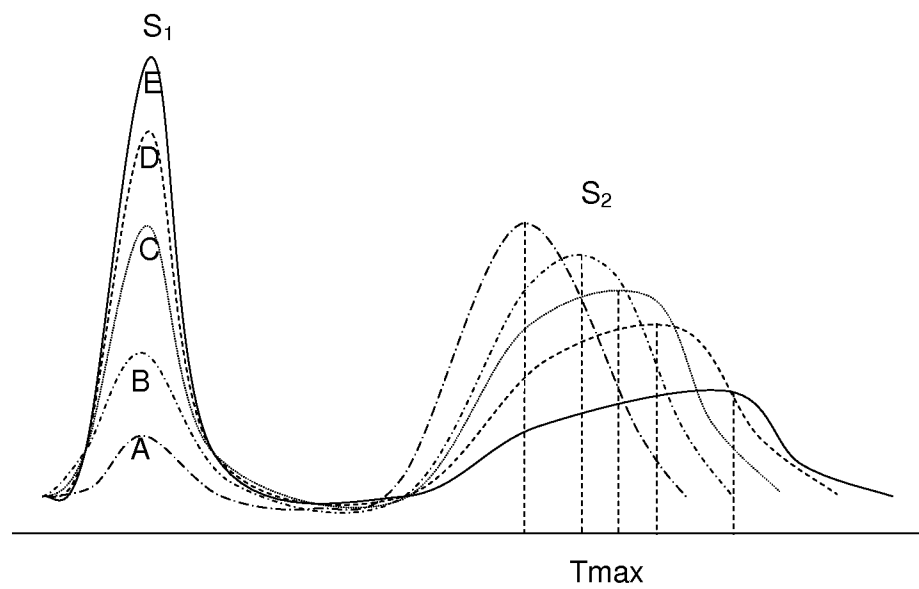


Figure 6

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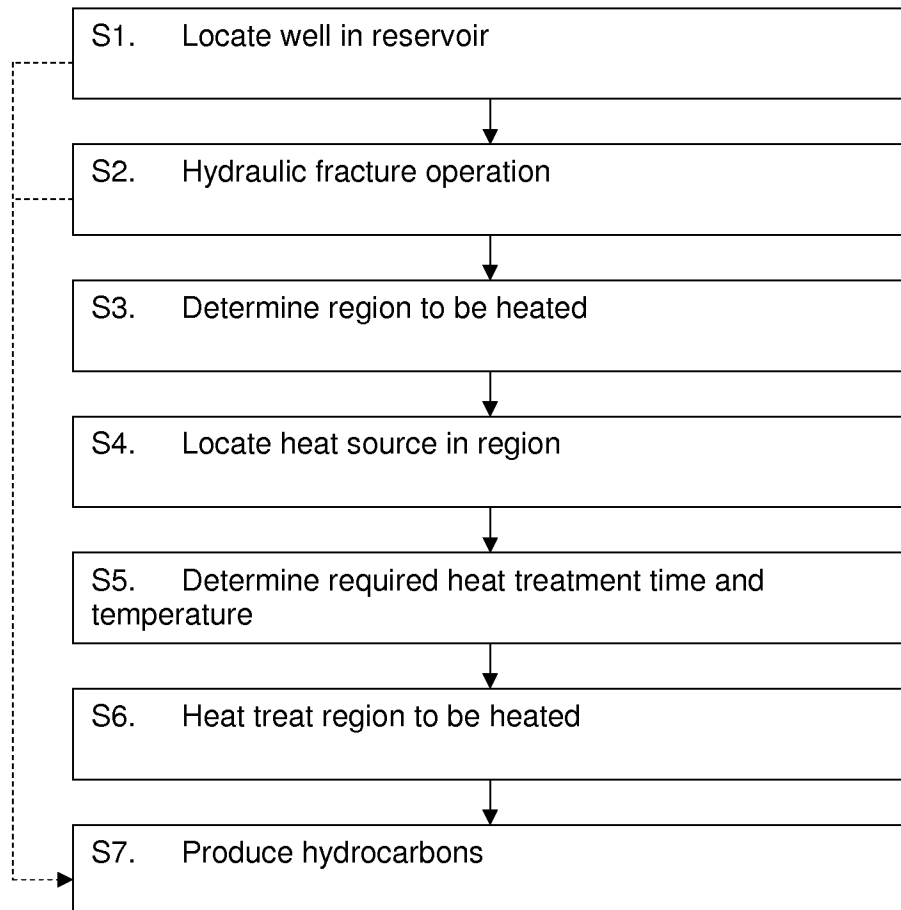


Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/063524

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/24 E21B43/241
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)

EPO-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 2010/101793 A1 (SYMINGTON WILLIAM A [US] ET AL) 29 April 2010 (2010-04-29) paragraphs [0003] - [0008], [0011] - [0019], [0097] - [0114], [0138] - [0142], [0151] - [0154], [0189] - [0208]; figures 1-4,7,8 -----	1-23



Further documents are listed in the continuation of Box C.



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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Dekker, Derk

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Information on patent family members

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