METHOD FOR INTERCEPTING AND CONNECTING UNDERGROUND FORMATIONS AND METHOD FOR PRODUCING AND/OR INJECTING HYDROCARBONS THROUGH CONNECTING UNDERGROUND FORMATIONS

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ABSTRACT
The present invention relates to a method for intercepting and connecting underground formations containing hydrocarbons, so as to make the production and injection of hydrocarbons technically and financially feasible in land and offshore oil production zones. It is claimed to be a method for the production and/or injection of hydrocarbons through thusly connected underground formations.
METHOD FOR INTERCEPTING AND CONNECTING UNDERGROUND FORMATIONS
AND METHOD FOR PRODUCING AND/OR INJECTING HYDROCARBONS THROUGH
CONNECTING UNDERGROUND FORMATIONS

[0001] This application is based on, claims the benefit of priority of, and incorporates hereby by reference the contents of Brazilian Patent Application No. PI 0502087-5 filed on Jun. 9, 2005.

SCOPE OF THE INVENTION

[0002] The present invention relates to a method for intercepting and connecting underground formations containing hydrocarbons, so as to make the production and injection of hydrocarbons technically and financially feasible in land and offshore oil production zones. It is presented as a method for the production and/or injection of hydrocarbons through connected underground formations.

FUNDAMENTALS OF THE INVENTION

[0003] To increase the extraction of underground formations containing hydrocarbons, when possible, wells are drilled horizontally, vertically, directionally and multilaterally. The fluid produced from these formations is extracted through the top of the well and thereafter, through diverse means (pipes, land transport), this fluid is routed to the refineries. At times, this strategy becomes impossible in view of current physical, financial, and technological limits for well construction and/or hydrocarbon flow. For example, hydrocarbons in zones with water at depths of 3000 m currently cannot be tapped.

[0004] In the past, oil wells were vertically drilled, where the height of the vertical section of the hydrocarbon formation was exposed to the oil well.

[0005] Nowadays the technology most frequently used is horizontal drilling, where horizontal wells are drilled perpendicular to the vertical axis of the formation, so that a larger area of the formation may be tapped. The horizontal portion of the oil well then is called a lateral well.

[0006] In the search for the perfect way to extract oil from a formation, the oil industry has concentrated on multilateral drilling, that in general are offshoots drilled from a single well.

[0007] A vertical, horizontal or directional well is normally constructed by using drills that cut through the formation until it reaches the underground formation containing the hydrocarbons or area of injection, at varying angles, theoretically, from zero degrees (vertical well) up to ninety degrees (horizontal) passing through the directional wells (0-90 degrees). These wells are constructed in stages whose drills and, consequently, the diameter of the well, have different measurements, that grow smaller as the well goes deeper. Each Stage of the well is usually encased with a steel pipe, except in the area of underground formations containing hydrocarbons where specific equipment is used for oil production or fluid injection. For example, the drilling of a well may begin by cutting through the formation with a drill 17.5" in diameter, having a steel pipe casing of 13⅛" in diameter and in the next stage a drill of 12⅛" in diameter may be used, with a steel pipe casing measuring 9⅛" in diameter. These stages are used in vertical, horizontal, and directional wells.

[0008] When intercepting underground formations containing hydrocarbons, the well is equipped to produce said hydrocarbons through piping connected to equipment located at the head of the horizontal, vertical, or directional well. Multilateral wells are also built with steel pipe encased drills, they differ from the previous ones because they have one or more offset lateral tracks, that is to say, offshoots built off of the main well. The construction of this lateral well is made using a diverter that is located at the main well, said diverter in combination with a special drill to cut iron, drills through the casing (steel pipes), creating a lateral opening, from which drilling of the side offshoot will continue. When the connection between the offshoots of the lateral wells with the main well becomes interrupted or obstructed, it can affect the production of hydrocarbons proceeding from the offshoots or can affect the fluid injection, indirectly compromising the production of hydrocarbons in the production area.

[0009] In an attempt to solve problems with mechanical integrity, U.S. Pat. No. 6,209,648 presents a method and a device to connect auxiliary columns to a main well, through a mechanical connection, in order to solve problems with instability of the formation at the junction. The connection is made by using a recoverable connector and a casing track, both installed inside the well, which determine the passage of the production flow.

[0010] Current conventional solutions for developing hydrocarbon production zones consider using isolated wells (horizontal, vertical, directional and multilateral wells) of limited scope. The horizontal wells of great capacity, when the formation allows, reach a maximum distance of 10 km.

[0011] Recently some alternative concepts have appeared. U.S. Pat. No. 6,488,087 describes a method for communication of fluid between a first and second oil well, where one main well intersects a formation with fractures that extend towards the outer side from the main well towards the interior of the formation. U.S. Pat. No. 6,488,087 uses sensors in the oil wells to transmit by electromagnetic sound waves and similar methods indications on the fluid characteristics in a remote station.

[0012] On the other hand, in U.S. Pat. Nos. 5,923,170 and 5,485,089 methods are presented that determine the distance and direction of target wells from a well that is being drilled, through the use of electronic measuring instruments. However, the described methods in the patents above only deal with determining distances between parallel wells.

[0013] Therefore, we can verify that the state of the art only provides instruction for hydrocarbon production from horizontal, vertical, directional, or multilateral wells, through the well itself, that is, through the head of the well itself. When this does not take place, drain off is accomplished through fractures in underground formations, without an effective interception and mechanical connection between wells.

[0014] Drilling techniques that determine the distance from one well to another have been used for drilling parallel wells, and not for the purpose of draining hydrocarbons from one well to another.

[0015] Therefore, there is a need in the art for a technical and economical feasibility in the production and/or injection
of hydrocarbons in land and offshore production zones, where there are physical, financial, or technical limitations.

SUMMARY OF THE INVENTION

[0016] The present invention proposes, in general terms, a method for the production and/or injection of hydrocarbons for development of oil zone production, where two or more wells are mechanically connected permitting the liquid or injected (injection) fluids from one of the wells to drain through connected wells.

[0017] Therefore, the main objective of the present invention provides a method for the interception and connection of oil wells.

[0018] Another objective of the present invention refers to a method for the drain off and/or injection of hydrocarbons through two such connected oil wells.

[0019] The method in accordance with the present invention may be used in the both land and offshore environments and among other benefits it may be applied in any formation functioning as a subterranean duct, draining hydrocarbons from under towns, draining off heavy oil towards the shallower waters, taking advantage again of “slots” in fixed platforms, or even reaching injection areas of difficult access and high cost.

[0020] Furthermore, the method presented in this invention allows lateral wells, through the installation of completion equipment, to control its production and/or controlled injection, as well as receiving equipment to optimize the production or injection. Lateral wells may be abandoned when necessary. These alternatives produce a significant cost x benefit ratio in comparison to current propositions.

[0021] Connecting sub-surface oil wells allows full exploitation of underground formations to be feasible, substituting or reducing the number of locations. Also, the method presented in this invention allows production/injection through fixed production units, connecting drilled wells such as maritime production units. Said maritime production units may be fixed or may be semi-submerged ships so that flowing from the well will take place in fixed production units. This means a drastic reduction in production costs and will revitalize financially mature sites. Therefore, using the method presented by this invention in deep water allows the production flow of hydrocarbons in deep waters towards shallower water in the bottom of the well, or that which is done today at the bottom of the sea through production lines, and because they are subject to environmental conditions, they create technical and economical limitations. The method of production of this invention also makes heavy oil production zone development economically feasible in deep waters where drilling conventional wells (horizontal, for example) create limitations.

[0022] By this method, it will also be possible to reduce costs in zones where environmental limitations do not permit placement of production units (environmental reserve areas), such as for example, coastal subterranean hydrocarbon formations that may be tapped by a production unit farther away from the coast with drilled wells and afterwards have the oil production drained off through a connection with a drilled well at the land location.

[0023] One of the advantages of this invention is that the simple connection of two oil wells may easily, with lower risk factors, reach the exposed area’s fold or, when applicable, allow drain off of the oil over long distances, for example for over a kilometer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a top view of the production area with interlinked multilateral wells, in accordance with the present invention.

[0025] FIG. 2 is a side view of the production area with interlinked drilled multilateral wells, in accordance with the present invention.

[0026] The modalities of this invention shall now be described, as an example only regarding the drawings that follow.

[0027] The attached Figures shall be used as numerical references to designate equal or similar parts.

DETAILED DESCRIPTION OF THE INVENTION

[0028] The method of interception and connection of the wells proposed by this invention shall now be described as referenced in FIGS. 1 and 2. It should be noted that the Figures represent the geometry of the multilateral wells, indeed, this method may be applied to any type of drilled well through proper geometry, in order to reach underground formations.

[0029] FIGS. 1 and 2 show the method for interception and connection of multilateral wells that are composed of the following stages:

[0030] 1. Drill and complete the primary multilateral well 1;

[0031] 2. Drill at least one second multilateral well 2 located at a point away from the head of the well of the primary multilateral well 1, with a production probe providing support to the primary multilateral well 1;

[0032] 3. Intercept the primary multilateral well 1 from the second multilateral well 2, by using a proper tool, such as for example, a magnetic emitter;

[0033] 4. Mechanically connect the primary multilateral well 1 with the second multilateral well 2;

[0034] 5. Finish connecting both of the multilateral wells 1 and 2, allowing for the produced or injected fluid to drain off from one multilateral well to the other;

[0035] 6. Produce or inject from one of the multilateral wells 1 and 2 in such a way that the well, (in which production is not taking place at the moment) is or not closed for production or injection optimization.

[0036] The implementation of each of this invention’s methods of interception and connection stages of the multilateral wells will be described in greater detail below.

[0037] Stage 1

[0038] a) Drill a multilateral well 1 according to the requirements for production area development, which, using proper geometry, should reach at least one subterranean formation. In this prototype, multilateral well 1 reaches underground formations E and D (also called reservoirs), which contain hydrocarbons.
As shown in FIGS. 1 and 2, in multilateral well 1 the lateral wells 1A, 1B have been drilled. These lateral wells 1A, 1B, connect underground formations E and D.

b) Encase a part of the main well of multilateral well 1 with steel pipes, leaving a section of the well open to carry out connecting operations;

c) Complete lateral wells 1A, 1B of the primary multilateral well 1 with a proper filtering device, after multilateral main well 1 has been encased. In this stage, proper filtering devices may be a cut "liner", cloth, gravel pack or similar devices.

Stage 2

d) Drill at least one second multilateral well 2 according to the requirements for production area development, which, using proper geometry, should reach at least one subterranean formation, containing hydrocarbons. Said subterranean formation should be located at a point away from the head of the first well of the primary multilateral well 1, with a production probe providing support to the primary multilateral well 1.

In this prototype, multilateral well 2 reaches underground formations B and C, which contain hydrocarbons. As shown in FIGS. 1 and 2, in multilateral well 2 the lateral wells 2A, 2B have been drilled. These lateral wells 2A, 2B connect underground formations B and C. If desired, a third multilateral well 3 may still be drilled, which also will follow the same procedure described above.

e) Complete lateral wells 2A, 2B of the second multilateral well 2 with a proper filtering device. A proper filtering device would be a cut "liner", cloth, gravel pack or similar device.

f) Encase with steel pipes the main well of the multilateral well 2;

Stage 3

g) Install a magnetic emitter in multilateral well 1 to orient the interception of multilateral well 1 towards another multilateral well, such as for example, multilateral well 2;

h) To gain access for the interception from multilateral well 2 to multilateral well 1, using conventional tools of navigation with the effect of the magnetic field emitted by the transmitter located in multilateral well 1;

i) Leave a fluid differential, when possible, in order to be aware of the interception in one of the wells;

Stage 4

j) Make a mechanical connection between the wells using a hollow guide shoe connected to an external casing packer, which has one end connected to the primary steel tube used for casing multilateral well 2. When the entire external packer is positioned inside the casing pipe of multilateral well 1, said packer will be inflated so that the insulated polymer will expand and create a hydraulic seal in the connection. Alternatively a mandril, a set of wash-cups and hollow guide shoe may be used all connected to the casing column.

Stage 5

k) Finish the well duct (main well), allowing for the oil fluid to drain off from one multilateral well another multilateral well;

Stage 6

1) Produce (or inject) both wells through multilateral well 2 or multilateral well 1, for example.

Once the connection and interception of the wells has been made, put multilateral well 1 into production so that the oil or injection may flow from multilateral 2.

In the method above described, multilateral well 2 may be a multilateral well with two legs and receive hydrocarbons from a third multilateral well 3.

The method for drain off of oil and/or injection through two interconnected oil wells, in accordance with this invention, is carried out by draining the oil production from two or more horizontal/multilateral connected wells, moving towards a well where the production will take place towards surface installations.

In this way, for a given area of deep water oil production, for example, a set of multilateral wells with two legs can be defined. Multilateral well 1 may be placed in shallower waters at a distance of 20 km from the head of multilateral well 2, situated in ultra deep waters, where it is possible to drill, but not possible to produce by conventional methods. One of the offshoots (not shown) of multilateral well 2 is drilled to reach a subterranean formation containing hydrocarbons in ultra deep waters. The other offshoot of multilateral well 2 will be connected to one of the #offs of multilateral well 1, situated in deep waters where it can be put into production. The other offshoot of well 1 may be used, either to connect with the other multilateral well or to connect with another area with hydrocarbons, or said offshoot may simply not exist, configuring, in this case, a horizontal well. In this way the hydrocarbons that are in the zone of ultra deep waters may drain off from multilateral well 2 towards multilateral well 1, where it will reach the production facility.

It should be mentioned that when the original pressure of the underground formations or from several underground formations is not sufficient to overcome the loss of load generated during the oil drain off, pumps may be used to help displace the fluid, similar to what is currently used in isolated wells (not connected).

The pumps may, for example, be installed in junctions between the multilateral wells. Additional offshoots to the well duct may be considered, made to come from or to be from multilateral well 1 or from multilateral well 2 that is closed. The connecting lateral branches are encased in steel pipes with hydraulic integrity, including at the connection between the wells.

1. Method for interception and connection of underground formations characterized by the following stages:

- drill and complete a primary multilateral well and encase a part of the main well of the multilateral well, leaving a section of the well open to carry out connecting operations;
drill at least one second multilateral well, located at a point away from the head of the well of the primary multilateral well, and encase the main well of the second multilateral well; intercept the primary multilateral well from the second multilateral well, by using a proper tool; mechanically connect the primary multilateral well with the second multilateral well; finish connecting both of the multilateral wells, allowing for the produced or injected fluid to drain off from one multilateral well to the other; produce or inject from one of the multilateral wells in such a way that the well, (in which production is not taking place at the moment) is or not closed for production or injection optimization.

2. Method in accordance with claim 1, characterized by including the stages of:

a) drill a multilateral well to be made according to the requirements for production area development, which, by using proper geometry, shall reach at least one subterranean formation, said multilateral well should have lateral wells connected to the underground formations.

b) encase a part of the main well of primary multilateral well steel pipes, leaving a section of the well open to carry out connecting operations;

c) complete lateral wells of the primary multilateral well with a proper filtering device, after the main multilateral well has been encased;

d) drill at least one second multilateral well according to the requirements for production area development, which, using proper geometry, should reach at least one subterranean formation, containing hydrocarbons. Said subterranean formation should be located at a point away from the head of the first well of the primary multilateral well, with a production probe providing support to the primary multilateral well, said second multilateral well should possess lateral wells;

e) complete lateral wells of the second multilateral well with a proper filtering device;

f) encase the main well of the multilateral well;

g) install a magnetic emitter in the primary multilateral well to orient the interception of the primary multilateral well towards another multilateral well;

h) to gain access for the interception from the primary multilateral well to the second multilateral well, using conventional tools of navigation with the effect of the magnetic field emitted by the transmitter located in primary multilateral well;

i) leave a fluid differential, when possible, in order to be aware of the interception in one of the wells;

j) make a mechanical connection between the multilateral wells;

k) finish the well duct (main well), allowing for the oil fluid to drain off from one multilateral well another multilateral well;

l) produce or inject both multilateral wells through the second multilateral well or the primary multilateral well.

3. Method in accordance with claim 2, characterized by a filtering device such as a cut “liner”, cloth, or gravel pack.

4. Method in accordance with claim 2, characterized by a connection between the wells in Stage (j) to be made using a hollow guide shoe connected to an external casing packer, which has one end connected to the primary steel tube used for casing the second multilateral well.

5. Method in accordance with claim 2, characterized by a connection between the wells of Stage (j) to be made using a mandril, a set of wash-cups, and a hollow guide shoe; all connected to the casing column.

6. Method for producing and/or injecting hydrocarbons through connecting underground formations, characterized by being carried into underground formations connected by the method of claim 1.

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