METHOD FOR MAKING WELLS FOR REMOVING FLUID FROM A DESIRED SUBTERRANEAN

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ABSTRACT

This invention provides a method for removing fluid from a desired subterranean formation. A substantially vertical main well that extends from a surface through the desired subterranean formation to a point below the desired subterranean formation is provided. The substantially vertical main well has a seam section that begins at a top of the desired subterranean formation and ends at a bottom of the desired subterranean formation. The seam section has substantially the same diameter as a substantially vertical main well bore lower section. An intersecting well bore that is offset horizontally from the substantially vertical main well bore and intersects the seam section of the substantially vertical main well bore.
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BACKGROUND OF THE INVENTION

10001) 1. Field of the Invention

This invention relates generally to removing fluid from a desired subterranean formation and more particularly to a method for making wells for removing fluid from a desired subterranean formation.

10002) 2. Description of the related art

Subterranean formations often contain desirable fluids that can be used for many applications. Therefore, there is need to remove the desirable fluids from the desired subterranean formation. The desired subterranean formations often extend horizontally over many thousands of feet and are often very shallow in depth.

10005) One prior art method used to remove desired fluids from a desired subterranean formation is drilling a horizontal well. The horizontal portion of the well may extend over a significant length of the desired subterranean formation. When the horizontal portion of the well extends over a significant length of the desired subterranean formation, it intersects multiple natural fractures within the desired subterranean formation. The natural fractures provide a pathway for fluids to migrate to the well bore.

10006) The desired subterranean formation often contains other fluids beside the desirable fluids that need to be removed before the desirable fluid can be removed. In prior art methods that only use a horizontal well having only a substantially vertical section, curved section and a horizontal section, it is difficult to remove the other fluid and thus makes the horizontal well inefficient for removing the desired fluid.

10007) Another prior art method used to remove the desirable fluid from the desired subterranean formation is drilling a vertical well. However, vertical wells only drain a small amount of desirable fluid around the radius of the vertical well because it only intersects a few natural fractures within the desired subterranean formation without any external stimulation. Thus, the vertical well can be inefficient for removing desirable fluid from the desired subterranean formation.

10008) In prior art methods using a vertical well or a horizontal well, it is desirable to use underbalanced drilling. Drilling fluid is often used during the drilling operations. The drilling fluid can be used to remove drilling shavings or cuttings and force them to the surface through circulation of the fluids. If the hydrostatic pressure created by the drilling process exceeds the natural pressure of the desired subterranean formation, the drilling shavings or cuttings may be forced into the formation.

10009) Another method previously used to remove desirable fluids is described in U.S. Pat. No. 6,280,000 issued to Zipanic. This method uses both a horizontal well and a vertical well that intersect each other. This method solves some of the problems of the prior art. However this method utilizes the drilling of an enlarged cavity in the vertical well. The enlarged cavity is more costly and requires a longer period of time to construct. The large diameter cavity can induce unstable conditions at the intersection of the horizontal and vertical well bores that causes the exposed coal and/or rock to fall and accumulate within the cavity or well bore. This accumulation impairs removal of fluids from the cavity or well bore.

SUMMARY OF THE INVENTION

This invention provides a method for removing fluid from a desired subterranean formation. A substantially vertical main well that extends from a surface through the desired subterranean formation to a point below the desired subterranean formation is provided. The substantially vertical main well has a seam section that begins at a top of the desired subterranean formation and ends at a bottom of the desired subterranean formation. The seam section has substantially the same diameter as a substantially vertical main well bore lower section. An intersecting well bore that is offset horizontally from the substantially vertical main well bore and intersects the seam section of the substantially vertical main well bore is provided. A means for removing fluid from the substantially vertical main well is provided.

The intersecting well bore can exit the seam section. The intersecting well bore can have a substantially vertical section. The intersecting well bore can have a slant section. The intersecting well bore can have a substantially horizontal section that is in the desired subterranean formation.

This invention provides for a method for removing fluid from a desired subterranean formation wherein a substantially vertical main well that intersects and exits the desired subterranean formation is provided. There is a fracture zone around the substantially vertical main well bore in the desired subterranean formation.

BRIEF DESCRIPTION OF THE DRAWINGS

The Figures referred to in the following embodiments are not to scale and are intended as illustrative representations of the described method for making a well for removing fluid from a desired subterranean formation.

FIG. 1 illustrates a cross-sectional view of a substantially vertical main well penetrating through and extending below a desired subterranean formation with an intersecting well bore intersecting the substantially vertical main well at the seam section.

FIG. 2 illustrates a cross-sectional view of a substantially vertical main well incorporating different casings and a bridge plug and a baffle.

FIG. 3 illustrates a cross-sectional view of a substantially vertical main well penetrating through and extending below a desired subterranean formation with an intersecting well bore intersecting the substantially vertical main well at the seam section and exiting the seam section.
FIG. 4 illustrates a cross-sectional view of a substantially vertical main well penetrating through and extending below a desired subterranean formation with an intersecting well bore intersecting the substantially vertical main well at the seam section and the intersecting well bore having a slant section.

FIG. 5 illustrates an isometric cross-sectional view of a substantially vertical main well having a fracture zone and an offset well bore having a first and second lateral well bore.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Definitions

"Fluid" means all liquids and gases including but not limited to water, brine, chemically entrained liquids, foam, air, nitrogen or hydrocarbons injected into and/or removed from a well.

"Desired subterranean formation" means a geologic stratum or strata targeted for recovery of hydrocarbons. These geologic strata include but are not limited to coal seams, carbonaceous shales, silicious shales, sandstone, limestones, chalk or any target formation containing hydrocarbons.

"Surface" means the topographic location on the Earth’s surface that has been designed for the purpose of drilling a well and accommodates any associated support facilities and equipment needed during the drilling process.

"A point below the desired subterranean formation" means an elevation (typically referenced to sea level) in feet or meters that is less than the elevation of the bottom of the desired subterranean formation.

"Seam section" is the portion of the main well bore that runs through the desired subterranean formation.

"Top of the desired subterranean formation" is the highest elevation point in the desired subterranean formation at the main well bore.

"Bottom of the desired subterranean formation" is the lowest elevation point in the desired subterranean formation at the main well bore.

"Substantially the same diameter" means having a similar measurement length of a straight line through the center of an object. For example, the width across the center of the well bore at one point is 10 inches and at another point 7 inches. The two points have substantially the same diameter.

"Well" means an orifice in the ground made by drilling, boring or any other means, from which fluids such as water, oil and gas are recovered or that was made for the purpose of recovering such fluids. A well may also provide a means for injecting fluids into a desired subterranean formation. A well is drilled from a surface elevation to a desired subterranean formation(s) providing a conduit for injecting fluids and/or removing fluids from the formation(s).

"Substantially vertical main well" is a vertical well used to remove the fluid.

"Intersecting well bore" is a well bore that intersects the substantially vertical main well.

"Offset horizontally from the substantially vertical main well bore" means set apart a horizontal distance on the surface from the substantially vertical main well.

"Intersects the seam section" means to meet and enter into the seam section.

"Means for removing fluid" means any apparatus or method for removing fluids from a well including but not limited to mechanical or electric drive pumps, gas lift systems and natural reservoir pressure methods.

"Exits the seam section" means a bore that goes out from the seam section of the substantially vertical main well and extends beyond the intersection of the substantially vertical main well and the intersecting horizontal well.

"Substantially vertical section" a portion of the well that is relatively perpendicular to the surface of the graded drill site.

"Slant section" means a portion of the well that is at an angle from the surface.

"Substantially horizontal section" means portion of the well that is relatively parallel to the plane or structure of the desired subterranean formation.

"In the desired subterranean formation" means located in the desired subterranean formation.

"Composite casing" means a solid non-metallic material which is composed of two or more substances which is used to line the well bore, the material can be comprised of carbon fiber, fiberglass or various types of plastics.

"Baffle" means a mechanical device inserted within the well casing to prevent drill cuttings and fluids from exiting the well casing below or above the location where the baffle is installed.

"Bridge plug" means a mechanical device inserted inside the well casing to prevent drill cuttings and fluids from exiting up through the casing above or below the location where the bridge plug is installed.

"Drilling through the composite casing" means using a drill and bit to cut into and through the main well bore and the composite casing.

"Intersects and exits the desired subterranean formation" means entering into the top of the desired subterranean formation, passing through the formation and leaving the bottom of the formation to a point below the desired subterranean formation.

"Fracture Zone" means an area where cracks in the desired subterranean formation were formed to provide pathways for fluids to migrate to the well bore.

"Main well bore lower section" means the section of the well bore that is below the initial casings. It is the diameter of most of the well bore. It will have a slightly larger diameter than the production casing. A well for example could have a 133/8 inch casing, a 95/8 inch casing and a 7 inch casing. The bore for the 7 inch casing would be 83/8 inch. The 83/8 inch bore would be the main well bore lower section.
[0046] “Largest diameter bore of the substantially vertical main well” means the biggest diameter hole used when drilling the substantially vertical main well.

Description

[0047] FIG. 1 shows a cross-sectional view of a well site 2 that removes fluid from a desired subterranean formation 8. The present method incorporates a substantially vertical main well 4 that extends from a surface 6 through a desired subterranean formation 8 to a point below the desired subterranean formation 10. The purpose of extending the substantially vertical main well 4 below the desired subterranean formation 8 is to provide a sump or chamber for the collection of fluids to be removed to the surface 6. A benefit of the substantially vertical main well 4 below the desired subterranean formation 8 is that it ensures that the thickness and elevation data obtained from logging the desired subterranean formation 8 and the substantially vertical main well 4 is used to aid in the design of an intersecting well bore 12.

[0048] The substantially vertical main well 4 is drilled and lined with casing. The substantially vertical main well 4 may be lined with a conductor casing 22, a surface casing 24, and a production casing 28 (FIG. 2 shows the casings). The casing is cemented from the top surface 6 to the bottom of each respective casing. The need for installation of casings will be dictated by the competency of the geologic strata and the presence of water producing zones. A borehole protection casing 26 can be utilized to prevent the strata from collapsing in an open borehole.

[0049] The substantially vertical main well 4 has a seam section 16. The seam section 16 begins at the top 18 of the desired subterranean formation 8 and ends at the bottom 20 of the desired subterranean formation 8. The seam section 16 has substantially the same diameter as throughout the seam section. The cased section 16 improves the stability of the well bore as compared with prior art that uses enlarged cavity designs.

[0050] An intersecting well bore 12 is drilled from a horizontally offset point 14 on the surface 8. A preferable horizontal distance between the intersecting well bore 12 and the substantially vertical main well 4 can be between 200 and 2000 feet. The intersecting well bore 12 intersects the substantially vertical main well 4 in the seam section 16. The intersecting well bore 12 has a substantially vertical section 30 and a substantially horizontal section 32. The substantially horizontal section 32 is in the desired subterranean formation 8. The intersecting well bore 12 may have a substantially vertical section 29 that extends from the surface 6 through the desired subterranean formation 8 to a point below the desired subterranean formation 10 to ensure that logging of the desired subterranean formation 8 accurately identifies the elevation of a top 18 and a bottom 20 of the desired subterranean formation 8. The intersecting well bore 12 is drilled using drilling techniques known to those skilled in the art including underbalanced drilling. Underbalanced drilling is a method of drilling the desired subterranean formation 8 whereby the hydrostatic pressure exerted by a column of drilling fluid in the well bore and/or drill string is less than the natural pressure inherent in the desired subterranean formation 8. Underbalanced drilling techniques are utilized to prevent damage to the desired subterranean formation 8 and in particular low pressure formations. The introduction of air, nitrogen or other gases to the drilling fluids reduces the density of the co-mingled fluids and effectively decreases hydrostatic pressure. Other low density fluids such as chemical foams and air mist (compressed air and water) may be used as a drilling fluid to achieve an underbalanced condition. The underbalanced environment prevents damage to the formation and facilitates the removal of cuttings and drilling fluids that are circulated out through the annulus of the drill string to a surface collection pit.

[0051] The substantially horizontal section 32 of the intersecting well bore 12 can be drilled up dip or down dip. FIG. 1 shows down dip and FIG. 3 shows up dip. If the desired drainage area is situated between the substantially vertical main well 4 and the intersecting well 12, then the substantially horizontal section 32 is preferably drilled down dip from the intersecting well 12 toward the substantially vertical main well 4. If the desired drainage area extends laterally beyond the intersection of the substantially vertical well 4 and the intersecting horizontal well 12, then the substantially horizontal section 32 is preferably drilled up dip from the substantially vertical main well 4. Lateral boreholes can be side-tracked off of the substantially horizontal section 32 within the desired subterranean formation 8.

[0052] As seen in FIG. 2, prior to intersecting the vertical main well 4 with the intersecting well bore 12, a baffle 36 (or alternatively a bridge plug) is inserted in the substantially vertical main well 4 below the seam section 16 to prevent cuttings and fluids from entering the sump portion 38 of the substantially vertical main well 4. After drilling the intersecting well bore 12 and ensuring the correct intersection has been made with the vertical main well 4, a bridge plug 34 may be inserted into the substantially vertical main well 4 above the seam section 16. The bridge plug 34 prevents cuttings and fluids from moving up the substantially vertical main well 4 above the bridge plug. The bridge plug 34 and baffle 36 (or second bridge plug) provide an internal seal that forces the cuttings and fluids to return through the intersecting well 12 to the surface 6.

[0053] The production casing 28 has a composite casing section 40 in the area of the seam section 16. Above and below the composite casing section 40, the production casing 28 is metal. The composite casing extends to a point above and below the seam section 16. When intersecting the substantially vertical main well 4 with the substantially horizontal section 32 of the intersecting well bore 12, the composite casing can be drilled through. As can be seen in FIG. 2, the diameter of the borehole drilled in the seam section 16 is substantially the same diameter as the substantially vertical main well bore lower section 56 which is less than or equal to the diameter of the largest diameter bore of the substantially vertical main well 4. Previous prior art methods required drilling of an enlarged cavity in the seam section 16. Well bore interception is accomplished by equipping the drill string in the access hole with a rotating magnet, a standard MWD (Measure While Drilling) tool, mud motor, and drill bit. From the surface, a magnetic field sensing tool is deployed by wireline into the target well. The sensing tool
detects the electromagnetic signal from the magnet. The distance and direction between the well is calculated. The drill bit is subsequently guided towards the acquired target.

[0054] As an alternative to installing a section of composite casing through the seam section 16, the entire production casing 28 can be metal. In the seam section 16 the metal casing is milled out so that intersection with the intersecting well can take place.

[0055] The substantially vertical main well 4 can be intersected by multiple intersecting well bores (not shown).

[0056] After the substantially vertical main well 4 is intersected by the intersecting well bore 12, the intersecting well bore 12 can be capped. A downhole pump is placed in the substantially vertical main well 4 to pump fluid from the desired subterranean formation 8 to the surface 6.

[0057] As shown in FIG. 3, the intersecting well bore 12 can have an exiting section 42 that exits the substantially vertical main well 4. There can be laterals side-tracked off of the exiting section 42 as well as laterals side-tracked from the substantially horizontal section 32.

[0058] FIG. 4 shows an alternate embodiment where the intersecting well bore has a slant section 31.

[0059] FIG. 5 shows an alternate method for removing fluid from a desired subterranean formation 8. The substantially vertical main well 4 is provided. A fracture zone 44 is created around the substantially vertical main well 4. Instead of intersecting the substantially vertical main well 4, an offset well bore having a substantially horizontal portion 46 within the desired subterranean formation 8 is drilled. A first lateral well bore 48 is drilled from an end of the substantially horizontal portion 46 on a first side 50 of the substantially vertical main well 4. A second lateral well bore 52 is drilled from an end of the substantially horizontal portion 46 on a second side 54 of the substantially vertical main well 4.

We claim:

1. A method for removing fluid from a desired subterranean formation comprising:

(a) providing a substantially vertical main well which extends from a surface through the desired subterranean formation to a point below the desired subterranean formation, the substantially vertical main well has a seam section that begins at a top of the desired subterranean formation and ends at a bottom of the desired subterranean formation, the seam section has a diameter less than or equal to the largest diameter bore of the substantially vertical main well;

(b) providing an intersecting well bore that is offset horizontally from the main well bore, and intersects the seam section of the main well bore; and

(c) providing a means for removing fluid from the main well bore.

2. A method for removing fluid from a desired subterranean formation as recited in claim 1 wherein the intersecting well bore exits the seam section.

3. A method for removing fluid from a desired subterranean formation as recited in claim 1 wherein the intersecting well bore has a substantially vertical section.

4. A method for removing fluid from a desired subterranean formation as recited in claim 1 wherein the intersecting well bore has a slant section.

5. A method for removing fluid from a desired subterranean formation as recited in claim 1 wherein the intersecting well bore has a substantially horizontal section in the desired subterranean formation.

6. A method for removing fluid from a desired subterranean formation as recited in claim 1 including a composite casing in the seam section of the main well bore.

7. A method as recited in claim 6 including installation of a baffle or bridge plug below the seam section of the main well bore.

8. A method as recited in claim 6 including installation of a bridge plug above the seam section of the main well bore.

9. A method for removing fluid from a desired subterranean formation as recited in claim 6 wherein the intersection of the intersecting well bore and the main vertical well bore is done by drilling through the composite casing.

10. A method as recited in claim 9 including installation of a baffle or bridge plug below the seam section of the main well bore.

11. A method as recited in claim 9 including a bridge plug above the seam section of the main well bore.

12. A method as recited in claim 1 including a baffle below the seam section of the main well bore.

13. A method as recited in claim 1 including a bridge plug above the seam section of the main well bore.

14. A method for removing fluid from a desired subterranean formation comprising:

(a) providing a substantially vertical main well bore that intersects and exits the desired subterranean formation;

(b) providing a fracture zone around the main well bore in the desired subterranean formation;

(c) providing an offset well bore that is offset horizontally from the main well bore, and has a substantially horizontal portion in the desired subterranean formation in the direction of the main well bore;

(d) providing a first lateral well bore from an end of the substantially horizontal portion of the offset well bore and continues in the desired subterranean formation on a first side of the main well bore without intersecting the main well bore and into the fracture zone; and

(e) providing a means for moving fluid from the main well bore.

15. A method for removing fluid from a desired subterranean formation as recited in claim 14 including providing a second lateral well bore from the end of the substantially horizontal portion of the offset well bore and continues in the desired subterranean formation on a second side of the main well bore without intersecting the main well bore and into the fracture zone.

16. A method for removing fluid from a desired subterranean formation as recited in claim 5 including a lateral well drilled off of the substantially horizontal section of the intersecting well bore.

17. A method for removing fluid from a desired subterranean formation comprising:

(a) providing a substantially vertical main well which extends from a surface through the desired subterranean formation to a point below the desired subterrane-
A method for removing fluid from a desired subterranean formation as recited in claim 17 including a composite casing in the seam section of the main well bore.

A method as recited in claim 22 including installation of a baffle or bridge plug below the seam section of the main well bore.

A method as recited in claim 22 including installation of a bridge plug above the seam section of the main well bore.

A method for removing fluid from a desired subterranean formation as recited in claim 22 wherein the intersection of the intersecting well bore and the main vertical well bore is done by drilling through the composite casing.

A method as recited in claim 25 including installation of a baffle or bridge plug below the seam section of the main well bore.

A method as recited in claim 25 including a bridge plug above the seam section of the main well bore.

A method as recited in claim 17 including a baffle below the seam section of the main well bore.

A method as recited in claim 17 including a bridge plug above the seam section of the main well bore.

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