PROCESS AND SYSTEM FOR THE RECOVERY OF VISCOS OIL

INJECTION FLUID

TUBING 31

CASING 21

PACKER 33A

STEAM & HOT WATER FLOW

OIL SAND 13

STEAM & HOT WATER FLOW

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ABSTRACT OF THE DISCLOSURE

A well bore is drilled into a subsurface formation containing viscous oil and then a plurality of wells is drilled to intercept the well bore and hot fluid is injected into the formation through the plurality of wells to cause viscous hydrocarbons to flow into the well bore.

The present invention is directed to recovery of viscous oil. More particularly, the invention is concerned with the recovery of viscous oils by the use of heat. In its more specific aspects, the invention is concerned with the recovery of viscous oils in which heated fluids are injected into a subsurface earth formation containing the viscous oil.

The present invention may be briefly described as a method of recovering viscous hydrocarbons from a subsurface earth formation containing the viscous hydrocarbons in which a well bore is drilled at least into the subsurface earth formation containing the viscous hydrocarbons. This well bore may be relatively large and may have a diameter ranging from about 1 to about 10 feet. Preferably, it will have a diameter in the range from about 2 to about 5 feet. The well bore may be drilled to provide a sump in which the viscous oil may accumulate. A plurality of wells is then drilled to intercept the well bore in the subsurface formation at a point preferably above the bottom of the well bore. The well bore and the plurality of wells communicate fluidly with the subsurface formation. A heated fluid which may be, air, steam, hot water, combustion products or the like may be injected into the formation from the plurality of wells. Injection of the heated fluid causes heating of the subsurface formation and, therefore, causes the viscosity of the viscous hydrocarbons to be reduced to the extent that the viscous hydrocarbons flow into and accumulate in the well bore. The heated viscous hydrocarbons may flow through the formation to the well bore and/or into the plurality of wells and thence into the well bore. Ordinarily, both flows may occur. Thereafter, the viscous hydrocarbons may be removed from the well bore such as by pumping.

The temperature of the heated fluid, whether it be steam, hot water, air or combustion products, should be sufficient to heat the formation and to cause the viscous hydrocarbons to flow. A suitable temperature of the heated fluids may range from about 150°F. to about 650°F.

In the practice of the present invention, it is contemplated that the well bore will be of relatively large diameter such as a diameter in the range of about 1 to about 10 feet. A well bore ranging in diameter from about 2 to about 5 feet may be satisfactory. Likewise, in accordance with the present invention, the well bore should be drilled into the formation a sufficient distance to provide a sump in which the viscous hydrocarbons accumulate. Thus, the well bore may be drilled completely through the subsurface formation containing the viscous hydrocarbons to provide a sump for the viscous hydrocarbons. The well bore may or may not be cased or lined with pipe.

Conversely, the wells which intersect the well bore should intersect the well bore at a point above the bottom of the well bore such that a sump is provided for accumulation of viscous hydrocarbons in the well bore.

In accordance with the present invention, it is contemplated that the heated fluid will be injected selectively from the plurality of wells into the subsurface formation to cause heating of same and reduction of viscosity of the viscous hydrocarbons. Preferably, the heated fluid is injected selectively near the top of the viscous hydrocarbon-containing subsurface earth formation, but it is within the contemplation of the present invention that the heated fluid may be injected at any selected point in the subsurface formation. This may be accomplished by providing a vertically movable valved injector pipe or tubing in each of the wells. The pipe is valved at its lower end and is also provided with a packer means just above the valve. A section of the pipe is slotted or perforated above the packer to allow fluid communication between the interior and exterior of the pipe. The valve means may be opened by response to certain temperatures or pressures. As the pipe is moved downwardly in the well, the packer and closed valve control the area of fluid injection into the formation.

Another means of injecting the heated fluid at a selected point is to provide a valved pipe similar to that mentioned above with the added provision of two packers spaced apart, above and below the perforated or slotted section. In either case, all or part of the heated fluids may be pumped into the formation through the well bore to the recovery well.

The present invention also involves a system for recovery of viscous hydrocarbons from a subsurface earth formation containing the viscous hydrocarbons which involves a well bore penetrating the subsurface formation having openings or perforations into the subsurface formation. A plurality of wells intersect the well bore in the subsurface formation and extend laterally through the subsurface formation, each of the plurality of wells having openings or perforations into the subsurface formation. Means are provided in each of the plurality of wells for injecting a heated fluid from the wells at least at a selected point into the subsurface earth formation. Means are provided in the well bored for recovering viscous hydrocarbons which flow into and accumulate in the well bore. Such means may include a pumping or other lifting means. The present invention is quite advantageous and useful in that it allows substantially complete recovery of viscous hydrocarbons from subsurface earth formations which heretofore has been accomplished only with difficulty.

The present invention will be further illustrated by reference to the drawing in which:

FIGURE 1 is a sectional view of a system in which the present invention is employed;

FIGURE 2 is a top view looking down on an arrangement of wells in accordance with the present invention;

FIGURE 3 is an enlarged fragmentary view of a por-
is evident that part of the oil may flow directly from the formation into the sump of the recovery well 12. As the formation surrounding the slotted section, such indication is by the short, arrowed lines while steam and hot water flow is indicated by the long curved arrowed lines. The flow of oil and water into the recovery well 12 is indicated by the heavy arrowed lines. While it may be preferred to introduce the hot or heated fluid into the formation 13 adjacent the top thereof as shown in FIGURE 3, it is within the contemplation of the present invention to introduce the hot fluid selectively into any portion of the formation 13. Thus, at the beginning of the operation, it may be desirable to introduce the hot fluid near the top of the formation 13 and thereafter selectively and/or progressively introduce the hot fluid at lower points in the formation. This may be accomplished also by moving a tubing string such as 31 carrying a valve, such as 32, and packer 33 down any of the wells 15, 16, 17 or 18 and causing same to open by pressure differential, specific temperature, or by manipulation by wire lines from the surface as may be desired. For specific spotting of injection fluids into the formation, it is evident that the straddle packers of FIGURE 4 would be more desirable.

The techniques for drilling large shafts ranging in diameter from 1 to 10 feet are well known and, therefore, will not be described further herein. Likewise, the techniques for drilling directional wells are well known and need not be described further.

As examples of types of viscous oil which may be recovered in accordance with the present invention, there are oil fields in California, Kansas and Texas, and elsewhere in the world which are susceptible to treatment in accordance with the present invention and recovery of hydrocarbons therefrom. Thus, the present invention is quite important and useful and also advantageous.

The nature and objects of the present invention having been completely described and illustrated, and the best mode and embodiment contemplated set forth, what we wish to claim as new and useful and secure by Letters Patent is:

1. A method of recovering viscous oil from a subsurface formation containing said viscous oil which comprises:

   - Drilling a well bore at least into said subsurface formation;
   - Drilling a plurality of wells to intersect said well bore in said subsurface formation;
   - Said well bore and said plurality of wells communicating fluidly with said subsurface formation;
   - Injecting a heated fluid into said formation from said plurality of wells;
   - Thereby causing said viscous oil to flow into and accumulate in said well bore; and
   - Recovering said viscous oil from said well bore.

2. A method in accordance with claim 1 in which the heated fluid is steam.

3. A method in accordance with claim 1 in which the heated fluid is hot water at a temperature sufficiently above formation temperature to cause said viscous oil to flow.

4. A method in accordance with claim 1 in which the heated fluid is a gas.

5. A method in accordance with claim 1 in which the well bore is of a diameter substantially greater than the diameter of each of said plurality of wells and said well bore extends below the point where said wells intersect the well bore.

6. A method in accordance with claim 1 in which heated fluid is injected selectively from said plurality of wells at a point adjacent the top of said subsurface formation.

7. A method in accordance with claim 1 in which said viscous oil is recovered from said well bore by pumping.

8. A method in accordance with claim 1 in which the plurality of wells is directionally drilled from horizontally spaced apart points on the earth's surface from said well.
bore through said subsurface formation to expose a large area of each of said plurality of wells to said subsurface formation.

9. A method in accordance with claim 1 in which the heated fluid is injected into said subsurface formation from selected points in said plurality of wells.

10. A system for recovery of viscous oil from a subsurface earth formation containing viscous oil which comprises:
   a well bore penetrating said subsurface formation having openings into said subsurface formation;
   a plurality of wells intersecting said well bore in said subsurface formation extending laterally through and having openings into said subsurface formation;
   means in said wells for injecting a heated fluid from said wells at least at a selected point into said subsurface formation; and

means adjacent the bottom of said well bore for recovering viscous oil which flow into and accumulate in said well bore.

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