July 27, 1965 H. K. VAN POOLLEN 3,196,947

METHOD FOR FACILITATING THE PRODUCTION OF VISCOUS PETROLEUM THROUGH A WELL

Filed June 14, 1962 3 Sheets-Sheet 1

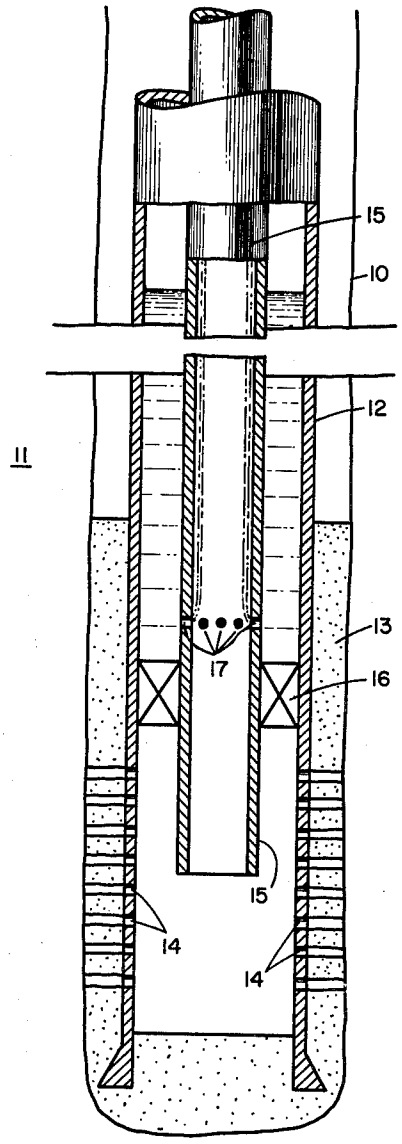

Fig. 1

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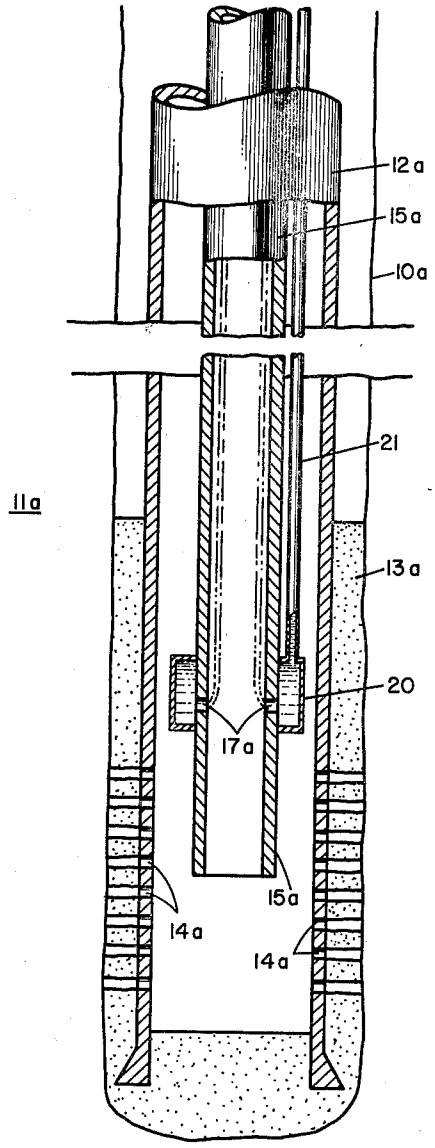

Fig. 2

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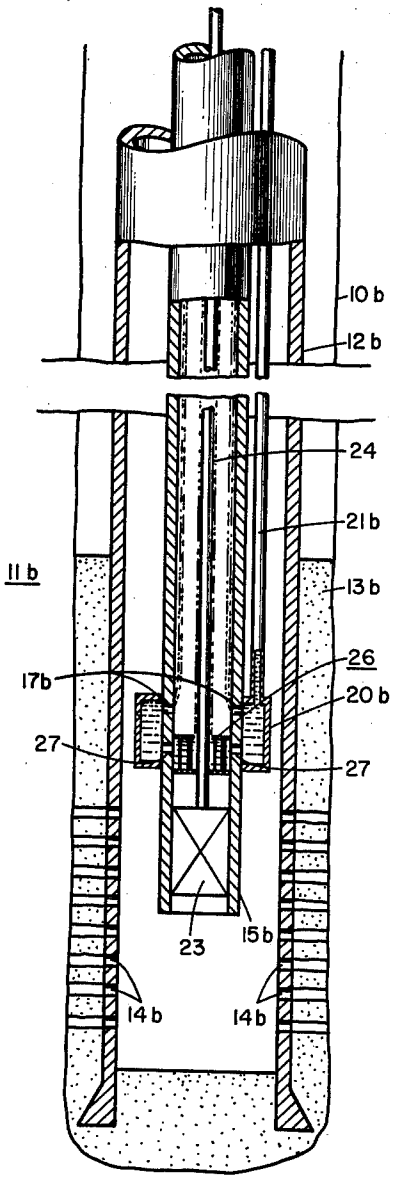

Fig. 3

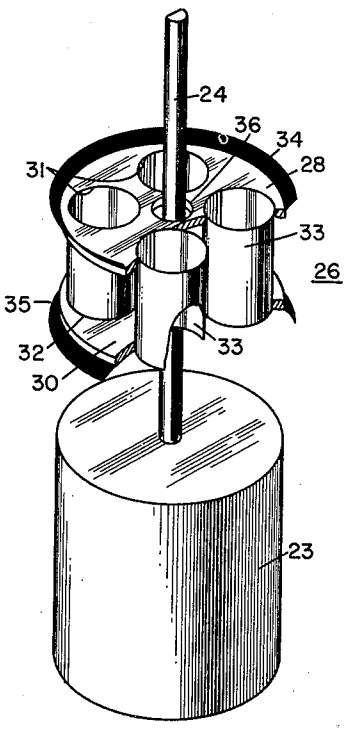

Fig. 4

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3,196,947

Patented July 27, 1965

3,196,947

METHOD FOR FACILITATING THE PRODUCTION OF VISCOUS PETROLEUM THROUGH A WELL

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Filed June 14, 1962, Ser. No. 202,574
4 Claims. (Cl. 166—45)

This invention relates to the production of petroleum from natural formations and particularly to an improved method for facilitating the production of viscous petroleum.

The production of viscous petroleum from wells is, of course, substantially more difficult than that of the lower viscosity fluids and various methods have been employed to facilitate the production of high viscosity petroleum. For example, various substances have been added in an attempt to reduce the average viscosity during production and heat has also been supplied to the production zone to lower the viscosity of the petroleum during production.

It is an object of the present invention to provide an improved method for facilitating the production of viscous petroleum from reservoir formations.

It is another object of this invention to provide an improved method for facilitating the production of viscous petroleum from wells, which method is simple and economical to employ.

Briefly, in carrying out the objects of this invention, in one example thereof, a body of water or aqueous solution capable of wetting the wall of the production tubing is provided adjacent the production zone and this solution is fed continuously in relatively small volume into the tubing about the inner periphery thereof to form an annular layer of solution between the walls and the produced petroleum; this effects lubrication between the petroleum and the tube wall and facilitates the upward flow of the viscous liquid. In variations of the method a separate supply of aqueous solution is fed continuously from the surface through a macaroni string or the like into an annulus about the production tube. When a pump is employed the aqueous solution is fed into the tubing above the pump outlet; and when the pump is driven by a sucker rod a second annulus of solution may be fed around the sucker rod for lubrication.

Instead of water or an aqueous solution, other low viscosity fluids which are not miscible with the produced liquids may be employed as the lubricating agent. For example, low molecular weight polyhydric alcohols such as ethylene glycol and glycerine may be employed.

The features of novelty which characterize this invention are pointed out with particularity in the claims annexed to and forming a part of this specification. The invention itself, however, and the procedure followed in utilizing it for the production of viscous petroleum, together with further objects and advantages of the invention, may best be understood upon reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a sectional elevation view of a cased well showing apparatus suitable for use in the practice of the invention;

FIG. 2 is a sectional elevation view similar to that of FIG. 1 illustrating another form of apparatus suitable for use in practicing the invention;

FIG. 3 is a view similar to that of FIG. 2 illustrating another apparatus suitable for the practice of the invention; and

FIG. 4 is an enlarged perspective view of a portion of the apparatus of FIG. 3.

Referring now to the drawings, FIG. 1 illustrates a well 10 drilled in a reservoir formation 11 and provided with

a casing 12 extending to the bottom of a well where it is fixed in position by an annulus of bonding material such as neat cement, as indicated at 13, and through which casing and cement perforations indicated at 14 are provided to secure access to a producing portion of the formation. A production tubing 15 extends downwardly into the well within the casing 12 and is secured in the lower portion thereof on an expandable packer 16 which isolates the bottom portion of the well adjacent the perforations 14.

During the production of petroleum fluids from a well as illustrated, the produced fluids move upwardly from the lower portion of the well through the tubing 15 to the surface. When the liquids produced are of high viscosity it becomes difficult to effect their continuous flow up through the tubing 15. Many of these wells have to be pumped and can be pumped only with difficulty. In addition a coating of the tubing results from precipitation and accumulation of solids such as paraffins and tends to impede the flow of the petroleum and to reduce production. It has been found that the transmission of liquids through pipes may be facilitated by providing an annulus of low viscosity liquid about the periphery of the pipe and in the practice of the present invention, when it is desired to increase the production of viscous petroleum, water or an aqueous solution of water and a selected surfactant is admitted to the production tubing near the production zone so that an annulus of the solution is formed between the viscous petroleum and the pipe and moves upwardly with the produced liquid. For the purposes of providing the aqueous solution a body of water or solution of water and additive is provided immediately above the packer 16 as indicated in FIG. 1, this water being maintained at a sufficient height to provide a head sufficient to force the water into openings indicated at 17 which are arranged in a ring or annulus about the lower end of the tube just above the packer 16. This water is admitted continuously at a relatively low rate and may be separated by gravity from the liquids when it reaches the surface. Water admitted in this manner not only aids the production of the petroleum liquids by providing a lubricating layer adjacent the inner wall of the tubing, but in addition minimizes the deposit of solids such as paraffins on the tubing surface and maintains the tubing in a satisfactory condition for operation and production over a longer period of time.

For some applications, it may be desirable to admit the water through a separate supply such as indicated in FIG. 2. In this figure the well casing and tubing are essentially the same as shown in FIG. 1 and have been designated by the same numerals with the suffix letter "*a*." In this installation, instead of employing a packer such as that indicated at 16 of FIG. 1, the water is supplied through an annulus 20 about the tubing 15*a* adjacent the annulus of openings indicated at 17*a*. Water or aqueous solution is supplied to the annulus 20 through a macaroni string or other suitable conduit indicated at 21. By this arrangement it is possible to maintain a sufficient pressure at the holes 17*a* to assure a continuous supply of the solution to the interior wall of the tubing 15*a* so that high viscosity liquid supplied to the tubing will move upwardly with lubrication provided by the solution in the manner described heretofore.

Another installation in which the method of this invention may be employed is that illustrated in FIG. 3 wherein again the reservoir formation, casing and tubing are essentially the same as that of FIG. 2, and in this figure have been designated by the same numerals with the suffix letter "*b*." In the well of FIG. 3 a pump indicated diagrammatically at 23 is employed to produce the petroleum fluids from the formation through the perforations 14*b* and is actuated by a sucker rod 24 which is

reciprocated by a horsehead or similar mechanism (not shown) located at the well head in the usual manner. Operation of this system is essentially the same as that of the system shown in FIG. 2 and the same method of production may be employed, solution being admitted to the tubing 15*b* through openings 17*b* located in a ring immediately above the outlet of the pump 23; the solution is supplied from an annulus 20*b* fed through a macaroni string 21*b*.

In order to secure the full benefit of the method of this invention, the sucker rod 24 is provided with a surface layer of lubricating fluid to facilitate its reciprocation in the viscous petroleum. For this purpose an annular manifold assembly 26 is positioned in the tubing 15*b* above the pump adjacent a plurality of perforations 27 in the walls of the tubing and which open into the annulus 20*b*. As clearly indicated in FIG. 4, the assembly 26 comprises two spaced end plates 28 and 30 having openings 31 and 32, respectively, connected by short tubes 33. The assembly is positioned centrally of the tubing 15*b* on upper and lower flexible sealing rings 34 and 35 and an opening 36 is provided about the sucker rod 24 for the discharge of a layer of lubricating fluid. The lower plate 30 has a sliding seal (not shown) about the sucker rod. Thus lubricating fluid entering the assembly 26 from the annulus 20*b* flows out solely through the opening 36. The tubes 33 afford ready passage of the petroleum discharged from the pump upwardly through the assembly 26. Thus during the operation of the system lubricating fluid may be supplied both to the inner surface of the tubing and to the surface of the sucker rod thereby minimizing friction of the produced liquids along the wall of the tubing and also friction between the sucker rod 24 and the liquid.

In the practice of this invention the admission of the annulus of liquid to the inner periphery of the tubing and about the surface of the sucker rod in installations such as that of FIG. 3 is particularly effective since the vertical arrangement of the tubing minimizes any tendency of the liquid and petroleum produced to separate during the production thereof.

This method of production of viscous petroleum makes possible the natural flow of viscous petroleum in some wells where pumping has heretofore been necessary and when applied to pumped wells the method results in a reduction of the power required for the pumping operation.

While the invention has been described in connection with particular structural arrangements of petroleum wells and production apparatus, it will be understood that it is not desired that the method be limited to use with the particular apparatus illustrated and described, and it is intended by the appended claims to cover all applications of the method which fall within the spirit and scope of the invention.

I claim:

1. The method for facilitating the production of viscous petroleum from the production zone of a well which comprises providing a production tubing in the well, introducing to the well adjacent the production zone thereof a low viscosity lubricating fluid not miscible with the petroleum, and admitting the lubricating fluid to the inner periphery of the tubing about the viscous petroleum to maintain a layer of fluid about the petroleum flowing upwardly in the tubing to reduce wall friction and facilitate the flow of petroleum through the tubing.

2. The method for facilitating the production of viscous petroleum as set forth in claim 1 wherein the step of admitting lubricating fluid to the tubing is effected by providing a concentric manifold about the tubing and communicating openings between the manifold and the interior of the tubing and by employing a macaroni string for conducting the lubricating fluid from the well head to the manifold.

3. The method for facilitating the production of viscous petroleum as set forth in claim 1 wherein the step of admitting lubricating fluid to the tubing is effected by providing a peripheral ring of openings in the tubing near the bottom end, positioning a packer on the tubing between the bottom end and the ring of openings, introducing the tubing into the well casing and lowering it into production position and expanding the packer, and pouring lubricating fluid into the casing to provide a body of fluid above the packer for supplying the fluid about the periphery of the petroleum intake during production.

4. In a petroleum production system including a pump actuated by a sucker rod in a well, the method for facilitating the production of viscous liquid petroleum which comprises providing a production tubing in the well about the sucker rod and in communication with the pump, providing a manifold about the tubing and a second manifold about the sucker rod adjacent the pump, introducing a lubricating fluid to both manifolds, directing the fluid into two annular layers the first between the produced petroleum and the wall of the tubing and the second between the sucker rod and the produced petroleum, and maintaining the layers of lubricating fluid during production to reduce friction and minimize turbulence of the viscous petroleum flowing through the tubing.

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