Sept. 5, 1944. D. S. KAUFMAN 2,357,660

METHOD OF PUMPING OIL

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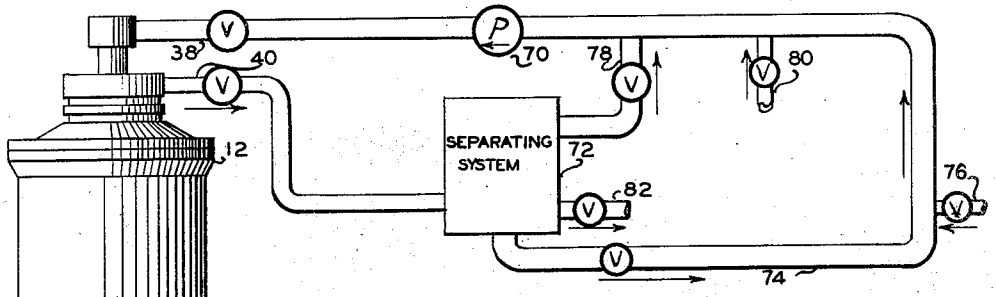
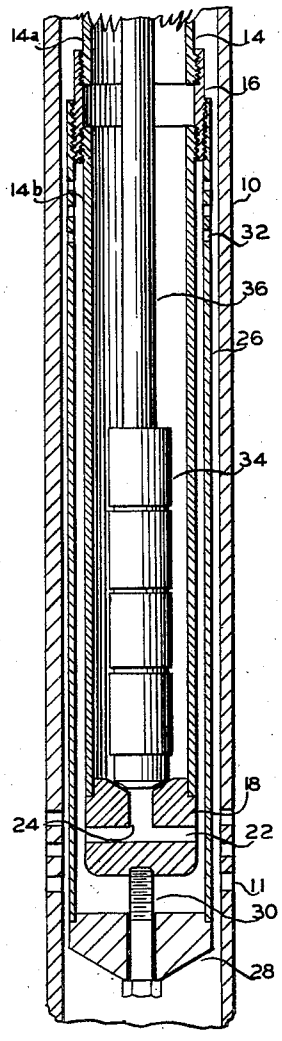


FIG. 1



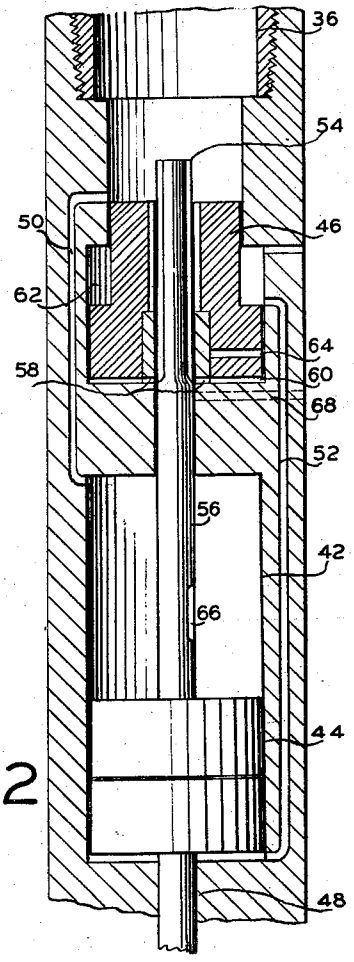


FIG. 2

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METHOD OF PUMPING OIL

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7 Claims. (Cl. 103—46)

This invention relates to a method of producing petroleum oils, and more particularly to a method of pumping such oils from underground formations by means of hydraulic pumps.

Hydraulic pumps have certain advantages over mechanical pumps when used for pumping oil wells, and their use has tended to increase during the last few years. These pumps are usually actuated by a relatively clean portion of crude oil being produced from the pumping well or nearby wells, the oil being forced down a power tubing under relatively high pressure. This power oil passes through the pump and then is exhausted into the oil being produced from the well. The power oil, therefore, becomes a part of the production oil, and new portions are continuously obtained for use in further pumping.

The chief difficulties with hydraulic pumps have been experienced when these pumps are employed for pumping oil from formations containing crude oil tending to deposit paraffin. These difficulties are encountered in the power tubing and also in the tubing carrying the production oil. It has been found that although the oil to be used as the power oil may be filtered before use, it still retains precipitable paraffin. This paraffin deposits in the relatively small diameter tubing carrying the power oil. As a result, the power required for applying adequate pressure to the oil is increased, and periodic shutdowns of the well and cleanings of the tubing are required.

The deposition of paraffin in the power tubing is especially heavy during the warm months of the year. This is thought to be due to the fact that when the oil at the surface is maintained at a relatively high temperature, light hydrocarbons are evolved and the loss of these hydrocarbons decreases the solubilizing properties of the remaining oil for paraffin. On the other hand, the problems of paraffin deposition in the flow tubing are especially troublesome during the colder months. In this case, it is thought the paraffin precipitates because the oil is cooled to a relatively low temperature in the course of its flow up the tubing. To keep the flow tubing of a well producing oil tending to deposit paraffin in condition to permit flow of oil, it has been necessary to resort to the familiar expensive methods of paraffin removal.

The present invention is concerned with a method of operating hydraulic pumps of the type described above, whereby difficulties with respect to paraffin deposition may be reduced or eliminated. The invention resides particularly in the use of a novel type of power fluid for actuating the pumps.

In order that the invention may be understood more fully, reference should be had to the drawing in which Figure 1 is a side elevation, partly in section, of an oil well equipped with a hydraulic pump. This figure also shows in diagrammatic form the flow of fluids at the surface employed in the operation of the present method. Figure 2 is an enlarged vertical sectional view of the power cylinder of a familiar type of hydraulic pump employed in oil wells.

Referring to Figure 1, a well is shown equipped with a casing **10** suspended from a casing head **12** and having perforations **11** opposite the formation. A flow tubing **14** is disposed within the casing. This flow tubing is in two sections, **14***a* and **14***b*, the two sections being connected by means of a coupling **16**. At the lower end of the section **14***b* is a shoe **18** containing passages **22** and **24**. A tubing **26** having a threaded engagement with coupling **16** defines an annular space with the external surface of section **14***b*. The bottom end of the tubing **26** is closed by means of a closure **28**. Rigidity of construction is provided by means of a bolt **30** which links closure **28** and shoe **18**. The tubing **26** is provided with perforations **32** at its upper end.

The pumping unit is represented generally at **34**. This unit may be of any familiar type and comprises in general a power cylinder, wherein a piston is caused to reciprocate by the power oil, and a pump or production cylinder, wherein a piston actuated by the power piston operates to pump oil from the well. A typical power cylinder is shown more in detail in Figure 2. Leading from the production unit to the surface is a power tubing **36** which is connected to a power fluid line **38**. Line **40** leads from the top of the casing head for the purpose of conducting the production oil from the well.

When pumping a well using a hydraulic pump of this general type, the pump is so disposed in the well that the crude oil rises at least to the perforations **32** in tubing **26**. The oil passes through these perforations and enters the annular space between tubing **26** and section **14***b* of the tubing **14**. From this space, it flows through passages **22** and **24** into the production unit of the pump. It is flowed from the pump and up tubing **14** to pipe **40**.

The operation of the pump will be understood by reference to Figure 2. In this figure, where corresponding parts appear, they bear the same reference numerals as the parts of

The device disclosed in this figure may be termed a hydraulic engine, and comprises, in general, a cylinder 42, a power piston 44, a valve 46, and ports and channels adapted to regulate the flow of the power fluid. The motion of the piston 44 is transmitted to a similar piston in the production cylinder, not shown, by means of a rod 48.

The power piston and valve are shown in the downward position. In this position, the power fluid flowing through power tubing 36 passes through the channel 50 to the upper end of the power cylinder, thus forcing the piston 44 downward. In this position, the lower end of the power cylinder is open to exhaust through the channel 52, the exhausted oil flowing into tubing 14, not shown in this figure. As the piston reaches the end of the downward stroke, grooves 54 in valve rod 56 permit the passage of the power fluid through ports 58 and into the space 60 below the valve body. Because the bottom end area of the valve is greater than the upper end area, the oil entering below the valve causes the valve to move upward. When the valve reaches its top position, the channel 50 is open to exhaust through the annular space 62, and the channel 64 is brought into alignment with channel 52, which causes the power fluid to enter the space beneath the piston and forces the piston to move upward. When the piston has reached its full upward position, a groove 66 in valve rod 56 is brought into alignment with a port 58 and a channel 68 leading to the exhaust. Thus, when the piston has reached its full upward position, the power oil below the valve body will be exhausted and the cycle repeated.

In accordance with the present invention, crude oil tending to deposit paraffin is pumped from an underground formation by a method comprising using a hydraulic pump of the type described above, and actuating the pump by means of a power liquid comprising a substantial aqueous phase. The power liquid may be water alone, but it is preferred to employ water containing a sufficient amount of a demulsifying agent to reduce or prevent emulsification of the water with the production oil. In an important embodiment of the invention, the power liquid comprises a mixture of water and a hydrocarbon oil, the mixture preferably also containing a demulsifying agent.

By using a power liquid of the class described above, difficulties with respect to paraffin deposition in the power tubing are eliminated. Further, depending upon the amount of the power liquid used and the characteristics of the production oil, the introduction of water into the production oil tends to reduce the deposition of paraffin in the flow tubing. Moreover, when it is particularly desired to control the deposition of paraffin in the flow tubing, the amount of water introduced into this tubing is adjusted so as to be at least sufficient to prevent or reduce such deposition.

Although the invention in its broader aspects includes the use of water alone as the power liquid, I prefer to employ an aqueous liquid containing other materials, as explained below. A crude oil which tends to deposit paraffin often contains constituents which reduce the emulsifying characteristics of the oil; but in some cases, when using water as the power liquid, there is a tendency for the water to form an emulsion with the production oil. By incorporating in the water a demulsifying agent which will prevent the formation of stable emulsions, difficulties from this source may be eliminated. Any suitable demulsifying agent may be used for this purpose; for example sulphonation derivatives of oils and higher fatty acids, such as sulphonated ricinoleic acid and sulphonated oleic acid and mixtures of these derivatives with the free acids; petroleum sulphonates; and lower alkyl derivatives of naphthalene sulfonates. These materials are employed in the form of their salts, such as their ammonium salts.

An especially important embodiment of the present invention comprises the use of a mixture of a hydrocarbon oil and water as the power liquid. A mixed liquid of this type may be made so as to be substantially free from a tendency to deposit paraffin, and yet to possess desirable lubricating properties. These properties are of advantage when the mixed liquid comes in contact with the engine piston and valve. Since as little as one per cent by volume of oil in the water is sufficient to impart desirable lubricating properties thereto, it is possible to use relatively refined oils in the operation. However, for reasons of economy and convenience, it is generally preferred to use a mixture of water and crude oil, which may be the production oil or oil produced from a nearby well. Mixed liquids containing from about 15 to 99 per cent water and from about 85 to 1 per cent crude oil by volume are satisfactory, both from the standpoint of paraffin deposition and accomplishing effective lubrication of the moving parts of the hydraulic pump. When using a mixed liquid of this type, it is preferred also to include in the mixture a small amount of a suitable demulsifying agent, such as disclosed above. It is not desirable or necessary that the mixed liquid be in the form of a stable emulsion, and, of course, emulsification of the water of the mixed liquid with the production oil is undesirable.

When using any particular hydraulic pump there is a definite ratio between the amount of power liquid and the amount of new production. This ratio is generally about 1:1 by volume. Since it has been found that where the well production contains at least 15 per cent water, paraffin deposition is decreased, I prefer to employ a power liquid containing an amount of water equal to at least about 20 per cent of the oil being produced. The type of power liquid to be used, therefore, will depend upon the specific characteristics of the oil and also in many cases upon the temperature at the surface. It has been pointed out that paraffin deposition in the flow tubing is greater in cold weather. Accordingly, it is important at such times to employ enough water in the power liquid to yield a mixed liquid at the well head containing at least 15 per cent water. When the well is producing some water, this water should be taken into account in determining the minimum amount required in the power liquid.

Therefore, to reduce paraffin deposition in both the power tubing and the flow tubing in the case where the ratio between the power liquid and production oil is 1:1 and substantially no water is being produced, the power liquid should be composed of at least 30 per cent water, and preferably would be composed of at least 40 per cent water.

The operation of the method will be made more clear by reference to Figure 1. In this case, a

mixture of water and a crude oil in about equal proportions by volume is employed as the power liquid. This mixture is raised by means of pump 70 to a desired pressure which may be of the order of 1,000 to 3,000 pounds per square inch, depending upon underground conditions, and is passed through valved line 38 to the well. The liquid flows through line 36 and actuates the engine in the manner before described. The production oil together with the exhausted power liquid, passes up flow tubing 14 and from the well through valved line 40. This line conducts the mixture into a separating system indicated generally at 72. In this system, which may be of any conventional type, the water is separated from the oil and is removed through valved line 74 which leads to the suction side of pump 70. Make-up water may be introduced through a valved line 76. Clean oil is removed from the separating system through valved line 78 and is combined with the water flowing in line 74. A suitable demulsifying agent may be added to the water through valved line 80. Production oil is removed from the separating system through valved line 82 and passed to storage.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In a method of pumping crude oil tending to deposit paraffin from an underground formation wherein a hydraulic pump is employed, a power liquid under pressure is forced down a power tubing to actuate the pump, and the exhaust power liquid is mixed with the production oil, the improvement which comprises actuating the pump by means of a power liquid comprising a substantial aqueous phase.

2. A method in accordance with claim 1 in which the power liquid also comprises a demulsifying agent.

3. A method in accordance with claim 1 in which the power liquid comprises water and a hydrocarbon oil.

4. A method in accordance with claim 1 in which the power liquid is composed substantially of water and a hydrocarbon oil and comprises at least 15 per cent water and at least one per cent hydrocarbon oil by volume.

5. In a method of pumping crude oil tending to deposit paraffin from an underground formation wherein a hydraulic pump is employed, a power liquid under pressure is forced down a power tubing to actuate the pump, the exhaust power liquid is mixed with the production oil in a flow tubing, and the volume ratio of power liquid to production oil is about 1:1, the improvement which comprises actuating the pump by means of a power liquid comprising at least 30 per cent water by volume, whereby deposition of paraffin is reduced in the power tubing and in the flow tubing.

6. A method in accordance with claim 5 in which said power liquid also comprises at least one per cent by volume of a hydrocarbon oil produced from said underground formation.

7. A method in accordance with claim 5 in which said power liquid also comprises a hydrocarbon oil and a demulsifying agent, said power liquid comprising at least one per cent by volume of said hydrocarbon oil.

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