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[54] **APPARATUS AND METHOD FOR LIQUID INTRODUCTION IN OIL WELLS**
8 Claims, 1 Drawing Fig.

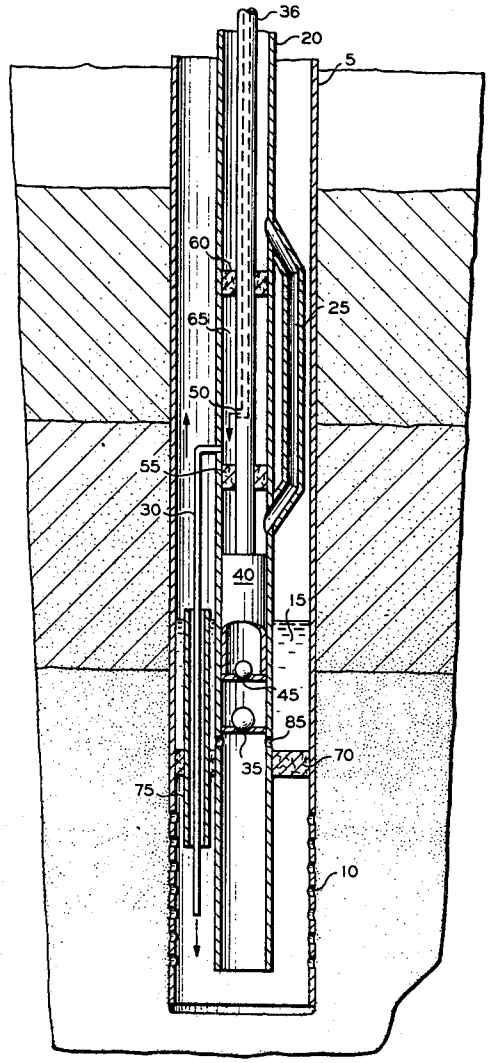
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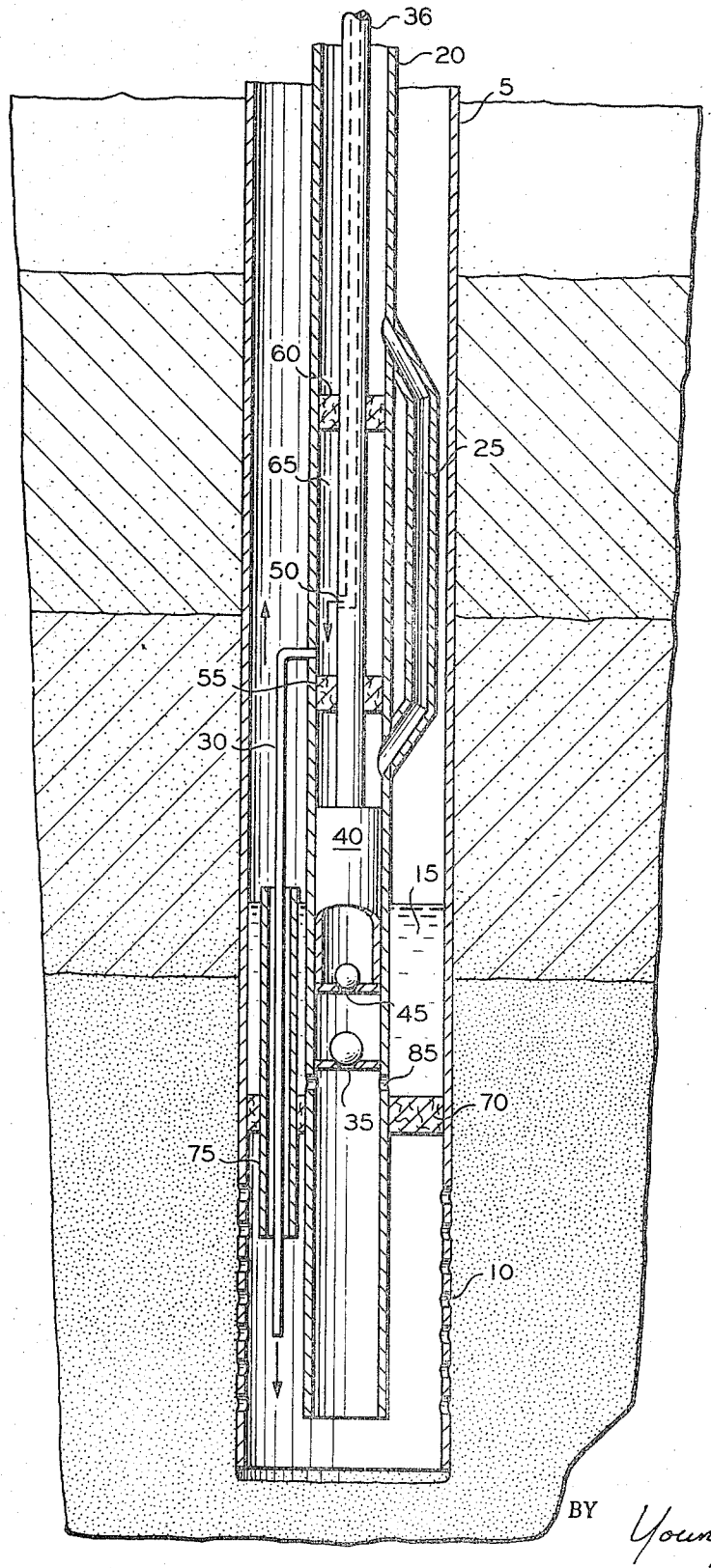
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ABSTRACT: Chemical treatment of oil wells is effected by placing the particular chemical in the well bore at the desired depth by the use of subsurface apparatus comprising a hollow sucker rod, the core of which is in communication with the well bore through the production tubing. The communication ports are isolated by packing means from the produced fluid flowing upwardly through the production tubing. The produced fluid bypasses the packed off area of the production tubing through a suitable crossover flow device.



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APPARATUS AND METHOD FOR LIQUID INTRODUCTION IN OIL WELLS

This invention relates to a method and apparatus for introducing a liquid into an oil well through a hollow sucker rod.

The introducing of various liquids into oil wells in order to increase production is known in the art. Accordingly, modern production technology recognizes the value of introducing defoaming agents, slurries, fluid cements, water for water flooding, combustion supporting gas for fire flooding, and the like. The production of foam in the well requires the introduction of a defoaming agent because the oil well pumping apparatus relies for operability on the incompressibility of the produced crude. Thus, when foam exists in the crude, the incompressible nature of the produced stream is partly or wholly destroyed and the downhole recovery pump either functions at greatly reduced efficiency or completely fails to raise the produced stream to the uphole location.

The reason foam exists in the produced crude is unknown; however, one theory suggests that foaming occurs as a result of the release of CO_2 and other dissolved gases as the pressure on the crude drops from formation pressure to bottom hole pressure.

To a certain extent all reservoirs contain dissolved gases and foaming can become a significant production problem in any reservoir and particularly in reservoirs that have been subjected to an in situ combustion secondary recovery technique.

According to one typical type of insitu combustion operation a high temperature zone is established in the oil-bearing region of a reservoir around a well bore. Suitable heating means for establishing a high temperature zone within the formation can comprise an electrical heating device or a gas fired bottom hole igniter or heater. Upon introducing a combustion-supporting or an oxygen-containing gas such as air into the heated formation via the well bore a high temperature combustion zone is created by the reaction between the oxygen and combustible residues within the high temperature zone of the oil-bearing regions. Upon continued introduction of the combustion-supporting gas this high temperature zone will commence to move into the formation outwardly from the well bore.

The combustion products of the combustion are primarily CO_2 and H_{20} and at the elevated pressures existing in subterranean reservoirs much of the large volume of CO_2 is dissolved in the crude and subsequently released when the pressure on the crude drops to downhole pressure during recovery. Thus, foaming is even a greater problem in reservoirs subjected to in situ combustion and in the case of low gravity, viscous crudes that produce a very stable foam, such as the Morichal crudes from Venezuela and certain of those in the United States, the problem becomes acute.

Since the foam is thought to be produced in the oil bearing region of the well when the pressure on the crude is reduced, a problem exists in placing the defoaming agent in the precise location where the foam is produced. If the defoaming agent is merely poured in the top of the well, it can become flocculated by the action of the upcoming produced gas and consequently fail to function. Even if the defoamer reaches the downhole location, it can form a layer on top of the column of crude in the well and fails to function because it is on top of the column instead of farther down into the column where the crude flows out of formation and into the bore hole and produces foam.

Thus, this invention represents an improvement over the prior art in that a liquid, and in a preferred embodiment a defoaming agent, can be introduced into the oil bearing region of a producing well through a hollow sucker rod and in another embodiment can be introduced into the region where the crude flows out of the formation and into the bore hole.

In one embodiment of this invention, an apparatus is provided for introducing a liquid into the oil bearing region of a producing cased well comprising a hollow sucker rod with a passageway from the exterior to the hollow region. In another embodiment of this invention, a length of tube is positioned in a cased well, a reciprocating pumping means is positioned within the oil bearing region of the cased well and a hollow sucker rod is operably attached to the reciprocal pumping means. First and second packing means are positioned respectively uphole and downhole from said sucker rod passageway slidably sealing said sucker rod to said tubing and thus forming an annular chamber. Additionally, means are provided to conduct said introduced liquid from the annular chamber to the oil bearing region, and bypass means are provided so the reciprocal pumping means can pump the produced fluid around the annular chamber and up the annular passageway between the tubing and sucker rod. In one still further embodiment of the invention, a closure is provided between the tubing and casing and a means positioned through said closure to communicate produced gas upward through the closure. In one still further embodiment of the invention, a closure means is positioned downhole from the inlet of the pumping means and the tubing contains a passageway positioned uphole from said closure and downhole from said pumping inlet. In one additional embodiment the means to conduct the introduced liquid from the annular passageway to the oil bearing region comprises a means to conduct said liquid downhole from said closure and the introduced liquid comprises a defoaming agent. In one still further embodiment of the invention, the means to communicate produced gas up through said closure comprises a first tube and the means to conduct fluid from said annular chamber to the oil bearing region comprises a second tube annularly positioned within said first tube.

One object of this invention is to provide method and apparatus for introducing liquid into the oil bearing region of an oil well through a hollow sucker rod. Another object of this invention is to prevent the formation of foam within the oil bearing region of a producing well. Another object of this invention is to introduce a defoaming agent directly into the oil bearing region of a producing well. Other objects, advantages and features of this invention will be readily apparent to those skilled in the art from the following description, drawings, and appended claims.

The attached FIG. represents a portion of a profile view in partial cross section of a cased producing well incorporating the instant invention.

According to the practice of this invention, a bore hole is established by methods well known in the art penetrating a subterranean oil bearing formation thus forming an oil bearing region within the bore hole. The bore hole is then cased by a casing **5** and perforated so as to form passageways **10** between the oil bearing formation and the bore hole. The pressure differential between the oil bearing formation and the bore hole causes crude to flow from the oil bearing formation through passageways **10** and form a column of crude **15** in the bore hole. A length of tubing **20** is then positioned within the bore hole. Tubing **20** contains a valve **35**, bypass means **25**, and a means **30** to conduct an introduced liquid into the oil bearing region. A hollow sucker rod **36** is then positioned within said tubing connected to a pumping cylinder **40** containing a valve **45**. Tubing **20**, valve **35**, pumping cylinder **40** and valve **45** cooperate to comprise a reciprocal pumping means when actuated by sucker rod **36**. The sucker rod **36** contains a passageway **50** from the exterior to the hollow portion of the sucker rod. Sucker rod **36** is slidably sealed for reciprocating movement within said tubing **20** by packing means **55** and packing means **60**, thus forming an annular chamber **65** between the closures. In an additional embodiment, packing means **70** seals tubing **20** within casing **5** so as to provide a reservoir below packing means **70** in which the defoaming agent can be inserted and isolated so as to intimately admix with the foaming crude.

Packing means **70** can be located at any distance up or downhole in the column; however, packing means **70** must be equipped with a means **75** to communicate produced gas upward through said closure. If the top of column **15** is below packing means **70** satisfactory results can be achieved, although in a preferred embodiment packing means **70** is below the top of column **15**.

Although packing means **70** can be omitted entirely, when the top of the column of crude **15** is below the passageway from the annular chamber **65** a more desirable result is achieved by incorporating packing means **70** into the invention and introducing the liquid downhole from packing means **70** through liquid introduction means **30**. In the preferred embodiment where the liquid is a defoaming agent this places the defoaming agent in the precise location where the foam is thought to form and greatly increases the defoaming action. If packing means **70** is not used satisfactory results can still be obtained, particularly when the top of the column of crude **15** is above the passageway from the annular chamber **65** into the bore hole and perforations extend uphole to the vicinity of the annular chamber.

In a preferred embodiment of the invention, the packing means **70** is positioned downhole from inlets **85** through said tube **20**. If inlets **85** are not provided in tubing **20**, a pressure differential is created across packing means **70** because the gas exiting through means 75 necessarily carries out quantities of liquid which will accumulate above packing means **70** and produce an extremely heavy column of liquid above packing means **70**. Although the invention will operate in this manner, it is desired to provide passageways **85** so the pressure in the column of crude **15** above packing means **70** will be substantially similar to that below packing means **70**. In a preferred embodiment, the means to conduct the introduced liquid from the annular chamber to the oil bearing region comprises a first tube and the means to communicate produced gas upward through said packing means **70** comprises an annularly positioned tube **75**.

Departing from the structure of the invention and focusing attention on the operation of the invention, sucker rod **36** is reciprocally driven by suitable uphole means while cylinder **40** and valve **45** cooperate with tube **20** and valve **35** so as to transport crude from the column of crude **15** up the annular region above cylinder **40** between tubing **20** and sucker rod **36**. Subsequently the produced fluid is conducted through bypass means **25** and up the annular region between tube **20** and sucker rod **36** to an uphole location where it is recovered and subjected to further processing steps. The gas produced by the practice of this invention flows up the annular region between tubing **20** and casing **5** and is recovered and processed. In the embodiment where packing means **70** is utilized, the gas that is produced below packing means **70** flows through means **75** and subsequently to the uphole location.

According to the operation of this invention, the liquid, which can comprise any liquid but in a preferred embodiment comprises a defoaming agent, is injected by suitable means such as described in Reese U.S. Pat. 2,639,674 down the hollow region of sucker rod **36** and flows into annular chamber **65** while sucker rod **36** is reciprocatingly driving cylinder **40** that cooperates with tubing **20** and the noted valves to comprise a pumping means. The liquid then flows from annular chamber **65** through means **30** into the oil bearing region and in a preferred embodiment where the packing means **70** is used, the liquid is deposited downhole from packing means **70**. Thus, according to the operation of the preferred embodiment of this invention a defoaming liquid can be introduced down the hollow sucker rod and further conducted into the oil bearing region to be intimately mixed with the oil flowing into the cased well so as to reduce foaming.

Examples of liquids that can be introduced down hollow sucker rod **36** include defoaming agents, slurries, fluid cements, water for water flooding, gas for fire flooding. As previously noted in a preferred embodiment, a defoaming agent is introduced. The defoaming agent used in the preferred embodiment can comprise any material capable of being injected in the bore hole according to this invention that will reduce or eliminate foaming. Specifically, two kinds of silicon compounds are commercially available to reduce or eliminate foam. One is a compounded silicon antifoam and the other is a straight dimethyl oil. Compounded antifoams are dispersions of silica filler in a low viscosity silicon fluid. The dimethyl silicon oils are high viscosity long chain polymers of silicon to oxygen bonds with two methyl groups attached to each carbon.

This invention is thus broadly applicable to the introduction of a liquid into the oil bearing region of a well through a hollow sucker rod.

As noted above, the drawing is merely diagrammatic and is not intended to fully show all component parts of the equipment which one skilled in the art would routinely design for operation. Specifically as noted, the position of packing means **70** can vary within the length of the column and several embodiments of means **30** and means **75** are provided. Indeed, the showing of one element of piece of equipment does not mean that all such are similar pieces of equipment which may or can be designed by one skilled in the art in possession of this disclosure cannot be utilized as substitution therefor. Likewise, the omission of an element which one skilled in the art may include in an actual unit does not mean that such a piece of equipment is intended to be omitted simply because it does not appear in the drawing. Suffice to say the drawing is for illustrative purposes only, as is the description thereof.

I claim:

1. Apparatus for introducing a liquid into the oil bearing region of a producing cased well comprising:

a. a length of tubing residing in said cased well from an uphole location to said oil bearing region;

b. reciprocal pumping means positioned within said casing in the oil bearing region adapted to pump produced fluid up said tubing;

c. a hollow suckerrod containing a passageway from the exterior of the rod to the hollow region, said rod positioned within said tubing and adapted to reciprocally actuate said pumping means;

d. first and second packing means positioned respectively up hole and down hole from said sucker rod passageway slidably sealing said sucker rod to said tubing so as to form an annular chamber;

e. means to conduct said introduced liquid from said annular chamber to said oil bearing region; and

f. bypass means to conduct said produced fluid around said annular chamber and up said tubing.

2. The apparatus of claim **1** further comprising:

a. closure means between said casing and tubing; and

b. means to communicate produced gas upward through said closure.

3. The apparatus of claim **2**:

a. wherein said closure means is positioned down hole from the inlet of said pumping means;

b. wherein said tubing contains a passageway positioned up hole from said closure means and downhole from said pump inlet;

c. wherein said means to conduct said introduced liquid from said annular chamber to said oil bearing region further comprises means to conduct said liquid down hole from said closure means; and

d. wherein said introduced liquid comprises a defoaming agent.

4. The apparatus of claim **3**:

a. wherein said means to communicate produced gas through said closure comprises a first tube; and

b. wherein said means to conduct liquid from said annular chamber to said oil bearing region comprises a second tube centrally positioned within said first tube.

5. A method of introducing a liquid into the oil bearing zone of a producing cased well comprising the steps of:

a. providing a reciprocally driven pump in pumping position in said oil bearing zone;

b. actuating said pump with a hollow sucker rod containing a passageway from the exterior of the rod to said hollow region;

c. providing a tubular closure around said sucker rod;

d. forming an annular chamber by:

1 providing a first closure means uphole from said sucker rod passageway slidably sealing said sucker rod to said tubular closure;

2 providing a second closure means downhole from said sucker rod passageway slidably sealing said sucker rod to said tubular closure;

e. conducting a liquid down said hollow sucker rod through said passageway and annular chamber and into said oil bearing zone;

f. pumping produced fluid from said oil bearing zone around said annular chamber and up said tubular closure to an uphole location; and

g. recovering produced gas from said oil bearing zone.

6. The method of claim 5 further comprising the steps of:

a. providing a closure within said casing;

b. providing a passageway through said casing closure for the recovery of said produced gas.

7. The method of claim 6:

a. wherein said casing closure is positioned downhole from the inlet of said reciprocally driven pump;

b. wherein said liquid comprises a defoaming agent;

c. wherein said tubular closure contains a passageway positioned uphole from said casing closure and downhole from said pump inlet.

8. The method of claim 7 further comprising:

a. recovering produced gas through a tubular passageway in said casing closure; and

b. introducing said defoaming agent into said oil bearing zone through a tubular member positioned annularly within said gas recovery passageway.