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METHOD OF INHIBITING PARAFFIN DEPOSITION IN OIL WELLS

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This invention relates to a method for inhibiting paraffin deposition in oil wells. According to this invention a heated solution of naphthalene in a normally liquid mineral oil is introduced into a well under conditions such that naphthalene in solution will be placed in the oil-bearing formation surrounding the well. The concentration of the naphthalene is such that upon cooling of the solution to formation temperature the major amount of naphthalene in solution will solidify in the formation and subsequently serve as an in-situ source of paraffin inhibitor when the well is producing. Thus as the oil flows towards the well it will dissolve a portion of the naphthalene and carry it into the well and through the tubing toward the earth's surface.

The addition of naphthalene to oil wells to inhibit paraffin deposition is well known. Several methods of adding naphthalene have been suggested. For example, a solution of naphthalene may be continuously added to the well or naphthalene itself can be added as a solid, or in solid admixture with beta-naphthol or anthracene, for example, see U.S. Patent 3,051,653. In such cases, however, the naphthalene is added to the formation oil in the bore hole and is more or less immediately removed in solution in the oil being produced. Thus, to be effective over a period of time the inhibitor must be added almost, if not continuously due to its high solubility in the oil and the mixing effect of the oil and the naphthalene in the well bore hole. Moreover, due to the restricted diameter of the bore, it is a certainty that all of the oil produced will come into contact with the total naphthalene in the bore hole thereby giving the greatest chance of dissolution of the inhibitor and its quick loss from the system. One solution to this problem has been to use the naphthalene in a form in which its solubility in oil is diminished, but such actions are only partly successful and often involve the use of more expensive chemicals.

By the present invention, there is provided a convenient and inexpensive manner of supplying the naphthalene inhibitor to the well over an extended period of time without the continued use of surface equipment or personnel. The objects of this invention are accomplished by forming a solution of naphthalene in mineral oil at a temperature of at least about 200° F. so that the amount of naphthalene in solution exceeds that which will form a saturated solution at the temperatures encountered in the well formation. For example, if the formation temperature is T° F. and at this temperature X pounds of naphthalene will saturate 1 barrel of crude oil, X pounds of naphthalene plus Y additional pounds of naphthalene are added to the oil. The amount Y of additional naphthalene should be sufficiently large to assure that the protection provided by the treatment is effective over an extended period of time, and for best results the Y pounds is greater than the X pounds of naphthalene. The oil-naphthalene mixture is heated to dissolve the naphthalene and placed in the formation while at a temperature of at least about 200° F. As the mixture cools below the melting point of naphthalene, finally reaching the formation temperature, the Y additional pounds of naphthalene will deposit in the formation as a solid. As the well produces, crude oil flowing toward the bore hole will slowly dissolve and carry the naphthalene with it. The crude oil will thus be continuously treated with a paraffin inhibitor

without attention from the operator or the extended use of surface equipment.

The temperature to which the crude oil-naphthalene mixture is introduced to the underground oil-bearing formation adjacent the well should be sufficiently great to insure that the mixture does not cool below about 200° F. before it has entered the formation. I prefer temperatures in the range from about 200 to 350° F. Normally, the amount of oil used in a single treatment of a well will be at least about one barrel and may often vary from about 5 to about 150 barrels, but could be higher or lower depending on the circumstances.

The amount of naphthalene used is at least about 10% by weight of the oil, advantageously at least about 15% and preferably about 30 to 80%. The amount of naphthalene required may depend upon the output of the well and the desired length of protection.

The mineral oil employed is normally liquid and usually has a viscosity not significantly exceeding that of the oil in the formation being treated. Various mineral oils may be used but crude oils are preferred due to their low cost and availability. Most advantageously the oil is the in-situ crude oil which has previously been produced from the well or field being treated.

In adding the oil-naphthalene solution, production of the well at the surface is usually stopped and the solution charged to the well bore and forced into the oil bearing formation adjacent the bore. The solution may be followed by noninhibited mineral oil to drive the solution away from the well bore wall and further into the oil-bearing formation. Usually the solution and thus the inhibitor are not greater than about ten feet away from the bore and are often at least about one foot away. Thus, the inhibitor after cooling and solidification may be concentrated in the area about 1 to 10 feet from the bore hole but, of course, it may extend to the bore hole wall if desired. This method is particularly advantageous in treating wells producing less than about 10 or even less than about 5 barrels of oil per day. The most desired conditions of oil flow rate and naphthalene concentration in the formation are those at which the naphthalene removal varies linearly with the oil flow rate so that the concentration of naphthalene in the produced oil at all flow rates would be the amount effective to inhibit paraffin deposition, e.g., about 10 to 100 p.p.m. naphthalene in the oil.

Laboratory tests wherein oil is run through a column containing sand and naphthalene indicate that the linear removal of naphthalene will occur at low naphthalene to sand ratios, e.g., less than 1:10 and low oil flow rates. In actual practice the inhibition obtained by depositing a given amount of naphthalene should be checked by withdrawing oil samples from a well and analyzing them for naphthalene content.

A typical example of paraffin inhibition according to this invention is as follows. For a relatively low producing well, 2 barrels of oil per day, about 1,500 pounds of naphthalene will provide protection from paraffin deposition for several months. The well is treated by introducing 100 barrels of hot crude oil at 320° F. to heat the well tubing and minimize heat losses from the naphthalene solution, followed by 10 barrels of oil at 320° F. in which 1,500 pounds of naphthalene has been dissolved. This in turn is followed by 90 barrels of oil at 320° F. For a well formation temperature of 87° F., it will take 14.08% by weight naphthalene to saturate oil at this temperature. Assuming no appreciable mixing of the oil containing the naphthalene with either the formation oil or the oil added after the naphthalene solution, the 820 pounds of oil (10 barrels) will be saturated with 400 pounds of naphthalene once it cools to formation tem-

perature. Thus 1,100 pounds of naphthalene will be left in the formation as a solid deposit.

It is claimed:

1. A method of inhibiting paraffin deposition in an oil well by depositing naphthalene in the underground oil-bearing formation adjacent the well which consists essentially of introducing into said well formation, at a temperature above about 200° F., a solution of naphthalene in crude oil previously produced by the well being treated containing from about 30% to 80% by weight of naphthalene based on the weight of the oil and allowing the solution to cool to formation temperature whereby a major portion of the naphthalene is deposited in the formation when the solution of oil and naphthalene reaches the temperature of the formation.

2. The process of claim 1 wherein the temperature of the naphthalene-oil solution added to the oil-bearing formation is about 200° to 350° F.

3. The method of claim 1 wherein introduction of the naphthalene-oil solution is followed by the introduction of said crude oil whereby the naphthalene-oil solution is displaced from the well bore wall further into the adjacent underground formation.

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