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METHOD OF REMOVING PARAFFIN FROM A WELL WITH HEATED SOLVENT

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ABSTRACT OF THE DISCLOSURE

A method of removing paraffin deposits from a producing well including injecting heated xylene bottoms solvent into the well bore at a temperature sufficiently high so that the solvent is at least 150° F. when it encounters the producing formation and thereafter pumping from the well to remove the solvent and dissolved paraffin and the solvent therefor which includes reformed aliphatic aromatic hydrocarbons and a stabilizing catalyst additive which functions to accelerate the dissolving of paraffin deposits and to increase the capacity of the solvent to retain the paraffin in solution when the solvent is cooled to the temperature of the producing formation.

Background of the invention

Many oil and gas wells, particularly pumping oil wells, are subject to greatly reduced production resulting from paraffin deposits on the producing formation in the vicinity of the well bore. Hot water, steam and a great variety of solvents have been injected into the well bores in an effort to remove the deposited paraffin and thereby regain some of the lost production capacity. While some success has been achieved in increasing production, the increased production has not been sufficient in relation to the expense of the treatment to render any of such treatment successful.

Summary

The present invention relates to an improved paraffin solvent and an improved method of removing paraffin from a producing formation.

It is therefore, an object of the present invention to provide an improved method of removing paraffin from a well which results in very substantial increased production from the well.

Another object is to provide an improved method of removing paraffin from the face and immediately surrounding producing formation in a well bore to increase the recovery from said producing formation at a relatively low cost in relation to the amount of the increase in production from the treated well.

These and other objects and advantages of the present invention are hereinafter set forth and described in detail.

THE PREFERRED EMBODIMENTS

The solvent

The preferred solvent of the present invention consists of a combination of aliphatic hydrocarbons that have been reformed by a catalytic process into a combination of both normal cyclic and normal aromatic hydrocarbons wherein the aliphatic substituted cyclic hydrocarbons are aliphatic substituted aromatic hydrocarbons having a boiling point in the range from 200° F. to 600° F. and at least fifty percent of said hydrocarbons are aromatic hydrocarbons, together with a stabilizing catalyst additive which functions to retain paraffins dissolved in such solvent when the solvent is cooled.

A typical solvent of the present invention for use in treating a producing well includes 4,200 gallons of xylene bottoms having a boiling point of 308° F. together with 110 gallons of a stabilizing catalyst additive having the following composition:

Component:	Approximate percent by weight
Carbon bisulfide	30
Naphthalene	22
An oil soluble surface active agent	12
A water soluble surface active agent	10
A combined oil and water soluble surface active agent	13
Terpene hydrocarbons	5
Kerosene	8

An oil soluble surface active agent which has been found to be particularly effective in such additive is commonly described as sorbitan partial fatty esters and is a mixture of esters of sorbic alcohol and oleic, palmitic and stearic acids. Such a product is sold by Atlas Powder Company under the name Atpec–200. The functions of this agent is to reduce the surface tension of the hydrocarbon fluids encountered by the solvent to thereby assure ready access of the solvent to the paraffin deposits to be dissolved. The particular agent has a specific gravity of 1.000, a viscosity of 1000 cp. @ 25° C., an HLB (hydrophilic-lypophilic balance) of 4.3 and is nonionic.

A water soluble surface active agent which has been found to be particularly effective is polyoxyethylene alkyl aryl ether which is an eight mol ethylene oxide adduct of nonyl phenol and is nonionic. Such a product is sold by Atlas Powder Company under the name Renex 648. The function of this agent is to reduce the surface tension of the water and brine encountered by the solvent in the producing formation to thereby assure ready access of the solvent to the paraffin to be dissolved. The particular agent has a specific gravity of 1.030, a viscosity of 223 cp. @ 25° C. and an HLB of 10.3.

A combined oil and water soluble surface active agent which has been found to be particularly effective is an alkyl phenol ethylene oxide condensate. Such agent is a ten mol ethylene oxide adduct of nonyl phenol and is nonionic. Such agent is sold by Chevron Oil Company under the name Ornite NIO. The function of this agent is to couple the other two surface active agents together and to aid in their balance to produce a greater activity in the reduction of surface tensions of the oil and water encountered by the solvent in the producing formation.

The carbon bisulfide is a liquid which has a high affinity for carbonaceous and sulfur bearing hydrocarbon materials. When used in a solvent such as xylene bottoms, it functions as a stabilizing catalyst to increase the capacity of the xylene bottoms for maintaining dissolved paraffin in solution even though such solution is cooled.

The naphthalene functions to aid in the dispersion of the paraffin and directly increases the penetration rate and solution rate of the solvent.

The kerosene is used as a diluent and carrier for the combined materials in the additive and assists in retaining dissolved paraffin in solution.

The terpene hydrocarbons are a mixture of terpene hydrocarbons, predominantly alpha pinene, dipentene and beta pinene and contain smaller percentages of terpene alcohols. The terpene hydrocarbons function as an accelerator to aid in increasing the dissolving of the paraffin, particularly where very dense paraffin deposits are encountered.

While the preferred solvent composition set forth above details specific quantity relationships and materials, it is contemplated that variations in the particular components or their equivalents which perform the indicated functions and variations in the quantities of such components may be used, keeping in mind that the solvent is to be injected hot into a well bore and that it is desired to remove all of the paraffin originally taken into solution when the solvent is pumped from the well bore after it has cooled by contact with the formation. Also, both the solvent and the additive should have sufficiently high boiling points so that they are not unduly vaporized during heating.

The preferred combination solvent has been found to remove sufficient amounts of paraffin to provide substantial increase in production from the treated well.

The method

The method of the present invention involves the introduction of a heated solvent into a well bore to allow the solvent to dissolve the paraffin from the portion of the producing formation within a few feet of the well bore. It has been discovered that a paraffin solvent, such as xylene bottoms, if heated sufficiently so that it comes into contact with the paraffin deposits at a temperature of 150° F. or higher, will dissolve substantially more paraffin than the same solvent will dissolve at lower temperatures, such as 75° F. It is believed that the heating of the solvent not only increases the solubility of the solvent but also melts the paraffin deposits. The melted paraffin is more readily taken into the solution. This heating of the solvent not only increases the amount of paraffin dissolved initially but also is believed to increase the amount of paraffin which remains in solution after the solvent has cooled to the temperature of the formation. A further advantage obtained by heating the solvent is that the solvent penetrates farther into the formation from the well bore than would be possible with the same solvent used in an unheated condition. This is advantageous since paraffin deposits which occur in a producing formation are not believed to be only at the face of the formation exposed by the well bore but in that portion of the formation within a few feet of the well bore. Removal of the paraffin deposit in the formation around the exposed face allows substantial increase in volume of fluids that may be produced from the well.

The method of the present invention is hereinafter described in relation to an oil well which is being pumped and which has lost production capacity due to paraffin deposits in the producing formation in the area surrounding the well bore. When treatment of such well is to begin, the pump and rods are removed together with the production tubing. Such equipment, while at the surface, is preferably cleaned and replacement parts needed are procured. With the well bore clear of production equipment, it is cleaned, as by bailing. Thereafter, the production tubing is lowered into the well bore. The tubing is hung in the well bore with care being taken, if the lower end of the tubing is normally near the bottom of the well bore, to assure that its lower end is positioned sufficiently above the bottom of the well bore to allow for thermal expansion.

The solvent to be used, such as xylene bottoms or xylene bottoms with a stabilizing catalyst additive is heated to a temperature which is preselected as hereinafter defined. The hot solvent is pumped through the production tubing into the well bore at a position therein so that it is in contact with the face of the producing formation. It is preferred that the solvent be heated to a temperature sufficiently hot so that its temperature on encountering the producing formation is at least 150° F. In other words, sufficient heat must be provided to allow for the heat loss of the solvent during its passage through the production tubing to the producing formation. It has been found in practice that heating the solvent to a temperature of 300° F. has resulted in the solvent having a temperature in the well bore at the producing formation of 225° F. Such preselected temperature must also take into account the effect it will have on the solvent, i.e., it should not be sufficient to vaporize substantial quantities of the components of the solvent.

The amount of solvent to be used is preselected to completely fill the well bore over the height of the producing formation and to move solvent out into the producing formation to a distance between two to five feet radially from the well bore. In actual practice, 4,310 gallons and 2,155 gallons of solvent have been used with success in treating well bores to remove paraffin.

The solvent is preferred to remain within the well bore in contact with the producing formation for a period of time sufficient for it to dissolve substantially all of the paraffin which it can dissolve. As a practical matter, the resetting of the production tubing and the pump and pump rods can take sufficient time for an adequate action of the solvent before pumping from the well bore is commenced. In practice, the solvent which has remained in the well bore from two to twelve hours has provided excellent increases in production capacity.

The pumping from the well is started when the solvent has been in the well bore for the desired length of time. Initially the well production is primarily solvent having paraffin in solution and thereafter fluids from the producing formation are pumped from the well bore.

This method of treating a well to remove paraffin deposits has been found to be very successful. In one well, treated as described with 4,310 gallons of solvent, the oil production was increased from eight barrels per day to fifty-one barrels per day, which increased production has been maintained for a period of sixty days after the treatment. Another well treated according to the method of the present invention with 2,155 gallons of solvent, experienced an increase in oil production from thirteen barrels per day to sixty-six barrels per day. The increased production achieved by treatment of these two wells is a very significant increase which is unexpected in the light of other methods previously used for treating wells. Another factor noticed in the production from treated wells is that other fluids, such as water, are produced in increased quantities which along with the increased oil production is believed to establish that not only are the paraffin deposits removed from the exposed face of the producing formation in the well bore but the paraffin deposits are removed from the formation in an area surrounding the well bore.

The initial production from the well immediately after treatment is the solvent which has remained in the well bore. Consideration should be given to separating the initial production in a volume which may be as large as half of the solvent injected into the well bore. Since it may contain only a minimal amount of dissolved paraffin, this solvent, if separated, may be suitable for re-use when reheated in combination with fresh solvent. This re-use of a portion of the solvent reduces the cost of treating the well. The remaining solvent pumped from the well is delivered to the usual storage tank and may be sold with the oil with which it is commingled. The price of oil as produced is less than the price of the solvent but the solvent can readily be sold with the oil. This further reduces the cost of the well treating.

From the foregoing, it can be seen that the present invention provides an improved method of removing paraffin from an oil well to achieve substantial increases in oil production at a reasonable cost by removing paraffin both from the exposed face of the formation and from that part of the formation outwardly around the well bore. Also, the preferred solvent of the present invention has a greatly improved capacity for retaining dissolved paraffin in solution by virtue of the stabilizing catalyst additive which also accelerates the dissolving of the paraffin deposits and facilitates the entry of the solvent into the producing formation.

What is claimed is:

1. The method of removing paraffin deposits from the producing formation surrounding the exposed face thereof in a well in which the normal temperature of such formation is less than 150° F. including the steps of

heating an amount of a xylene bottoms paraffin solvent to a preselected temperature,
said amount of solvent being sufficient to fill the well bore over the height of the producing formation and to fill the formation outwardly at least two feet from the exposed face in the well bore,
injecting the heated solvent into the well bore to deliver the solvent to the fact of the producing formation exposed in the well bore,
said preselected temperature of said solvent being sufficiently high so that the temperature of the solvent when delivered to the face of the producing formation is at least 150° F., and
pumping fluids from the well which fluids include the solvent and dissolved paraffin.

2. The method according to claim **1**, wherein
said preselected temperature of said solvent is at least 250° F.

3. The method according to claim **1**, wherein
said solvent includes a stabilizing catalyst additive comprising carbon disulfide whereby substantial amounts of paraffin dissolved therein remain in solution when said solvent cools to formation temperature.

4. The method according to claim **1**, wherein
said solvent includes a stabilizing catalyst additive comprising carbon disulfide and naphthalene whereby substantial amounts of paraffin dissolved therein remain in solution when said solvent cools to formation temperature.

5. The method according to claim **1**, wherein
said solvent includes a stabilizing catalyst additive comprising carbon disulfide, naphthalene and a surface active agent whereby substantial amounts of paraffin dissolved therein remain in solution when said solvent cools to formation temperature.

6. The method according to claim **1**, wherein
said solvent includes a stabilizing catalyst additive comprising carbon bisulfide, naphthalene, an oil soluble surface active agent, a water soluble surface active agent, and a combined oil and water soluble surface active agent whereby substantial amounts of paraffin dissolved therein remain in solution when said solvent cools to formation temperature.

7. The method according to claim **1**, wherein
said solvent includes a stabilizing catalyst additive comprising carbon bisulfide, naphthalene, sorbitan partial fatty esters, a polyoxyethylene alkyl aryl ether, an alkyl phenol ethylene oxide condensate, and terpene hydrocarbons whereby substantial amounts of paraffin dissolved therein remain in solution when said solvent cools to formation temperature.

8. The method of removing paraffin deposits from the producing formation surrounding the exposed face thereof in a well in which the normal temperature of such formation is less than 150° F. including the steps of
initially removing the production tubing from the well bore,
cleaning the well bore,
heating an amount of a xylene bottoms paraffin solvent to a preselected temperature,
said amount of solvent being sufficient to fill the well bore over the height of the producing formation and to fill the formation outwardly at least two feet from the exposed face in the well bore,
injecting the heated solvent into the well bore to deliver the solvent to the face of the producing formation exposed in the well bore,
said preselected temperature of said solvent being sufficiently high so that the temperature of the solvent when delivered to the face of the producing formation is at least 150° F., and
pumping fluids from the well which fluids include the solvent and dissolved paraffin.

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