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3,424,249

CLEANING STEAM INJECTION WELL TUBING STRING IN SITU

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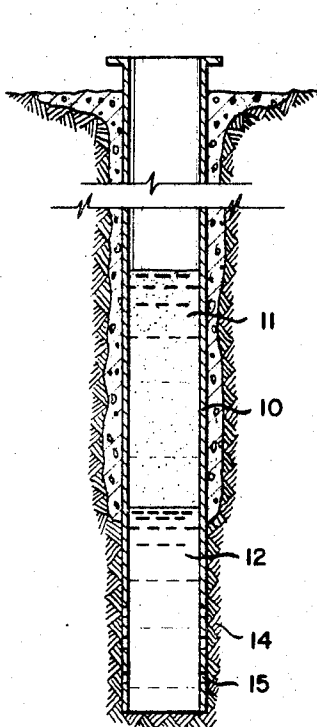


FIG. 1

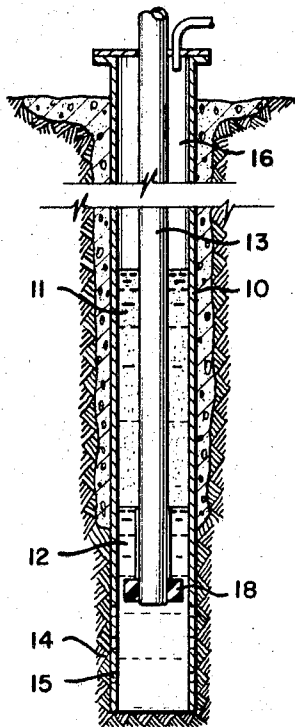


FIG. 2

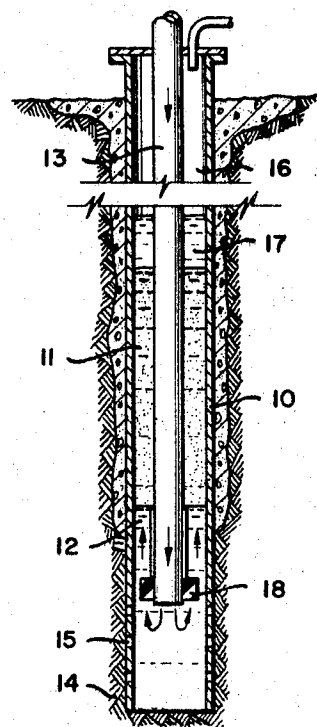


FIG. 3

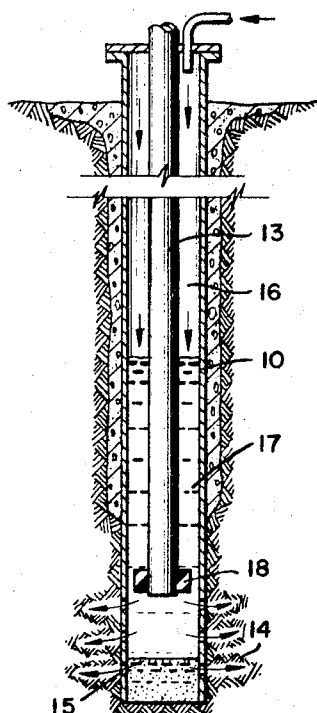


FIG. 4

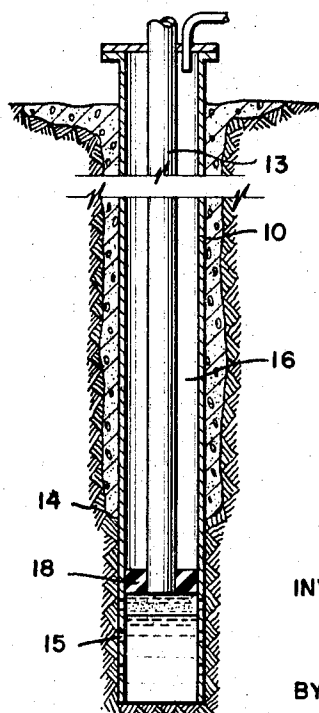


FIG. 5

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CLEANING STEAM INJECTION WELL TUBING STRING IN SITU

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ABSTRACT OF THE DISCLOSURE

A method of installing a bright coated tubing string in a well and preventing the formation of substantially opaque hydrocarbon deposits on said string whereby a tubing string is first lowered into a well containing oil after which a hydrocarbon solvent is introduced on top of the head of oil and moved by pressurizing the space above the solvent to thereby drive the solvent and other fluids present in the well into an oil bearing formation in communication with the well; the solvent thus serving to remove hydrocarbon deposits from the bright coated tubing string.

This invention relates to providing well tubing with radiation shielding for use in injecting heated fluid and more particularly to a method of removing oil from the tubing.

The producing formations of many oil wells contain low gravity oil whose viscosity is of a value sufficiently high to prevent easy flow of the oil from the formation and into a well. In some fields of this type, steam soaking of the producing formation is carried out through one or more wells. In these operations, steam is injected in order to reduce the viscosity of the oil and the heated fluids surrounding the wells are back-flowed into the wells and produced to the surface. A typical method and apparatus for treating an oil-bearing formation by steam soaking is disclosed in U.S. Patent No. 3,259,186 to Dietz. In method of this type, a tubing string is usually mounted concentrically within the well casing and steam is injected into the well through the tubing string. In order to reduce the heat lost to the well casing from the tubing string by radiation, the tubing string may be plated or clad with a bright reflective material which reduces the emissivity of the tubing and thus lower the radiation heat loss. For example, the tubing may be chrome plated or wrapped with stainless steel or aluminum as disclosed in U.S. Patent No. 3,142,336 to Doscher which issued on July 28, 1964. However, field and laboratory tests have shown that if the bright tubing is covered with oil, the subsequent injection of steam through the tubing string will heat the oil thereby forming substantially opaque hydrocarbon deposits. The heating may be sufficient in some cases to cause the oil to carbonize or coke on the tubing. The opaque coating on the bright tubing is highly undesirable since the emissivity of the tubing is raised thus rendering it ineffective in reducing radiation heat loss.

In summary, the subject invention provides a method of cleaning a bright coated well tubing string in place thereby eliminating the above-mentioned opaque coating. In accordance with the invention a bright coated tubing string is lowered into an oil well containing a static heading of oil so that the tubing string extends into the oil. In order to remove the oil from the tubing string a solvent of a lower density than the oil is introduced into the well to thereby form a layer of solvent on top of the oil. The space above the solvent is then pressurized to drive the solvent downwardly along the tubing string so that as

the solvent moves it contacts and cleans the tubing string. The solvent may be driven into the oil bearing formation adjacent the well. After the well is cleaned of solvent and other fluids, the annular space between the tubing string and well casing may be closed off to prevent re-entry of fluids.

It is therefore an object of this invention to provide a method for preventing the formation of hydrocarbon deposits on the bright tubing so as to minimize radiation heat loss from the tubing.

It is a further object of this invention to provide a method for cleaning bright tubing which can be performed in place in a well casing.

These and other objects will become apparent upon a reading of the following detailed description of the method taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic drawing of an oil well casing containing a static head of crude oil on water;

FIGURE 2 is a schematic drawing showing a bright tubing lowered into a well casing;

FIGURE 3 is a schematic drawing showing solvent being introduced into a well;

FIGURE 4 is a schematic drawing showing the annulus between the tubing and the casing being pressurized to force the solvent and other fluids out of the annulus; and

FIGURE 5 is a schematic drawing showing the liquids displaced from the outer surface of the bright tubing with the annulus closed.

Referring to FIGURE 1, a well casing 10 is shown containing a static head of crude oil 11 floating on a layer of water 12. The well is in communication with an oil-bearing formation 14 through perforations 15 in the casing 10. When a bright coated tubing string 13 is lowered into the well as shown in FIGURE 2, the tubing and the wall of the well form an annular space or annulus 16. As the tubing string is lowered it passes through the crude oil thereby coating the surface of the bright tubing with crude oil. After the annulus is displaced free of liquids, subsequent heated fluid injection through the tubing string 13 would cause the oil coating on the tubing to carbonize or form opaque hydrocarbon deposits thereby raising the emissivity of the tubing and destroying its radiation insulating property.

In order to remove the crude oil from the surface of the bright tubing before steam is passed through the tubing, a cleaning solvent is pumped into the well. The solvent can be pumped down the annulus or down tubing string 13, as shown in FIGURE 3. Although toluene or xylene is preferred, other oil-soluble solvents may be used without departing from the spirit of the invention. When the solvent is introduced through the tubing string 13 the solvent, which is lighter than any water in the well, rises through the water to contact and dissolve any oil in the annular space 16 between the tubing string 13 and the casing 10. The rising of the solvent creates a beneficial turbulent flow over the oil-coated tubing as the solvent moves through the heavier fluids. The amount of solvent introduced will depend on the size of the well and the amount of oil in the well, the important consideration, however, being that sufficient solvent is introduced in the well to form a layer of solvent 17 to contact and dissolve the oil on the exterior of the tubing string when the solvent is moved along the tubing string as will be later described. Preferably, the amount of solvent used at least equals the volume of the casing from the lower end of said tubing string to the static oil level existing within the well. Thus, the solvent will substantially dissolve the oil leaving only the solution of oil-solvent in contact with the tubing string 13.

After the toluene or other solvent is injected, the circulation is reversed by pressurizing the gas above the liquids in the annulus 16 as shown in FIGURE 4 causing the water, oil and then the solvent layer 17 to be forced into the formation 14 or up through tubing string 13. The annulus is pressurized until the upper level of the solvent reaches the end of the tubing string 13 as shown in FIGURE 5. A convenient method of determining this point is to pressurize the annulus until the pressurized gas is blown up the tubing string 13.

Thus far, the static head of oil has been expelled from the well by reversing the circulation after the solvent has been introduced through the tubing string 13 thereby displacing the oil into the formation 14 or up through the tubing string 13. However, it is contemplated that the solvent chosen may have a specific gravity close enough to that of the oil in the well so that it will not immediately invert with the oil and form a layer of solvent on top of any undissolved portion of the oil. In this case the solvent will remain below the oil and by continuing normal circulation, i.e., down the tubing string and up the annular space 16, undissolved portions of oil can be forced out the top of the well. The annular space is then filled with solvent which can subsequently be expelled by pressurizing the annular space 16 as described.

An expansible packer 18 is located near the lower end of the tubing string. The packer is left open during the steps above-described, and is closed in a manner well known in the art when the fluids have been forced out of the annulus 16 thereby preventing oil from re-entering the annulus (see FIGURE 5).

At this point the tubing string exterior is substantially free of oil except for a thin film of oil-solvent that may remain. In order to prevent this additional solvent, for example isopropyl alcohol or other suitable material may be injected into the annular space 16 while the cleaning solvent is still in the annular space. The alcohol will displace the cleaning solvent and remain on top since it is about equal to or lighter than the solvent and oil. When the annular space 16 is pressurized as described above, the alcohol is dispelled along with the other fluids. As the alcohol contacts the tubing string 13, it dissolves and removes any oil-solvent film that may remain on the tubing string. Alternatively, the alcohol can be injected in the annulus 16 after the annulus has been pressurized to expel the cleaning solvent and the packer 18 closed. In this case, the packer 18 must be re-opened and the alcohol forced out under pressure. The packer 18 is then re-closed when all the alcohol has been expelled. The solvent is then forced out of the annulus under pressure by opening the packer 18 and re-closing it after the alcohol has been expelled. The tubing is now clean and will retain its bright coating during subsequent steam injection through tubing string 13.

For most efficient cleaning the solvent should remain in contact with the tubing string at least 30 minutes. Thus, the rate that the solvent is injected and the rate at which the fluids are expelled under pressure should be chosen to assure sufficient contacting time. Of course, if the amount of solvent injected is sufficient to displace the static head of oil, these rates do not have to be regulated since the solvent will be in contact with the entire portion of the tubing string that is oil-coated. In this case, it is merely necessary to wait 30 minutes before pressurizing so that all oil-coated portions of the tubing string remain in contact with the solvent for at least 30 minutes.

In the methods thus far described, solvent is injected only through the tubing string. However, in some well installations, it may be desirable to introduce the solvent either solely or in part directly into the annular space 16 from the top of the well. All subsequent operations of contacting the tubing string and expelling the fluids are performed by pressurizing the annular space 16 as described above.

The procedure described also removes oil from the

interior of the casing 10 at the same time the tubing string 13 is cleaned. This further protects the bright coating on the tubing string since any oil on the casing may result in the deposition of coke on the bright tubing when steam is injected.

The cleaning method described has proved successful in laboratory and field tests. Since the tubing is cleaned in place, the method reduces down time by eliminating the need to periodically withdraw the tubing string and remove coke which has baked on the exterior of the tubing.

We claim as our invention:

1. In a well in communication with an oil-bearing formation and having a static head of oil in said well, the method of installing a bright-coated tubing string in said well and preventing the formation of substantially opaque hydrocarbon deposits on the outer surface of said tubing string comprising:

lowering said tubing string into said well through said static head of oil to a point where it terminates in the vicinity of said oil-bearing formation thereby forming an annular space between said tubing string and the wall of said well;

introducing a hydrocarbon solvent into said annular space to form a layer of solvent adjacent said head of oil in said well; and

moving said layer of solvent and said oil through said annular space while maintaining said solvent layer upstream of said oil and continuing said movement until said solvent layer has traversed the exterior of said tubing string thereby combining with and substantially removing any oil remaining on the exterior of said tubing string, said layer of solvent being moved by pressurizing gas in said annular space above said solvent to thereby drive said solvent and any other fluids present in the well into said oil-bearing formation.

2. The method of claim 1 wherein said solvent is of lower density than said oil and is introduced into said well to form a layer of solvent on top of said oil in said well.

3. The method of claim 2 wherein the volume of solvent introduced is at least equal to the volume of said static head of oil between said upper level of said oil and the lower end of said tubing string.

4. The method of claim 2 wherein said layer of solvent is moved by pressurizing gas in said annular space above said solvent to thereby drive said solvent and any other fluids present in the well into said oil-bearing formation.

5. The method of claim 1 including the step of:

subsequently removing oil-solvent remaining on said tubing string by contacting said string with additional solvent.

6. The method of claim 4 including the step of:

closing said annular space near the lower end of said tubing string to prevent the re-entry of fluids from said formation into said annular space.

7. The method of claim 2 wherein said solvent is introduced directly into said annular space.

8. The method of claim 1 wherein said solvent is introduced into said well through said tubing string.

9. The method of claim 1 including the step of:

maintaining said solvent in contact with any oil coated exterior portion of said tubing string for at least 30 minutes.

10. The method of claim 1 wherein the step of introducing solvent comprises introducing toluene into said well.

11. The method of claim 1 wherein the step of introducing solvent comprises introducing xylene into said well.

12. In a well in communication with an oil-bearing formation and having a static head of oil in said well, the method of installing a bright-coated tubing string in said well and preventing the formation of substantially opaque hydrocarbon deposits on the outer surface of said tubing string comprising:

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lowering said tubing string into said well through said static head of oil to a point where it terminates in the vicinity of said oil-bearing formation thereby forming an annular space between said tubing string and the wall of said well;

introducing a hydrocarbon solvent into said annular space to form a layer of solvent adjacent said head of oil in said well; and,

moving said layer of solvent and said oil through said annular space while maintaining said solvent layer upstream of said oil and continuing said movement until said solvent layer has traversed the exterior of said tubing string thereby combining with and substantially removing any oil remaining on the exterior of said tubing string; and, subsequently closing said annular space near the lower end of said tubing

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string to prevent the re-entry of fluids from said formation into said annular space.

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