

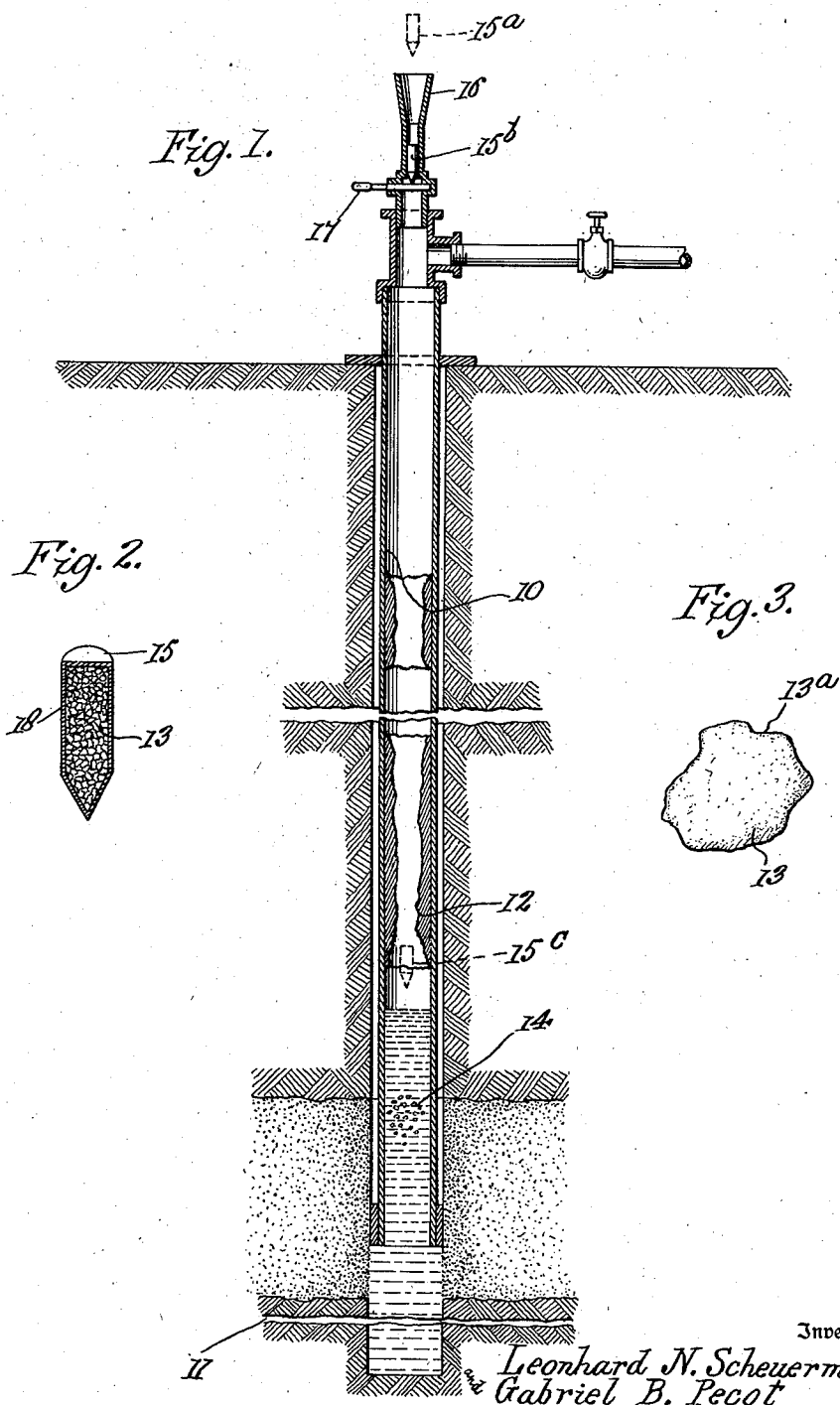
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METHOD AND ARTICLE FOR CLEANING OIL WELLS AND THE LIKE

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METHOD AND ARTICLE FOR CLEANING OIL
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18 Claims. (Cl. 166—16)

The present invention relates to improvements in methods and articles for cleaning oil wells and the like, and is a continuation in part of application Serial No. 411,248, filed September 17, 1941, now forfeited.

An object of the invention is to provide a method for cleaning oil wells and the like in which accumulations of paraffin or other obstruction may be easily and quickly removed to restore full flow in the well or pipe.

The improved method is useful in cleaning oil lines, flow lines, gathering lines, separators, measuring and storage tanks and in fact any line or receptacle that is subject to paraffin or other deposit clogging.

Another object of the invention is to utilize a mechanical abradant in entrainment with the oil in the line to thus acquire sufficient momentum to cut the paraffin in a mechanical manner, and in the oil the abradant or abrasive material will be insoluble.

A further object of the invention is to provide an improved method and material for use in cleaning pipe lines and the like in which, while the abrasive is insoluble in the oil so as to be entrained in the current thereof for mechanical impingement upon the paraffin and the cutting away of the same, such abrasive will be soluble in water to the end that any accumulations resulting from combinations of the paraffin and abrasive can be dissolved out by circulating water through the well or line. In addition to the removing of paraffin deposits, the improved method is useful in cleaning and removing other deposits and/or obstructions in pipe lines and the like.

A further object of the invention is to provide an improved material for carrying out the herein described method in which the material will embody numerous discrete particles having sufficient weight and also preferably irregular cutting edges as to mechanically chip, cut or wear away obstructions when brought into collision therewith incident to the flow of the oil in which such particles are entrained.

A still further object of the invention is to consolidate such discrete particles into a plug bound together with dextrin or some other suitable binder by which the completed plug will possess weight superior to the individual particles to enable the same to be placed without difficulty below the obstruction; the binder being such as to thereupon disintegrate under conditions obtaining below the obstruction to free the discrete particles for entrainment in the flowing oil.

With the foregoing and other objects in view, the invention will be more fully described hereinafter, and will be more particularly pointed out in the claims appended hereto.

In the drawing, wherein like symbols refer to like or corresponding parts throughout the several views,

Figure 1 is a vertical sectional view of a conventional form of oil well with the invention applied,

Figure 2 is a perspective view, with parts broken away and parts shown in section, illustrating a plug constructed in one form according to the invention, and

Figure 3 is a plan view, magnified, of a form of soluble abrasive crystal employed.

In accordance with the improved method, solid and semi-solid obstruction in oil flow lines containing oil may be removed by placing in the oil stream discrete particles, and permitting the flowing oil to entrain such particles and cause them to contact with the obstruction. Salts in general may be used as the particles. Crystalline salts are particularly effective. The materials which produce most unusual and superior results are water-soluble crystalline salts.

Salts having the following properties are preferred:

1, crystalline form, and of a size which would not be too fine for the purpose involved; 2, sufficient hardness; 3, insolubility in petroleum oil; 4, solubility in water; 5, non-poisonous; 6, the general properties of not reacting with oil or water, and of being non-injurious to equipment or personnel.

Sodium chloride is indicated as the most useful salt in view of its general physical properties; its solubility in water and insolubility in oil are additional factors which make common salt a preferred material. Some examples of other salts useful for the purpose are:

Cupric sulfate (CuSO_4); magnesium sulfate (Epsom salt— $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$); potassium chloride (KCl); potassium nitrate (KNO_3); sodium nitrate (NaNO_3).

It is to be understood that these are not all of the salts that can be used but that they are merely given by way of example.

Common salt of the coarse variety, such, for instance, as that type commonly called "ice-cream salt," has been found to be extremely useful for the purpose. "Ice-cream salt" is common crystalline salt having an approximately particle size such as to pass through a 4 mesh screen and to be retained by a 10 mesh screen. Particularly

effective results have been obtained by the use of a 7 to 10 mesh salt.

The method for cleaning oil wells may vary somewhat, dependent upon the character and place of the deposits. The following are only some of the examples practicable according to the improved method.

Example 1.—For cleaning oil lines, we have found that coarse salt, a soluble abrasive, when lowered into the tubing of a well and released at given depths, will, upon rising with the flow of oil, act as thousands of miniature knives, cutting away the paraffin and/or other undesirable deposits that may be left behind through the flowing of oil. Deposits of paraffin or other hydrocarbons are frequently deposited on the walls of the tubing or pipe lines when oil is flowed there-through. The type of deposit, hardness, volume of deposition and other factors are functions of the type of oil, temperature, size of pipe, pressure, etc. Such soluble abrasive cuts the undesirable deposits into very small particles which are carried with the flow of oil up through the choke and then through the manifold through the flow line into the separator, cleaning everything in its path. The abrasive is not soluble in the oil and retains its crystalline form. However, it is soluble in water, as hereinafter explained.

Example 2.—The salt or soluble abrasive may be mixed with the oil from the well being treated, and then allowing such mixture to drop through the lubricator on top of the well. The salt settles by gravity to a point below the deposit. It is to be noted that the salt or abrasive is soluble in water and insoluble in oil. Thereupon the well is allowed to flow, the same action taking place from this point as explained in Example 1.

Example 3.—In cleaning oil lines, gathering lines, flow lines, etc., the soluble abrasive or coarse salt is mixed with the oil from the well being treated. The amount of the abrasive suggested is five pounds per charge. This suggestion is a minimum, and the maximum is recommended in that paraffin or oil deposits are harder in some wells than others, thus requiring more soluble abrasive action to remove the harder deposits. An approximate maximum charge of 100 to 125 pounds is recommended in cases where the deposit is harder and/or thicker, and thus more difficult to remove.

Example 4.—The choke may be removed and the soluble abrasive mixed with oil poured into the riser. Or the choke may remain in the manifold, the riser being broken below the choke and the soluble abrasive-oil mixture poured into the broken connection or riser.

Example 5.—Insert a T below the choke and use this connection more or less as a funnel to receive the abrasive mixed with oil. After the mixture has been introduced, a bull plug may be inserted in the opening and the well opened, allowing the abrasive action to occur in the line from the point where the soluble abrasive has been introduced. The above method will prove most satisfactory when working with wells under pressure. The pressure from the well will agitate the soluble abrasive, thereby creating the desirable mechanical action. In wells that lack pressure, such as pumpers, the pressure may be obtained through the use of air pressure pumps or oil pressure pumps to create the abrasive action necessary.

Example 6.—In cleaning tanks, gas, air or steam pressure may be employed to bring about

agitation which is necessary to put the soluble abrasive into action. It is suggested that in open tanks the abrasive be scattered over the top of the undesirable deposits. The gas pressure from wells, or air pressure created by an air pressure pump, or steam pressure should be used to agitate the soluble abrasive in order that said undesirable deposits may be so cut that removing will be easily accomplished.

The result obtained by practicing methods according to the above examples has been found most satisfactory in practice. Wells, flow lines, etc., have been caused to return the allowable oil production to normal, all obstructions hindering the flowing of oil being removed with the soluble abrasive.

Sand has been heretofore proposed as an abrasive, but from a comparative standpoint sand is impractical as well as dangerous when introduced in the wells, flow or pipe lines.

Sand has a definite tendency to adhere to paraffin and to agglomerate with the accumulations and deposits of paraffin or other foreign matters, thus clogging the tubing or lines and making the flow of oil more difficult because the diameter of the hole through which the oil flows is consequently made smaller instead of larger as with coarse salt. In the event coarse salt would for some unknown reason clog the line or the tubing, the remedy would be to flush the line with water, thus dissolving the obstructions. The dissolving action will be through the solution of the salt agglomerated with the deposit and the entrainment of the loosened deposit. Sand would be impossible to dissolve under the same conditions. When sand is used for any type of cleaning, expensive equipment is needed. Sand, when used as an abrasive, must be shot from a mechanical device of some sort in order to obtain the desired results. Coarse salt is very inexpensive, but at the same time it is the most efficient paraffin remover.

From experience we have learned that a soluble abrasive such as coarse salt has none of the disadvantages of sand. To an oil operator, sand is the antithesis of a cleaning agent, and no oil operator could be prevailed upon to risk the hazards of the use of sand for cleaning purposes.

It will be understood that the steps of the method might be used in other order than that set out, and we do not wish to be limited except as required by the claims.

Referring more particularly to the drawing, 10 designates the tubing of an oil well, up through which moves the oil from the oil-bearing stratum 11, and 12 represents a deposit of paraffin, asphalt, carbonaceous deposit or the like which tends to clog the passage and restrict, and in extreme cases cut off, the flow of oil. Usually the heat of the earth below a certain depth keeps fluid the paraffinic and asphaltic constituents, but as the oil ascends to higher levels and cooler strata, a temperature point is reached where these constituents are deposited on the walls of the tubing. Small original accretions grow and form nuclei about which form further deposits. The problem is to dislodge and remove such accumulations. To this end particles or crystals 13 (Figure 3) of ice-cream salt, or other soluble abrasive, are introduced in gang quantities 14 (Figure 1) to a point below the deposit 12 by means of plugs 15 (Figure 2) dropped down through the tubing 10 in successive phases or doses as indicated at 15^a, 15^b and 15^c (Figure 1). A funnel piece 16 may be used

to charge the plugs 15 into the head of the tubing, the liberation of a plug being controlled by a sliding gate 17.

The plugs 15 may be formed simply of the particles 13 of ice-cream salt and an oil soluble binder, for instance dextrin or a binder of some other substance having adherent qualities under normal conditions but disintegratable at higher temperatures through contact with oil. It is preferable that the plug be coated with a film of paraffin or other suitable material. The object of such coating is to protect the plug prior to use from climatic moisture and to assist in the movement of the plug through the line, prior to disintegration. The plug will remain hard and cohesive until passing below the deposit 12, where it will disintegrate into the myriad of crystals 14. These crystals, as seen in Figure 3, are relatively large and have irregular and jagged edges 13^a for cutting and slicing the deposits 12.

In use, the plugs 15 in suitable numbers are introduced into the well through its surface connections and allowed to fall through the tubing while the well is shut-in. By virtue of the shape and weight of the plug, it will rapidly descend past the point 12 and below the depth of the accumulation. The plugs 15, as shown in Figure 2, are preferably pointed and cylindrical in shape and of such diameter as to permit free passage of the plug past the deposit as it falls there-through.

The plug is so constructed that the various physical factors present below the depth of the paraffinic or asphaltic accumulation will cause its disintegration and the subsequent release of the loose crystals. The disintegration of the plug form is further advanced by other physical factors which have their effect during the fall of the plug from the surface to the desired point of disintegration and the plug is constructed and arranged to take advantage of these factors, which are, namely: (1) heat, (2) pressure, and (3) vibration and agitation created by the flow of oil.

(1) *Heat*.—When the plug becomes heated in the oil well, the paraffin coating melts and the binder is dissolved in the warm oil, thus causing the plug to disintegrate, allowing the discrete particles to slice and cut away the undesirable deposits while entraining in the oil.

(2) *Pressure*.—The paraffin coating cracks or breaks up upon application of pressure, allowing the oil to come in contact with the oil soluble binder, thus releasing the salt crystals, the oil making the binder non-cohesive.

(3) *Vibration and agitation*.—When oil is flowing through the well or line, enough vibration and agitation are created to break the coating, allowing the oil to dissolve the binder, thus releasing the salt crystals so that the discrete particles will cut or slice away the undesirable deposits while entrained in the oil flow.

The depth of paraffinic or asphaltic accumulations within well tubing is largely controlled by the melting point of the accumulations and the geothermal gradient. The geothermal gradient varies, as does the melting point of the accumulations. Therefore, the plug should be designed for a specific field, where necessary, or a certain type plug may be used within various ranges of subsurface temperatures and melting points of accumulations. Thus, a plug may be designed for disintegration at a predetermined depth based

on the geothermal gradient and melting point of the coating on the plug.

Thus, through the use of the plug form, it is possible to place loose soluble abrasive crystals below the depth of accumulation. The rate of fall of the plug through the particular oil, based largely on specific gravity and viscosity, determines the length of time that the well is allowed to remain shut-in after the introduction of the plug at the surface. After this predetermined period, which is calculated to allow the plug to fall a sufficient distance below the depth of accumulation, the well is re-opened and the loose soluble abrasive crystals are then entrained in the flow of oil and cut and remove the accumulation within the tubing. The use of the plug is by no means confined to its usage within tubing, but the plug has been primarily designed for use within tubing to allow the placement of the soluble abrasive crystals at a point below the depth of the accumulation. The use of the plug for the removal of the paraffinic and asphaltic accumulations in surface flow lines is abetted by the following factors: 1, ease of handling; 2, less waste of material; 3, faster application; and 4, less man power to apply.

The plug is constructed by mixing the soluble abrasive crystals with a binder which is soluble in oil. The mixture is then formed into a plug, shaped in a mold and subjected to a drying and final formation process. After the plug has been thoroughly dried, it is removed from the mold or other forming equipment and coated with paraffin 16 or other substance having a melting point closely relating to that of the accumulation within the line to be cleaned. Upon being introduced into the tubing or line, the various forces of pressure, heat and agitation cause the saturation of the plug with oil; disintegration takes place and thus the crystals are released in a loose form.

The length and diameter of the plug are determined by the size of the line or tubing to be cleaned. Its length is determined primarily by the amount of material necessary for removal of the accumulation, but limited in its length to ease of handling, formation and shipment. In the event that a larger volume of material is required than can be contained in a single plug, the cleaning process is effected through the use of more than one plug.

The salt crystals have jagged, sharp and irregular edges 13^a which enhance the cutting effect. Salt crystals 13 of this character possess substantial weight and size as referred to the weight and size of grains of granular table salt and exhibit different characteristics of edge 13^a. By reason of their weight, they acquire substantial momentum when entrained in loose form with the rapidly moving oil stream flowing upwardly toward the surface, by which such particles are caused to collide with the deposit 12 with sufficient velocity and momentum to cut and slice it away. This mechanical action chips, cuts, slices and by attrition wears the deposit, reduces it and finally removes such deposit. This is the action of the particles.

A further step of the method, which may be practiced in those cases where the deposit is refractory by reason of agglomeration with the salt particles, is to circulate water or some other suitable solvent through the tubing or to the agglomerated deposit after the initial action of the salt. The water will dissolve the salt as it exists as a structural and coherent part of obstructive accumulations in the line, thus hollow-

ing out and destroying the foundations and honeycombing these accumulations or obstructions so the passage of the oil through the skeletonized structure will be able to wear it down and entrain it for removal from the oil well. Thus, the salt crystals have a double function of hard-hitting mechanical action and attrition, and also the power under solvent treatment to dissolve and disappear from obstruction masses to break and weaken those masses from within.

The physical form of ice-cream or coarse salt crystals cooperates with the action of entrainment in a vehicle such as oil to the end of bringing about the attrition of crystals 13 against the deposit 12. The result is to restore improved flow in the well or pipe.

The improved method and article will be found useful in removing paraffin accumulations or such other obstructions as pipe scale of various types. The action of the crystals is particularly applicable to hydrocarbon accumulations, such as paraffin, asphalt, gums, etc.

Paraffin may be used as a binder or as a coating for the plug. As a coating it acts as preservation agent to protect the plug from the elements, handling conditions, etc. The paraffin also acts as a lubricant while the plug is traveling through the line, and most particularly as such when traveling vertically downward through tubing.

The plug form, while useful in horizontal lines, is primarily designed for and useful in vertical tubing whereby discrete particles are effectively transported from downstream to upstream through the tube. Thus, the plug is designed to hold the particles together and to transport them from downstream to upstream, and thus place them at an upstream point where they can be entrained in the fluid stream, and then carry out the cleaning process.

While we have described a preferred form of our invention, it will be apparent to those skilled in the art that there are many modifications thereof which come within the scope of our invention, as defined in the claims.

What is claimed is:

1. The herein described method for cleaning oil lines and the like which consists in introducing coarse salt crystals into a body of oil flowing in the line whereby such crystals are carried along with the body of oil and caused thereby to impinge against accumulations of paraffin and the like to cut and slice such paraffin by mechanical action.

2. The method according to claim 1, further characterized by introducing water to the line to dissolve the coarse salt agglomerating with the paraffin deposits.

3. The herein described method which consists in injecting into the oil stream in the tubing of an oil well at a great depth below the surface where non-freezing temperatures prevail a quantity of ice-cream salt crystals having jagged, sharp and irregular edges, said crystals moving in entrainment with the oil to impinge upon and dislodge accumulations in the well, and from time to time introducing into the well a stream of water or other solvent for the crystals to dissolve and wash out such crystals as have agglomerated with other material in oil passage obstructing accumulations.

4. The method for removing solid and semi-solid obstruction from oil flow lines containing oil, comprising placing discrete abrasive, water soluble particles upstream from the obstruction, and flowing the oil containing the discrete particles in entrained condition through the flow line into contact with the obstruction at a rate of flow sufficient to remove at least a part of said obstruction.

5. The method as set forth in claim 4 in which the particles are a salt.

6. A method as defined in claim 4 in which the particles are sodium chloride.

7. The method of claim 4 in which the particles are ice cream salt crystals.

8. The method for removing solid and semi-solid obstruction from oil flow lines containing oil, comprising placing a solid plug of disintegratable, discrete, abrasive water soluble, crystalline particles upstream from the obstruction, disintegrating the plug into discrete particles, and flowing the oil containing the discrete particles in entrained condition in contact with the obstruction at a rate of flow sufficient to remove at least a part of said obstruction.

9. The method of claim 8 characterized in that the particles are a salt.

10. The method of claim 8 characterized in that the particles are sodium chloride.

11. The method of claim 8 characterized in that the particles are coarse, salt crystals.

12. The method for removing solid and semi-solid obstruction in vertical oil flow lines containing oil, comprising consolidating into a plug numerous abrasive water soluble crystalline particles, dropping the plug from above the obstruction down past the obstruction to a point below the obstruction in the line, disintegrating the plug below the obstruction to liberate the particles, and flowing the oil containing the particles in entrained condition in contact with the obstruction at a rate of flow sufficient to remove at least a part of said obstruction.

13. An article for removing solid and semi-solid obstruction from oil flow lines containing oil, comprising numerous abrasive water soluble crystalline particles, and a binder to hold the particles into plug form.

14. An article for removing solid and semi-solid obstruction from oil flow lines containing oil, comprising a plug, said plug comprising discrete abrasive water soluble crystalline particles, and a binder to hold the particles into said plug form, said binder being soluble in oil.

15. An article as recited in claim 14 in which the particles are a salt.

16. The article as defined in claim 14 in which the particles are coarse, salt crystals.

17. The method in accordance with claim 4 in which water is introduced into the flow line subsequent to the treatment with said particles to dissolve particles which have agglomerated with the obstruction.

18. The method in accordance with claim 8 in which water is introduced into the flow line subsequent to the treatment with said particles to dissolve particles which have agglomerated with the obstruction.

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