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METHOD OF TREATING WELLS

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The invention relates to the treatment with acids of wells yielding fluid products, more particularly oil or gas wells, to increase the production therefrom.

In the prevailing method of treatment a charge of acid is introduced into the well and forced therefrom into the surrounding earth or rock by the application of fluid pressure. The acid enlarges the passages in the earth by dissolving calcareous matter therein and thus facilitates and increases the flow of oil or gas to the well when the pressure is released. A disadvantage of this process is that the acid may incidentally open or enlarge passages in the earth through which brine or water can reach the well and so promote or increase the production thereof. The principal object of our invention is to prevent bringing about or increasing brine production incident to improving the output of a well by an acid treatment.

Among the known methods of preventing a flow of brine into oil wells is that described in U. S. Patent 1,421,706 according to which brine-bearing passages are cemented off or plugged by introducing thereinto a precipitating agent consisting of an aqueous solution of a sulphate, carbonate, or silicate which forms an insoluble precipitate in situ with the calcium, magnesium, or barium salts. Such salts may be present as constituents of the brine in or introduced into the well for the purpose. In the practical use of this procedure to seal off brine-bearing passages prior to the introduction of acid so that the acid will not pass into such passages while acting upon oil-bearing passages, we have found that the latter may become cemented off also and thus hinder or prevent the normal flow of oil or gas to the well. This is due to the fact that the spent acid resulting from the acid attacking the calcareous matter in the oil-bearing earth formation reacts with the precipitating agent to form a precipitate in the oil-bearing passages. This procedure, therefore, seals up not only the brine-bearing passages, but also the oil-bearing passages as well. In order to attain the principal object of our invention we have found that provision must be made not only to prevent the flow of acid into brine-bearing earth and so to obviate attack thereof by the acid, but also to prevent the formation of clogging precipitates with the spent acid in the oil-bearing passages.

To the accomplishment of the foregoing and related ends, the invention, then, consists in the method hereinafter fully described and particularly pointed out in the claims, the following de-

scription setting forth certain detailed procedures embodying the invention, these being illustrative, however, of but a few of the various ways in which the principle of our invention may be applied.

In the treatment contemplated by our process instead of introducing a charge of acid into the well directly following the precipitating agent, we first introduce the precipitating agent into the earth formation and then remove the excess thereof from the oil-bearing passages before introducing the charge of acid. As an alternative procedure we may introduce oil, water, or like neutral liquid into the well ahead of the acid instead of withdrawing the excess of precipitating agent, so as to keep the latter separated from acid in the earth formation. By removing precipitating agent from the earth formation or interposing a neutral liquid between it and the acid, the latter, when spent, is prevented from acting on the agent to form a precipitate in oil passages, so that resumption of oil flow may be had without hindrance therefrom when the well is put into production.

In carrying out the invention brine and oil standing in the base of the well preferably are removed, if such are there, then the pump rods and standing valve are pulled, and thereafter we introduce a charge of a fluid agent capable of forming a suitable precipitate with brine. A fluid precipitating agent comprises a water solution of a soap formed from a suitable fatty acid such as palmitic, margaric, oleic, stearic, etc., and a base such as alkali metal bases, ammonium hydroxide, triethanol amine, etc.; sodium oleate, palmitate, etc., on account of their cheapness are used preferably. The fluid agent may be of such consistency or concentration that it will flow readily or may be made to flow under fluid pressure. For example, a soap concentration of from 10 to 40 per cent by weight, the balance being water, is suitable, although other concentrations may be used, if desired. A preferable concentration is about 30 per cent. The amount to employ may be that calculated to fill the voids to be plugged. For example, about 5 to 50 gallons or more may be employed, depending upon the particular well and conditions peculiar to it.

The usual brine to be found in brine-bearing formations contains soluble salts of calcium or magnesium and is, therefore, capable of coagulating or forming a precipitate with a water-soluble soap. Brines containing sodium salts and the like, but no calcium or magnesium salts,

do not coagulate such soaps. Therefore, where such brines are encountered we may employ diphenyl sulphonic acid or similar sulphonates as the fluid precipitating agent instead of a soap solution. Such sulphonates form a coagulum or precipitate on contacting a sodium salt brine. Such precipitates are semi-solid colloidal materials that stop up the pores, channels or the like originally containing brine, thus preventing or impeding the subsequent passage of either brine or acid thereinto or therethrough.

We then proceed to prevent the possibility of subsequent formation of a precipitate in those parts of the earth formation that do not contain brine by removing therefrom the unprecipitated fluid agent or introducing into the well a neutral liquid that prevents further precipitation occurring when acid is subsequently introduced. The removal of unprecipitated agent may be effected preferably by pumping or by allowing the well to flow, if a flowing well. Such removal need not be resorted to if, after the fluid precipitating agent is introduced, a quantity of a neutral fluid such as oil or water, that does not form a precipitate with oil or brine, is run into the well. By this means the unprecipitated excess of the precipitating agent is forced from the region to be treated and kept separated from the acid subsequently introduced. This procedure also has the advantage that the charge of fluid precipitating agent may be forced into the surrounding earth or rock to a considerable distance beyond the base of the well.

After removing the excess of precipitating agent from the region of the earth to be treated with acid or introducing a neutral liquid therein, the charge of acid is introduced into the earth formation without danger of a clogging precipitate being formed by the products of the action of acid and precipitating agent. Such acid may be introduced into the well in any convenient manner and forced therefrom into the surrounding earth by the application of fluid pressure.

Suitable acids for the purpose are those capable of acting upon the earth or rock formation to form water-soluble salts therewith which remain in solution and may be removed from the well. In this respect hydrochloric or nitric acid are preferred to sulphuric or phosphoric, although the two last mentioned acids may be used where difficulty is not encountered due to the formation of insoluble sulphate or phosphate, respectively. Mixtures of these acids may be used; other acids such as hydrobromic and hydrofluoric are operative, but are in general more expensive. Aqueous hydrochloric acid is generally suitable and may be used in a concentration between 5 and 20 per cent or preferably between 10 and 15 per cent, although other concentrations may be used, if desired. The stated concentrations permit retaining dissolved salts in solution in the spent acid. By adding a suitable inhibitor to hydrochloric acid solution, as disclosed in U. S. Patent 1,877,504, damage to the metallic casing, pump tube, etc., due to acid attack, may be avoided.

Inasmuch as passages in the earth formation bearing brine are substantially sealed by coagulation therein of fluid precipitating agent, acid is prevented from entering such and instead is directed to the remaining passages through which fluid may flow. The acid attacks the water-soluble constituents of the passage walls and enlarges their flow capacity. Since precipitating agent is removed from those passages not sealed by coagulum, precipitation therein is prevented and re-

sumption of oil flow may occur, therefore, without hindrance.

Other modes of applying the principle of our invention may be employed instead of those explained, change being made as regards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In a method of treating a well with acid, the steps which consist in introducing successively thereinto a fluid precipitating agent capable of forming a coagulum with brine, then a neutral liquid, and thereafter a charge of acid capable of acting upon the earth formation.

2. In a method of treating a well with acid, the steps which consist in introducing successively thereinto a water solution of a soap, then a neutral liquid, and thereafter a charge of acid capable of acting upon the earth formation.

3. In a method of treating a well with acid, the steps which consist in introducing successively thereinto a water solution of a soap, then a quantity of water, and thereafter a charge of acid capable of acting upon the earth formation.

4. In a method of treating a well with acid, the steps which consist in introducing successively thereinto a water solution of a soap, then a quantity of oil, and thereafter a charge of acid capable of acting upon the earth formation.

5. A method of shutting off water in oil wells penetrating formations containing brine and delivering brines into the well, which comprises injecting into the formations an aqueous soap solution, producing a plastic water insoluble but oil soluble deposit in the water formation.

6. A method of differentially shutting off water in oil wells penetrating both oil and water producing formations without permanently hindering flow of oil into the well wherein two aqueous solutions containing reagents adapted upon admixture to react to form a water-insoluble oil soluble plastic are forced consecutively into the well and adjoining formations producing said plastic in place in the interior of the water formation.

7. A method of differentially shutting off water in oil wells penetrating both oil and water producing formations without permanently hindering flow of oil into the well wherein two aqueous solutions containing reagents adapted upon admixture to react to form a water-insoluble oil-soluble plastic are forced consecutively into the well and adjoining formations forming the plastic in the water formations, the well being flushed with water under pressure before injection of the second solution.

8. The matter of claim 6 wherein one of the solutions contains a salt of a fatty acid.

9. The matter of claim 6 wherein one of the solutions contains a salt of a fatty acid and the other solution a strongly ionized acid.

10. A method of shutting off water in oil wells penetrating water bearing formations which comprises injecting into the formations adjacent the well an aqueous solution of sufficient liquidity and of such fluid character as to readily penetrate fine pores and crevices, said solution containing a soap which forms upon admixture with local waters an insoluble deposit in the pores and crevices of the formation.

11. A method of shutting off water in porous water bearing formations which comprises forc-

ing into the pores thereof a soap solution of sufficient liquidity to travel a substantial distance therein and of such character as to produce an insoluble clogging solid deposit.

12. The method of treating an oil well to increase the proportion of oil and decrease the proportion of water produced therefrom, which comprises depositing in a water wet sand adjacent the well a chemical precipitate which acts to render the sand less permeable to water without substantially retarding the flow of oil to the well.

13. The method of treating an oil well, which comprises forcing into the well and into a water wet sand adjacent the well a solution of a precipitable chemical compound, and reacting the chemical compound in situ within the sand

to effect a precipitation of the reaction product within the sand to render the latter less permeable to water without substantially retarding the flow of oil to the well.

14. The method of treating an oil well to increase the proportion of oil and decrease the proportion of water produced therefrom, which comprises forcing into the well and into a water wet sand adjacent the well a solution of a chemical compound which reacts upon contact with the water and metal salts present in the sand to cause a precipitation of a reaction product within the sand to render the latter less permeable to water without substantially retarding the flow of oil to the well.

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