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TREATMENT OF WELLS

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7 Claims. (Cl. 166—25)

The invention relates to the treatment of deep wells. It more particularly concerns a method of treating oil and/or gas wells with acids to bring about an increase in the permeability of the formation surrounding the well bore and thereby an increased production from the well.

In treating wells with acids, such as for example with hydrochloric acid inhibited against corrosive attack upon iron or steel, it is the conventional practice to pressure the acid into the formation under a column of oil which serves to hold the acid at the desired location until the reaction between the acid and the calcareous rock is sufficiently completed to indicate that its withdrawal is desirable. The well is then put back on production, usually by a swabbing operation which removes the spent acid from the formation and draws the desired mineral fluid into the well bore. While the procedure outlined above is generally very successful as regards bringing about a highly satisfactory increase in production, in some instances the desired increase fails to materialize and, in fact, the original production of the well before treatment may be lost. This condition is observed to arise most frequently in connection with treating those wells having very low formation pressures. In such cases it is believed that the ineffectiveness of the treatment is largely due to the inability of the formation to purge itself of the treating fluid which tends to resist flow to a much greater degree than oil and/or gas.

It is, therefore, an object of this invention to provide a method of acid treating wells having low formation pressures without danger of retarding or otherwise detrimentally affecting the flow of the desired mineral fluid to the well bore.

Another object of the invention is to provide a method of treating wells with acids which more positively insures the return of the spent acid to the well bore.

Other objects and advantages will be apparent as the description of the invention proceeds.

My invention resides in the discovery that much of the difficulty of recovering spent acid from the formation and returning a well to production is eliminated by introducing into the formation ahead of the acid solution a material which reverts to a gas unless confined under a substantial pressure. As the pressure is released on the spent acid solution the action of the material first introduced is to expand to a gas, and thus force the spent acid from the pores of the formation allowing the oil and/or gas to reach the well bore more readily. The material which is normally a gas further acts to separate any oil that may be present from the acid and by dissolving to some extent in the oil renders the oil less viscous, thus not only tending to prevent the formation of an emulsion between the acid and oil by separating the two solutions, but at the same time changes the characteristics of the oil so that it is enabled to flow through the formation more readily at lower pressures.

In carrying out the method of the invention in a well equipped with the usual casing and tubing it is preferable to first fill the well with oil and thereafter introduce the liquefied gas into the well through the tubing as by pumping while allowing oil to escape through the casing in the manner taught by the Carr Patent 1,891,667. In this manner the position of the liquefied gas is definitely known. When the liquefied gas reaches the bottom of the tubing it is displaced into the formation to be treated and followed with a charge of the desired acid solution which may be displaced into the formation in conventional manner as by forcing a quantity of oil into the tubing on top of the acid. However, it has also been found to be highly desirable to pressure the acid into the formation with an additional quantity of liquefied gas since this material returns to a gaseous state when the well is opened, thus eliminating the necessity of removing the oil or other pressuring fluid from the well bore as a preliminary to returning the well to production. After the desired quantity of acid has been displaced into the formation in the foregoing manner and sufficient time allowed for it to react, the well may be put back into production as by opening the well and performing a swabbing operation in conventional manner if the well does not automatically purge itself of the spent acid.

It is to be understood that the readily liquefiable gas may be employed in conjunction with any acid treatment as conventionally carried out. For example, it may be found desirable to place a packer on the tubing and seal the annular space between the tubing and casing while introducing the liquefied gas and acid through the tubing in the proper order.

The readily liquefiable gases suitable for the purpose at hand are characterized by possessing a vapor pressure in excess of atmospheric and preferably they should posses a vapor pressure or a saturated vapor pressure of several atmospheres under the conditions encountered in the well in order that the most desirable results are realized as regards forcing the spent acid back to the well bore after the acidization step of the

treatment is completed. Among the materials that have ben found suitable for the purpose at hand are hydrocarbon gases such as propane and butane. Butane is readily and cheaply available at refineries processing oil and thus it is locally available at the time of treatment. Of course, mixtures of the above gases may also be employed and other gases than the hydrocarbons having the aforementioned characteristics and not detrimentally affecting the producing ability of the formation may be employed. The pressures required to maintain these gases as liquids are not excessive, for example, butane may be maintained as a liquid at 80° F. at an absolute pressure of 37.6 pounds per square inch and at 120° F. at an absolute pressure of 70.8 pounds per square inch. Propane is a liquid at 80° F. at an absolute pressure of 142.8 pounds per square inch and at 120° F. an absolute pressure of 240 pounds per square inch is required to maintain this gas in a liquid state. Since the temperatures ordinarily encountered will be within the above range the gases can be readily maintained as a liquid during the course of the treatment. These gases may be readily maintained in a liquid state while the pumping and placing operation is occurring by use of suitable pumps adapted for handling these types of materials.

The quantity of the readily liquefiable gas to employ may vary quite widely. Illustrative of a generally suitable amount of liquefied gas to employ is from about 200 to 1000 gallons or more.

Any of the conventionally used acids or mixtures thereof may be suitably employed in the method, such as for example a 10 to 25 per cent solution of hydrochloric acid containing a corrosion inhibitor adapted to prevent corrosive attack of the acid on the iron well equipment. The method is also adapted for use in connection with other treating fluids commonly used in wells.

By employing the foregoing improved method the liquid agent employed ahead of the acid is capable of expanding to a gas under appreciable pressure thus greatly increasing in volume so that, as the pressure being employed to hold the acid in position is released, the acid is forced back towards the well bore. This method thus affords a high degree of improvement in treating wells having low formation pressures or those wells in which difficulty is encountered in withdrawing the spent acid from the formation.

I claim:

1. In a method of treating an oil and/or gas well, the steps which comprise introducing thereinto and thence into the surrounding formation a liquid which reverts to the gaseous state unless confined under pressure, and thereafter introducing a charge of acid into the well.

2. In a method of treating an oil and/or gas well, the steps which comprise introducing thereinto a readily liquefiable gas possessing a vapor pressure in excess of atmospheric pressure, and thereafter introducing a charge of a treating fluid into the well.

3. In a method of treating an oil and/or gas well, the steps which comprise introducing thereinto and thence into the surrounding formation a liquid which reverts to the gaseous state unless confined under a substantial pressure, introducing a charge of acid into the well and forcing it therefrom into the surrounding formation, allowing the acid to react with constituents of the formation, and thereafter putting the well back into production.

4. In a method of treating an oil and/or gas well, the steps which comprise introducing butane thereinto and thence into the surrounding formation, and thereafter introducing a charge of the acid into the well and thence into the surrounding formation.

5. In a method of treating an oil and/or gas well, the steps which comprise introducing propane into the well and forcing it therefrom into the surrounding formation, and thereafter introducing a charge of acid into the well and displacing it into the formation.

6. In a method of treating an oil and/or gas well, the steps which comprise introducing thereinto and thence into the surrounding formation a liquid which reverts to the gas unless confined under substantial pressure, introducing a charge of acid into the well, thereafter introducing a quantity of said liquid which reverts into the gas on top of the acid, and applying pressure thereto so as to force the acid from the well bore into the surrounding formation.

7. In a method of treating an oil and/or gas well, the steps which comprise introducing thereinto a liquified gas possessing a vapor pressure in excess of several atmospheres at ordinary temperatures, displacing said liquefied gas in the formation surrounding the well bore, and thereafter introducing a charge of acid into the well and applying pressure thereto to force the acid into the formation.

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