Patented Feb. 25, 1941

2,233,271

UNITED STATES PATENT OFFICE

2,233,271

TREATMENT OF WELLS

John G. Staudt, Tulsa, Okla., assignor to The Dow Chemical Company, Midland, Mich., a corporation of Michigan

No Drawing. Application February 17, 1938, Serial No. 190,975

5 Claims. (Cl. 166—21)

The invention relates to an improved method of acid treating a well drilled into or through a calcareous formation to increase the yield of fluid mineral products therefrom. It more particularly concerns an improved method of acidizing oil and gas wells.

In the treatment of a well with an acid solution which is capable of dissolving constituents of the productive earth and rock formation penetrated by the well bore, thereby increasing the permeability of said formation, I have found that in some instances the acid will drain into the formation with relatively great facility and when this occurs an increase in production is not often obtained. I have observed that this draining action may occur even in wells which at the time of treatment produce at a very substantial rate. It is evident therefore, that in such cases production is being derived from the relatively impermeable sections and that the acid when introduced into the well simply drains into the relatively permeable portions without beneficially affecting the tighter portions, for otherwise the action of the acid in dissolving the rock and enlarging the pores of the formation would bring about an increased rate of production.

It is, therefore, an object of the invention to provide a method of treating well formations with an acid, whereby the acid reagent may be substantially prevented from draining into the relatively permeable sections of the formation. Another object is to provide a method of treating well formations with an acid, whereby the acid is directed into the relatively impermeable sections of the formation while being prevented from draining into relatively permeable sections. Still other objects and advantages of the invention will be apparent from the following description.

I have now found that the foregoing objects can be attained and greater increases in output obtained by introducing into the well along with the acid one or more successive small portions or slugs of a substantially non-penetrating liquid mixture substantially unaffected by the acid and having a specific gravity about the same as that of the acid. The term "non-penetrating liquid mixture" used herein and in the appended claims means a liquid mixture comprising a dispersion or solution in a liquid of a material which prevents the liquid from penetrating porous formations such as those traversed by a well bore, but of sufficient fluidity to be introduced into the well and readily withdrawn therefrom. The non-penetrating liquid mixture introduced along with the acid is carried into the relatively permeable portions of the formation sealing them against drainage of the acid thereinto.

By the foregoing method, thus briefly described, it is usually possible to increase the production of a well in which the producing formation is of such a nature as to readily admit relatively large volumes of acid without beneficial results. The invention, then, consists of the method hereinafter fully described and particularly pointed out in the claims.

In carrying out an acid treatment according to the invention in a well equipped with the usual casing and tubing, the acid solution is first introduced into the well, preferably through the tubing, and maintained under a pressure sufficient to force the acid into the formation. When it is observed that the acid is rapidly draining away into the formation under little or no applied pressure, a quantity of a non-penetrating liquid mixture is introduced into the well, preferably in slugs, along with the acid. The volume of the individual slugs generally may be from 5 to 30 gallons, although larger slugs may be required in some cases depending upon the area of permeable formation to be sealed. The non-penetrating liquid mixture flowing down the tubing in slugs with the acid is carried by it to the highly permeable portions of the formation where it becomes filtered out forming a sealing deposit. The sealing deposit substantially prevents further entrance of the acid into these sections and thereafter the acid solution is thereby directed into the relatively tight unsealed portions of the formation. The injection of acid is continued until the desired quantity has been injected into the formation, usually 500 to 5000 gallons or more being employed, while slugs of non-penetrating liquid mixture are introduced as often as it appears that the acid is draining away into porous sections of the formation, whereby loss of acid due to drainage into the porous sections is prevented. Usually it is necessary to add from 3 to 5 slugs of the non-penetrating liquid mixture during an acid treatment, although in some cases one slug of the said mixture is all that is required to produce the desired results. After the charge of the acid is introduced into the well, fluid pressure such as oil or gas may be applied to displace the acid from the tubing, if necessary. The well is then closed in until the reaction is substantially complete, after which the pressure may be released and the spent acid removed by pumping it from the well. When the well is put into production, the flow of fluids into the well readily removes the non-penetrating liquid mixture de-

posited on the walls of the well bore, thus allowing unhindered flow from substantially all portions of the producing formation.

Among the non-penetrating liquid mixtures that are useful for preventing the acid from penetrating into the more porous sections are those that have substantially the same specific gravity as that of the acid being used, preferably immiscible with the acid, and not attacked by it. A mixture having suitable characteristics may be made for example by forming a relatively thick emulsion of oil and water. Such an emulsion may be made by passing the oil and water together through a mixing head or homogenizer at a high rate of speed in conventional manner. Any of the well-known emulsifying agents may be incorporated in the mixture to facilitate the forming of the emulsion. Any suitable consistency can be obtained by varying the proportion of the ingredients. Another type of non-penetrating liquid mixture having gel-like characteristics may be made by mixing from 3–5 per cent of certain soaps such as aluminum stearate and aluminum palmitate with a liquid such as kerosene, gasoline, benzene, and preferably crude oil because of its cheapness, and then heating the mixture to a temperature of from 50 to 80° C., after cooling to normal temperatures it is ready for use. Still another type of non-penetrating fluid consists of a solution or dispersion of an organic jellifying material in water. By an "organic jellifying material" is meant an organic material capable of being dispersed or dissolved in water to make a mobile liquid dispersion or solution, which liquid exhibits jellifying characteristics after a time. Suitable organic jellifying materials may be prepared from starches, such as those of cassava or rice, by mixing them with water to form a thin paste and boiling the mixture until the starch is hydrolyzed. The cooked starch is dried at about 80° C. and the dried material ground, preferably to a fine powder. The powder so produced may be mixed with water in a concentration of from about 1 to 8 per cent by weight to give a dispersion or solution of an organic jellifying material. Tests on cores secured from typical formations rendered relatively porous by acid treatment, have shown that such non-penetrating liquid mixtures are not forced through the cores even when relatively high pressures are applied to the mixture.

Suitable acids to employ in carrying out an acid treatment according to the invention are those acids capable of attacking and dissolving the calcareous rock, and preferably those forming water soluble salts therewith, such as a 15% solution of hydrochloric acid. Other acids, such as nitric acid, or mixtures of nitric and hydrochloric acids may be used.

Among the advantages of the invention are that relatively impermeable sections of the formation ordinarily not attacked by the acid are penetrated and rendered more porous, thus enabling greatly increased production to be obtained from these sections; and that excessive loss or drainage of the acid into the relatively open or porous portions of the formation may be greatly reduced or prevented.

Other modes of applying the principle of my 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.

I therefore particularly point out and distinctly claim as my invention:

1. In a method of acid treating a well in a calcareous formation to prevent the loss of acid reagent by drainage into porous sections, the steps which include introducing a quantity of acid into the well, thereafter continuing the introduction of acid while including therewith a relatively small quantity of substantially non-penetrating liquid mixture having about the same specific gravity as the acid, whereby the non-penetrating mixture is deposited on the porous sections of the formation, sealing them against the flow of acid thereinto, and repeating the foregoing steps as desired.

2. In a method of acid treating a well in a calcareous formation to prevent the loss of acid reagent by drainage into sections being rendered porous by the acid, the well being equipped with the usual casing and tubing, the steps which include introducing a quantity of acid into the well through the tubing, and while said acid is flowing into the well including in the acid stream at least one slug of an aqueous dispersion of an organic jellifying material having about the same specific gravity as that of said acid, whereby the organic jellifying material is deposited on the porous sections of the formation, temporarily sealing them against the flow of acid thereinto.

3. In a method of acid treating a well in a calcareous formation having a section of relatively low permeability adjacent the bottom of the well bore, to prevent the loss of acid reagent by drainage into sections being rendered porous by the acid solution, the steps which include introducing a quantity of acid into the well and thereafter continuing the introduction of acid while including therewith a small quantity of a substantially non-penetrating liquid mixture having about the same specific gravity as the acid, whereby the non-penetrating liquid mixture is deposited on the porous sections of the formation, temporarily sealing them against the flow of acid thereinto, and repeating the foregoing steps as desired.

4. In a method of acid treating a well in a calcareous formation to prevent the loss of acid reagent by drainage into the porous sections, said well being equipped with the usual casing and tubing, the steps which include introducing a quantity of acid into the well through the tubing and while said acid is flowing into the well including in the acid stream at least one slug of a substantially non-penetrating emulsion having about the same specific gravity as that of said acid, whereby the emulsion is carried into the well by the acid and deposited on the porous section of the formation sealing it against the flow of acid thereinto.

5. In a method of acid treating a well in a calcareous formation to prevent the loss of acid reagent by drainage into the porous sections, the well being equipped with the usual casing and tubing, the steps which include introducing a quantity of acid into the well through the tubing, and while said acid is flowing into the well including in the acid stream at least one slug of non-penetrating mixture comprising oil and from 2 to 5 per cent aluminum stearate, said mixture having about the same specific gravity as the acid, whereby said mixture is deposited on the porous sections of the formation sealing them against the flow of acid thereinto.

JOHN G. STAUDT.