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METHOD OF TREATING OIL WELLS

Allen D. Garrison, Houston, Tex., assignor to The Texas Company, New York, N. Y., a corporation of Delaware

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9 Claims. (Cl. 166—21)

This invention relates to the treatment of an oil well, and more particularly to the chemical treatment of the sand adjacent a producing well in order to render the sand preferentially wettable by oil to thereby increase the proportion of oil and decrease the proportion of water produced by that well.

It is recognized that ordinary sand is more easily wet by water than by oil. It is further recognized that oil producing sands are predominantly water-wet. When the pore spaces of an oil producing sand contain both water and oil the fact that the sand surfaces are water-wet will cause the water to occupy the smaller capillaries and crevices to the exclusion of the oil, thereby limiting the flow of the oil to the larger capillaries only, this flow of oil through these capillaries being retarded because the pore spaces of the capillaries are substantially reduced in cross-section by the presence of the relatively immobile water film on the sand grains. The oil flow into and through the smaller capillaries and crevices is opposed by the interfacial tension between the oil and the water. My invention resides in a method of causing oil to flow through all of the capillaries and crevices of an oil producing sand by removing the water film from the walls of the capillaries and crevices, and rendering the surfaces oil-wettable. In this manner, the flow of water into the well is retarded by the same force which obstructs the flow of oil through the average water-wet oil producing sand.

In Patent No. 2,024,119, issued to William V. Vietti and Allen D. Garrison, there is disclosed and claimed a method of treating a producing sand of this character which is wet with water, by the depositing of a water and oil insoluble precipitate on the sand grains, which precipitate is of such character that it does not fill or block the pore space of the sand and is preferentially wettable by oil so that the sand becomes wet with oil, whereby the proportion of oil produced by the well is increased while the proportion of water so produced is decreased. In accordance with the method of said patent, a water solution of a water soluble alkali metal salt of a sulfonated fat, fatty acid or oil is introduced into the well and into the sand adjacent the well, and this solution either reacted with the calcium and magnesium salts of the brine naturally occurring in the well, or else reacted with a subsequently introduced water solution of a soluble alkaline earth or heavy metal salt, to cause precipitation of an alkaline earth or heavy metal sulfonate within the sand to form the said water and oil insoluble film coating upon the sand grains.

The present invention constitutes an improvement over the method of said patent, and involves additional treatment of the producing sand following the deposition of the water and oil insoluble film coating upon the sand grains to substantially completely remove water from the pore space of the treated sand adjacent the well bore.

In accordance with the present invention, the producing sand is first treated to deposit a water and oil insoluble film coating upon the sand grains, which coating is preferentially wettable by oil. The treated sand is then dehydrated to remove water from the pore space thereof, as by introducing into the well under pressure a dehydrated gas to cause evaporation of the water or to drive the water farther back into the formation. Thereafter, a charge of oil is forced into the well and into the treated sand, so as to insure that the sand is wet with oil and the pore space thereof substantially free from water, prior to the production of oil from the well.

The initial coating of the sand grains with a thin adhering film of a water and oil insoluble precipitate which is preferentially wettable by oil may be accomplished in the manner disclosed in the above mentioned Patent No. 2,024,119. As set forth therein, there is forced into the well and into the sand adjacent the well, a solution of a precipitatable compound of the preferential wetting character described. This is followed by a solution of a compound which is active to react with the first mentioned compound to produce the desired precipitate when these two solutions are brought into contact with each other within the producing sand being treated, whereby the precipitate so produced is effectively distributed and deposited throughout the treated sand zone adjacent the well bore. The procedure described above may be repeated one or more times, so as to secure the desired effective deposit and coating of the sand grains throughout the water-wet sand.

Suitable materials which possess the preferential wetting property include various water and oil insoluble salts of sulfonated oils, fats or fatty acids. For example, the alkaline earth and heavy metal salts, including those of calcium, barium, iron, manganese, zinc, tin, lead, and the like, of sulfonated oils, fats or fatty acids may be employed. Natural fats, such as tallow, olein,

stearin, and the like, which have been sulfonated by treatment with sulfuric acid, are suitable. Likewise, sulfonated fatty acids formed by sulfonating stearic, palmitic, oleic and the like, are included. A very satisfactory and comparatively cheap material, which is a by-product of the petroleum industry, is the sulfonic sludge acid derived from the treatment of petroleum oil with sulfuric acid, and termed herein a petroleum oil sulfonate. These various materials may conveniently be used in the form of their alkali metal salts, whereby a water solution of the soluble salt may first be forced into the bore of the well and into the sand immediately surrounding the well. Then a water solution of a water-soluble salt of calcium, barium, or other alkaline earth or heavy metal, such as a chloride or nitrate, is forced into the well and into the sand to react with the first mentioned solution to produce a precipitate of the water and oil insoluble metal salt of the sulfonated oil, fat or fatty acid upon the sand grains.

If sufficient brine carrying naturally-occurring calcium and magnesium compounds is present in the producing sand being treated, the introduction of the initial water solution of alkali metal sulfonate, so as to react in situ with the calcium and magnesium compounds of the brine, may be sufficient to produce the desired coating.

In addition to the materials specified above for producing the oil wettable coating, other substances can be employed, such as the metallic sulfides of my co-pending application Serial No. 212,975, filed June 10, 1938, including the sulfides of heavy metals which do not hydrolyze in slightly acid water such, for example, as sulfide of lead, copper, cadmium, cobalt, iron, mercury, molybdenum, nickel, tin, silver, zinc, arsenic, antimony, and the like. This coating is conveniently formed by introducing into the well a mineral oil solution of a heavy metal compound which is soluble in the oil, and following this by the introduction of a mineral oil solution of a sulfide compound which reacts within the producing sand with the heavy metal compound to produce a precipitate of a heavy metal sulfide. Various heavy metal soaps which are sufficiently oil-soluble to be employed in this manner are satisfactory for this purpose, such as heavy metal salts of oleic, stearic, palmitic and other fatty acids as well as the heavy metal salts of naphthenic acids. Various mineral oil fractions can be employed as the solvent, such as kerosene, naphtha, gas oil, lubricating oil or crude oil. Following the introduction of the oil solution of the heavy metal soap, there is then charged into the well an oil solution of an oil-soluble sulfide compound such as hydrogen sulfide. The same mineral oil fractions as specified above may be employed as solvents for the sulfide compound used.

In addition to the above compounds for producing the oil wettable film coating, there may be employed a film coating of a water and oil insoluble bitumen of my co-pending application Serial No. 212,976, filed June 10, 1938, such as may be obtained from a petroleum or coal tar pitch, asphalt, natural asphalt and the like. A very satisfactory material for this purpose is a modified asphalt produced by sulfurizing asphalt at high temperatures, or by highly oxidizing asphalt by air blowing for extended periods of time and at temperatures to produce a resultant asphaltic material which is substantially insoluble in crude oil as well as in water. A satisfactory and cheap starting material for the production of this water and oil insoluble asphalt is a cracked petroleum residue such as a cycle fuel oil or a heavy pitch derived from cracking operations. The bituminous or asphaltic materials of this type may be applied to the sand in the form of an extract of the same in a suitable non-aqueous organic solvent. Various aromatic solvents of the character of benzol, toluol, xylene, light coal tar oil and the like may be employed. Likewise, chlorinated aromatic solvents such as chlorbenzene and nitrated aromatic solvents such as nitrobenzene may be used. Also, certain chlorinated aliphatic solvents such as carbon tetrachloride, or other solvents of high solvent power such as carbon disulfide may be used. These solvents will dissolve a substantial proportion of the modified asphaltic material which is insoluble in crude petroleum oil, and consequently will be precipitated upon contact by and dilution with oil in the pore space of the sand.

Irrespective of the method and the compounds employed to produce the desired film coating upon the sand grains, the pore space of the sand may still contain a substantial proportion of water, where the film coating is not preceded by a dehydrating treatment as disclosed and claimed in my co-pending applications Serial No. 212,974, filed June 10, 1938, and Serial No. 212,976, filed June 10, 1938. Particularly in the case where the desired film coating is formed by introducing water solutions of the compounds which react within the pore space of the sand to produce the desired precipitate, will substantial quantities of water be present therein. But even in the case where oil or aromatic solutions are employed, it is found that these are ineffective to completely flush the water from the treated sand zone. In accordance with the present invention, the film coating step as described above is followed by a dehydrating treatment which is effective to substantially completely remove remaining water from the pore space of the treated sand. This may be conveniently accomplished by introducing into the well a gas under pressure, so that this gas is blown through the pore space of the producing sand adjacent the well to take up and remove moisture therefrom, and to force unevaporated water farther out into the formation. Any suitable gas may be employed for this purpose, such as air, flue gas, natural gas, methane and the like. Preferably, this gas is compressed, cooled and dehydrated before it is introduced into the well. Other methods of dehydration may be employed, such as by lowering a heated body or electrical heater into the well opposite the producing sand which has been treated, either with or without the application of gas under pressure so as to pass over the heated body and thence into the producing sand.

Following the dehydration of the treated sand, which will leave the producing zone immediately around the well bore with a dried coating of the preferentially oil-wettable material, there is introduced into the well a flushing oil so as to insure wetting of the treated sand with oil and filling of the pore space thereof with oil substantially free from water. Any suitable crude oil or mineral oil fraction can be employed for this purpose. Preferably there is used a crude oil carrying in suspension a hydrophobic colloidal material, such as very finely divided asphalt, tar acids, graphite, coke particles, pitchy residues and the like. Such hydrophobic colloidal material will

tend to deposit upon the sand grains in the absence of water, giving a wider and more uniform application of the film coating than may be obtained by the initial treatment in the presence of water. The net result is that the producing sand adjacent the well bore is effectively wetted by oil in the substantially complete absence of water, and such sand will offer increased resistance to the subsequent encroachment of water into that treated zone. The well is then ready to be placed on production, with the result that the proportion of oil produced is materially increased, while the production of water from that well is greatly reduced, if not substantially completely prevented, at least for an appreciable time following the treatment.

As a further modification, the gas used to dehydrate the sand may have incorporated therein a substantial proportion of hydrogen sulfide, which is found to assist in waterproofing the pores of the treated zone.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, the steps which comprise coating the sand grains of the said producing sand adjacent the bore of the well with a film coating which is preferentially wettable by oil without blocking the said sand, and then dehydrating the coated sand to substantially completely remove water from the pore space of the treated sand adjacent the well bore.

2. The method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, which comprises coating the sand grains with a film coating which is preferentially wettable by oil, then dehydrating the coated sand, and finally flushing the coated and dehydrated sand with oil.

3. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, the steps which comprise coating the sand grains of the said producing sand adjacent the bore of the well with a film coating which is preferentially wettable by oil without blocking the said sand, and then blowing the coated sand with a gas to substantially completely evaporate moisture therefrom and force remaining water farther out into the formation.

4. The method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, which comprises coating the sand grains with a film coating which is preferentially wettable by oil, then blowing the coated sand with a gas to evaporate moisture therefrom and force remaining water farther out into the formation, and finally flushing the treated and dried sand with oil.

5. The method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, which comprises coating the sand grains with a film coating which is preferentially wettable by oil, then dehydrating the coated sand, and finally flushing the coated and dehydrated sand with oil carrying a hydrophobic colloid which will deposit upon the coated sand in the absence of water.

6. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, involving the coating of the sand grains with films which are preferentially wettable by oil, the steps of compressing, cooling and dehydrating a gas, and then forcing the cooled and dehydrated gas into the well and into the said sand to substantially completely remove water from the pore space of the said sand adjacent the bore of the well.

7. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, involving the coating of the sand grains with films which are preferentially wettable by oil, the step of introducing into the well and into the said sand a gas containing hydrogen sulfide to remove water therefrom and to waterproof the dried sand.

8. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, the steps of blowing the sand with a gas to evaporate water therefrom and force remaining water farther out into the formation, and then flushing the dehydrated sand with oil carrying a hydrophobic colloidal material to deposit the said colloidal material upon the sand grains and render them preferentially wettable by oil.

9. In the method of treating an oil well to convert a water-wet producing sand to one which is preferentially wettable by oil, the steps of dehydrating the sand, and then flushing the dehydrated sand with oil carrying a hydrophobic colloidal material to deposit the said colloidal material upon the sand grains and render them preferentially wettable by oil.

ALLEN D. GARRISON.