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TREATMENT OF WELLS

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This invention relates to the treatment of oil wells, and especially to a method of treating oil wells to prevent or reduce the amount of water produced from the wells.

The exclusion of water from oil wells is a problem which has occupied the attention of producing men for many years and several more or less satisfactory methods for accomplishing this purpose have been proposed. Water may enter a well from strata overlying the oil bearing formations, from strata between oil producing horizons, or from the producing formation itself. In the latter case the water is usually edge-water which has moved up the formation. The methods which are used most frequently for the treatment of wells producing excessive water are designed to cement off the strata through which the water enters. The manipulative procedure employed in these methods varies depending upon the point of entry of the water, the equipment available, and the specific nature of the strata. When using these methods care must be exercised to avoid closing off the producing sand along with the water sands.

Several well-known cementing methods employ arrangements of apparatus including a tubing through which the cement is passed to the formation, a retainer having a back pressure valve, and means at the surface for subjecting the cement to high pressures of at least 3,000 pounds per square inch. When cementing through perforated casing or liner using a retainer of this type it is common practice also to employ a packing device below the strata it is desired to treat to insure that the cement slurry is forced into the proper point. Similar results may be obtained by locating a cement slurry opposite the formation into which the slurry is to be introduced by pumping it down tubing or drill pipe and measuring the volume of mud or water pumped after it. Fluid is displaced from the casing head until the batch of slurry reaches the desired location. Then the casing is closed and pressure is supplied to the slurry to force it into the formation surrounding the well bore. These methods based upon the principle of forcing cement at a high pressure into the formation are referred to as squeeze cementing methods.

The present invention is concerned with a method of treating an oil well so as to exclude water therefrom which from a manipulative standpoint is similar to these high pressure cementing operations. The method differs over the prior methods in that a novel class of mate-

rials is employed for closing off or plugging the water bearing strata.

Accordingly, the principal object of the invention is to provide an efficient method for preventing or reducing the entry of water into an oil well, which method possesses important advantages over the cementing methods. Other objects of the invention in part will be obvious and in part will appear hereinafter.

In accordance with the invention a slurry of a solid, finely-divided, oil-wettable material, such as a finely-divided carbonaceous material, in an oil, particularly a hydrocarbon oil, is injected at a high pressure into a formation producing an undesirable amount of water. In speaking of a high pressure, a pressure is meant which is sufficient to force the slurry a substantial distance back into the formation. Generally, it is preferable to employ as high a pressure as can be attained in existing equipment. In any event it is preferred to employ a pressure at the surface of the order of 3000 pounds per square inch or above. By proceeding in this way, the flow of water into the well is substantially reduced or prevented and the possibility of shutting off the oil sands is eliminated.

While it is not intended that the invention shall be limited to any theory of operation, it is thought that under high pressures the slurry of oil-wettable material lifts overlying strata and flows into crevices between the oil and water strata. The oil-wettable material under the pressure of the overlying strata is formed into compressed sheets substantially impervious to water. These sheets prevent the vertical movement of the water within a considerable distance of the well bore. For example, in cases where water enters a well from the bottom it appears that the body of water in the sand is in the shape of a cone having its apex in the well bore. By placing sheets of water-impermeable material between the planes of the strata the movement of this bottom water upward to form the cone is prevented. Since there is also an effective plugging of the surface of the sands through which the water would normally flow, satisfactory exclusion of water is accomplished.

The treatment of a formation by the present method may be accomplished without taking precautions to avoid plugging the oil sands because when deposited the slurry of oil-wettable material will permit the passage of oil. Accordingly, the difficulties with respect to plugging of the oil sands, which frequently arise in normal squeeze cementing operations, are substantially eliminated and it is not necessary to inject the slurry only

opposite a zone through which water is entering the well bore. The method of the invention has the further advantage that while cement is impervious both to oil and water and prevents the flow of both, the sheets of oil-wettable material, being pervious to oil, assist in conducting the oil to the well bore.

The oil slurries used in the present method may be prepared from various kinds of oils and solid, finely-divided oil-wettable materials. Suitable hydrocarbon oils comprise distillates, such as kerosene and heavier oils, and crude oils. In many cases the crude oil being produced may be suitable for use in the preparation of the slurry. The oil-wettable material should be finely-divided, say 50 to 100 mesh, and may be a material such as graded carbon, ground petroleum coke, and metallic sulphides such as iron, lead, or copper sulphides. It is preferred to employ a slurry of finely-divided carbon in crude oil. At this point it should be noted that in describing the solid materials as being oil-wettable, materials which are water-repellent are necessarily connoted. The oil and oil-wettable material may be combined in various proportions. In general, the resulting slurry should be thick but pumpable and should contain sufficient oil-wettable material to deposit a sheet over the desired area within a reasonable period of time.

From what has been said above it will be obvious that from a manipulative standpoint the present method may be carried out in various ways; e. g., the familiar manipulative procedures used in squeeze cementing may be employed. Usually, prior to introducing the slurry, the well bore should be cleaned out as by the use of a bailer. Thereafter the oil slurry may be introduced through a tubing disposed in the casing, and may be preceded and followed by another fluid such as water, oil, or a drilling mud. With the slurry in place and the casing closed, sufficient pressure is exerted at the surface to accomplish plugging of the formation as above described. When the plugging is completed the excess slurry may be circulated to the surface by a following stream of fluid.

A preferred method of treating an open formation comprises first gun perforating the formation to loosen the sands. An oil slurry is then pumped into place opposite the entire formation including the oil sands and, if desired, strata both below and above the formation. Pressure is then applied to force the slurry back into the formation. When the well is placed on production the water flow is reduced while the flow of oil is not retarded.

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. The method of treating an oil well which tends to produce both oil and water to reduce the amount of water flowing into said well, which comprises placing an oil slurry of a finely-divided,

oil-wettable, water-repellent, material opposite a formation surrounding the well bore, and, while maintaining said slurry in place, subjecting said slurry to a pressure of the order of 3000 pounds per square inch and above at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

2. The method of treating an oil well which tends to produce both oil and water to reduce the amount of water flowing into said well, which comprises placing an oil slurry of a finely-divided, oil-wettable, water-repellent, carbonaceous material opposite a formation surrounding the well bore, and, while maintaining said slurry in place, subjecting said slurry to a pressure of the order of 3000 pounds per square inch and above at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

3. The method of treating an oil well which tends to produce both oil and water to reduce the amount of water flowing into said well, which comprises placing an oil slurry of a finely-divided carbon opposite a formation surrounding the well bore, and, while maintaining said slurry in place, subjecting said slurry to a pressure of the order of 3000 pounds per square inch and above at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

4. The method of treating an oil well which tends to produce both oil and water to reduce the amount of water flowing into said well, which comprises placing a slurry of a finely-divided carbon in crude oil opposite a formation surrounding the well bore, and, while maintaining said slurry in place, subjecting said slurry to a pressure of the order of 3000 pounds per square inch and above at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

5. The method of treating an oil well to reduce the amount of water flowing into said well which comprises placing an oil slurry of a finely-divided, oil-wettable, water-repellent, material opposite the entire formation surrounding the well bore, and, while maintaining said slurry in place, subjecting said slurry to a pressure of at least 3000 pounds per square inch at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

6. The method of treating an oil well producing an excessive amount of water along with the oil which comprises gun perforating the entire producing formation, placing an oil slurry of a finely-divided, oil-wettable, water-repellent, material opposite the formation, and, while maintaining said slurry in place, subjecting said slurry to a pressure of at least 3000 pounds per square inch at the surface to force the slurry into the formation and thereby reduce the flow of water while permitting the flow of oil into the well.

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