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METHOD OF CLEANING THE WALLS OF MUDDED BORE-HOLES

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This invention relates to a method of restoring, by chemical treatment, the porosity of the wall surfaces of oil, gas or other wells in which such wall surfaces have been sealed or "mudded" by the rotary drilling procedure.

According to the standard procedure in drilling wells, for example, oil wells, with rotary equipment, a fluid is forced into the well bore adjacent the drilling tool for the purpose of carrying away cuttings and the like produced by the action of the drilling tool, to lubricate the drills, hold back incoming gas and oil, and like purposes. Thus, such a fluid, commonly called "rotary mud", may contain a clay such as bentonite to help hold the drillings in suspension in the mud and act as a lubricant in the drilling operation, and may also contain a heavy material such as barytes, hematite or other suitable material which "weights" the mud for the purpose of holding back gas and oil pressures encountered during the drilling operation. One of the particular advantages of rotary drilling procedure lies in that the rotary mud will tend to coat over the walls of the well in an impervious mass, gumming or filling up the openings in the earth formations and thus prevent caving of uncased portions of the bore. The coating or sealing action of the rotary mud is so pronounced, however, that under some circumstances a bore is frequently passed right through a producing formation without the knowledge of the driller for the reason that this rotary mud is forced into the porous formation and egress of oil from the formations effectively stopped. Through careful drilling control and a knowledge of the zone through which the drilling tool is progressed, it is possible however to ascertain definitely whether or not the drilling tool has reached the producing formation, but it becomes necessary to in some manner remove the impervious coating from the producing zone of the bore to bring the well into production. The method hitherto used for removing this rotary mud coating, preferably after the producing zone of the bore has been provided with a perforated liner or the like, generally involved a "swabbing" operation which frequently results in bringing the well into production, and in the event of failure of the swabbing operation, oil or water is generally forced through the lining perforations and circulated back of the liner to flush out the mud coating. These methods are not always satisfactory, and frequently the perforations in the liner are found to be solidly filled with hard-packed mud which contributes to the ineffectiveness of such swabbing or circulating procedures.

The principal object of this invention is to provide a method of treating clogged wall surfaces in the producing zone of a bore formation, by chemical action, whereby the described coating of mud and an important proportion of the mud which has been forced into the interstices of the producing formation is substantially removed so that the porosity of such formations is improved to an important degree.

A further object of the invention is to provide a method of increasing the porosity of "mudded" bore walls by chemical action whereby the mud coating is caused to disintegrate and placed in such physical condition as to slough from the well walls whereby it may be pumped to the surface and removed from the bore.

The invention in its broad scope contemplates the use of chemically inter-reactive materials which, when brought into contact with each other within or in contact with the mud coating in a bore-hole, will react to loosen or disintegrate the mud coating. While in the preferred embodiment, the inter-reactive materials are preferably such as to cause evolution of a gas, this particular result is not a definite requirement, in that any two or more inter-reactive materials may be used which inter-react in such manner as to result in a disintegration or by, for example, mud coatings of the sloughing increasing the porosity of such mud coating or otherwise lowering the mechanical or physical strength of such coating, whereby removal thereof by a flushing or swabbing operation is made more practicable. It will be understood, therefore, that our invention is directed broadly to the use of any two or more chemically inter-reactive substances which, when caused to react with one another, within or in contact with the mud-coating in a bore-hole, will cause the mud to become disintegrated, loosened, or otherwise altered in characteristics to such an extent as to cause the same to slough off or to become readily removable by swabbing or washing operations.

According to a preferred embodiment of the present invention, the mudded portion of the producing formation may be subjected to impregnation or penetration by two or more chemical agents in such a manner and in such sequence as to obtain a chemical reaction resulting in the formation of a gaseous material within the interstices of the mud coating,

whereby such mud coating is subjected to the disintegrating action of the produced gas, and mechanically disintegrated.

In our co-pending patent application Ser. No. 715,000, filed concurrently herewith, we have described in detail a process for removing a mud coating from the walls of a producing well formation wherein the mud which was circulated within the well during that portion of the drilling adjacent the producing formation contained a primary reagent which could be subsequently chemically reacted with another or secondary reagent subsequently introduced into contact with the coating of such mud on the bore wall, to effect disintegration and removal of the mud coating. The present disclosure is particularly directed to a method of removing mud coatings from the production zone of a well bore where the mud used in the drilling operation is not preliminarily treated to contain a desirable reagent as a constituent, or where a mud such as described in said co-pending application has been used but found not readily or completely removable by the simple treatment described in said application.

A principal object of the invention is to provide a method of removing rotary mud coatings from a well bore produced by a rotary drilling procedure by first impregnating the coating with a chemically active agent and subsequently contacting or impregnating the coating with a second chemically active agent of a type adapted to react with the first-named agent in a manner productive of a disintegration and/or loosening of such coating whereby such coating may be removed from the bore and the well brought into production.

A further object of the invention is to provide a method of the character set forth in which a mud coating on the walls of a well-bore is subjected to alternate contact or impregnation with two or more chemically inter-reactive reagents of a type adapted to form a gas within the mud coating and thus disintegrate said coating and facilitate the removal thereof from said bore. A further object of the invention is to provide a method for increasing the production capacity of an oil well by flushing or otherwise subjecting such wall portions of the well-bore as are adjacent or in the producing formations to the solvent action of a suitable solvent to remove any emulsified oil-mud coating from the inside surface of an existing mud coating, and subjecting said mud coating to an alternate or successive treatment with two or more chemically inter-reactive reagents of a type adapted to form a gaseous reaction product within the interstices of said mud coating and cause a disintegration thereof whereby said mud coating may be removed from said bore.

The method of the present invention may comprise, in its preferred form, the impregnation of a rotary mud coating in a well-bore with one reagent, preferably under hydrostatic pressure, and the subsequent impregnation of said mud coating with a second reagent adapted to react with the first-named reagent to cause formation of a gaseous reaction product in place at or under the surface of said mud coating whereby the evolution of such gas will mechanically disintegrate the compacted particles of mud materials. The chemical reaction between the first and second-named reagents may at first be substantially confined to the surface layer of the mud coating, dependent on the porosity thereof, but it will be appreciated that after the surface layer of mud coating is disintegrated, the second-named reagent will continue to contact such portions of the first-named reagent as have impregnated the coating to a further depth. In case the mud coating is not completely impregnated by the first-named reagent, then the second-named impregnating reagent penetrates the mud coating past the depth to which the first-named reagent has penetrated, an impregnation of said coating comparable to the first-described impregnation will result, and the disintegrating reaction may be continued by a successive impregnation with the first-named reagent or with some other reagent adapted to react with the second-named reagent to effect a disintegration of the mud. It will be appreciated that this procedure may also be followed where the actual penetration of the mud coating is complete, but the disintegration of such coating is incomplete. Alternate impregnation of the mud coating in this manner will thus result in a substantially complete disintegration of said coating, and the disintegrated coating may be from time to time removed from the bore by bailing or the like.

When the method of the present invention is applied to the clearing of an oil well bore, it is occasionally found that an appreciable amount of oil or other oily matter is present in such a bore even though the well is not actually a producing well, and in such event we consider it preferable to precede the disintegration treatment with a suitable flushing treatment to remove the principal proportion of such oily matter from the bore hole so that the disintegration treatment may be made effective. For example, we consider it preferable to subject the producing zone of such a bore to the action of a suitable solvent for such oil or oily material, such as alcohol or a light distillate or other liquid having a solvent effect. Such solvent may be lowered into the bottom of the bore by means of a dump-bailer or the like and allowed to stand for from one to six days. This solvent may then be removed from the well by bailing or in any other suitable manner, and the first of the selected reagents introduced into the bottom of the well to obtain the desired impregnation of the mud coating.

Numerous chemically inter-reactive agents may be employed to obtain the desired disintegration of the mud coating according to the procedure above-outlined, and we preferably employ two reagents which are both water soluble or at least relatively soluble in solvents which are miscible so that where one reagent is caused to impregnate the mud coating, the second reagent will be brought into contact with the first reagent under conditions which will facilitate the chemical reaction therebetween.

In general we prefer to employ reagents which react to form a gaseous product so that the expansion of this gas in its evolution will obtain the desired disintegration of the mud coating and we have found that the most advantageous type of reagents are those which will react with the formation of carbon dioxide as a reaction product. For example, any one of a number of water soluble carbonate-containing compounds, such as sodium or potassium carbonate, ammonium carbonate, sodium or potassium acid carbonate, et cetera, may be advantageously employed as one of the reagents, and an acid compound, of such nature as to be reactive with the

selected reagent from the above group to cause evolution of carbon-dioxide, such as dilute HCl, H_2SO_4, $CH_3(COOH)$, et cetera. Numerous other reactive agents of a type adapted to cause evolution of a gas upon being brought into contact with one another in solution, will be apparent to one versed in chemical knowledge.

While inter-reactive substances which are adapted to form a specific gaseous material such as carbon dioxide upon reaction, are possibly the least costly in the light of present knowledge, it will be apparent that other types of inter-reactive materials may be of practical advantage in the present use. For example, potassium dichromate will react with sulphuric acid with the evolution of oxygen; sodium sulphite or sodium acid sulphite will react with strong sulphuric acid with the evolution of sulphur-dioxide, and the like.

It will be appreciated that any desired sequence of operations may be followed in the practice of the present invention, but we prefer to first subject the mudded wall to the penetration of the reagent which is possessed of the greatest diffusing power. For example, if sodium carbonate and hydrochloric acid are the selected reagents, we would prefer to subject the mudded wall to penetration by the hydrochloric acid first, and then subject the impregnated wall to the action of a sodium carbonate solution. This particular procedure is not a requisite, however, as any sequence which appears most satisfactory to a particular user will of course be considered preferable to him. As a general rule, however, the last impregnation is preferably carried out using a reagent which is not particularly damaging to the metal elements present in the bore, such as the casing, liner or the like. Thus, when using the above two reagents, the last treatment is preferably with the sodium carbonate solution, whereby the remaining acid is neutralized. It will be further appreciated that any desired hydrostatic pressure may be provided in the bore during the impregnation procedures, by lowering the solution into the bore in some manner such as by means of a dump-bailer, and then lowering water or oil on the solution layer to obtain the desired pressure. It will be further recognized that precautions are preferably taken at the surface of the bore for the reception of any solutions which may be blown from the well as a result of the well coming into production as a flowing well. Such precautions are desirable in view of the fact that a solution such as of sulphuric acid would be quite dangerous if allowed to be blown from the bore over the area and equipment surrounding the bore-hole at the surface.

As a specific example of clearing the wall surfaces of a mudded oil well bore, such a bore may be subjected to the solvent action of a suitable solvent for any oily matter present, as above described, throughout at least the portion of such bore as is in the producing formation, and the first of the selected reagents may be lowered into such bore after removal of the solvent liquid. For example, a hydrochloric acid solution of suitable concentration, say 10% HCl in water solution, may be lowered into the well by means of a dump-bailer or the like and the penetration of the mudded bore surfaces by such solution may be increased, if desired, by lowering a suitable volume of water or oil onto the column of solution whereby an increased hydrostatic head is obtained thereon. After the acid solution has suitably penetrated the bore surfaces or has been left in the bore for a period which would indicate that the desired penetration had been obtained, say for a period of from one to six days, such solution may be removed in any suitable manner and a solution of the second of the selected reagents may be lowered into the well in the same manner as described in connection with the first reagent, either with or without the provision of an increased hydrostatic pressure head. This second solution may comprise an aqueous solution of sodium carbonate ($NaCO_3$) for example, in a concentration of five per cent or more. After this second solution has remained within the bore for a suitable period, say from one to six days, the bore may be bailed to remove the residual solution and any disintegrated mud. As above-described, this procedure may be repeated any necessary number of times to effect the desired disintegration and bring the well into production.

In the event that the well has been brought into the expected production, and the well is not of a "flowing" nature so that the residual solutions are not completely removed from the bore by the oil flow, it is advisable, where a solution of an acid nature was the last solution used, to lower a suitable quantity of an appropriate neutralizing agent into the bore to effect neutralization of any residual acid. This neutralizing agent may of course comprise a reagent of the type employed in the disintegrating treatment, but may equally well comprise any other reagent which will have the desired neutralizing effect on the particular acid used. After removal of the neutralizing agent the bore may be considered ready for production and may be provided with the conventional form of pumping means for raising the desired fluid to the surface, as will be understood by one familiar with the art.

It will be appreciated that the method of the present invention may be applied to the method set forth in our above-mentioned co-pending application in the event that the treatment described in said co-pending application is not productive of the desired results, due, for example, to an insufficiency of the reagent incorporated in the mud during the drilling procedure. In such a case, a reagent adapted to react with the acid or secondary reagent used in such treatment may be lowered into the bore-hole and allowed to react with the residual reagent present in the bore-hole, whereby a further disintegration of the mudded bore walls is obtained, and the process continued according to the teaching of the present disclosure, if desired. For example, if a mud were used in a drilling procedure which contained a solid reagent such as calcite, and it was found that a subsequent acid treatment was ineffective to obtain the desired disintegration of the mud coating, such acid treatment might be followed by an impregnation with a solution such as the above-mentioned sodium carbonate solution, and a disintegrating reaction with the residual acid thus obtained, and if this impregnation was found to be ineffective in bringing the well into production, a further impregnation with an acid reagent might be employed, and so on, according to the present teaching.

Numerous modifications of the described procedure and the suggested reagents will occur to one familiar in the art, and we in no way consider ourselves limited to the specific examples

herein given, but rather to the scope of the following claims.

We claim:

1. The method of restoring the porosity of mudded well bores which comprises: impregnating the mud coating of such a well-bore throughout at least a portion of its length with a reagent in solution; subsequently impregnating said mud coating with a second reagent in solution in a solvent miscible with said first solution, said first-named and said second-named reagents being of such type as to chemically interreact to cause a disintegration of said mud coating; and removing from said bore the material resulting from the disintegration of said mud coating.

2. The method of restoring the porosity of mudded well bores which comprises: impregnating the mud coating of such a well-bore throughout at least a portion of its length with a reagent in solution; subsequently impregnating said mud coating with a second reagent in solution in a solvent miscible with said first solution, said first-named and said second-named reagents being of such type as to chemically inter-react to cause evolution of a gas; causing, by such impregnations, the disintegration of said mud coating; and removing from said bore the material resulting from the disintegration of said mud coating.

3. The invention set forth in claim 2, one of said reagents comprising a material containing a gaseous constituent in chemical combination.

4. The invention set forth in claim 2, one of said reagents comprising a material containing a gaseous constituent in chemical combination and the other of said reagents comprising an acid reagent of a type adapted to react with said first-named reagent to cause liberation of said gaseous constituent.

5. The invention set forth in claim 2, one of said reagents comprising an aqueous solution of a chemical compound containing a carbonate radical.

6. The invention set forth in claim 2, one of said reagents comprising an alkali metal carbonate, and the other of said reagents comprising an acid.

7. The method of restoring the porosity of mudded well bores which comprises: impregnating the mud coating of such a well-bore throughout at least a portion of its length with a reagent in solution; subsequently impregnating said mud coating with a second reagent in solution in a solvent miscible with said first solution; subsequently impregnating said coating with said first-named reagent and then impregnating said coating with said second-named reagent in an alternate and successive treatment procedure, said first-named and said second-named reagents being of such type as to chemically inter-react to cause evolution of a gas; causing, by such impregnations, the disintegration of said mud coating; and removing from said bore the material resulting from the disintegration of said mud coating.

8. The method of restoring the porosity of mudded oil-well bores which comprises: subjecting the mud coating of such a well bore throughout at least a portion of its length with a solvent of such character as to effect solution of oily material present in said bore; removing said solvent from said bore; impregnating said mud coating with a reagent in solution; subsequently impregnating said mud coating with a second reagent in solution in a solvent miscible with said first solution, said first-named and said second-named reagents being of such type as to chemically inter-react to cause evolution of a gas; causing, by such impregnations, the disintegration of said mud coating; and removing from said bore the material resulting from the disintegration of said coating.

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