

UNITED STATES PATENT OFFICE

2,234,790

MUD WALL DISINTEGRATOR

Vernon B. Zacher, Ventura, Calif., assignor to
Tidewater Associated Oil Company, New York,
N. Y., a corporation of Delaware

No Drawing. Application February 13, 1939,
Serial No. 256,237

8 Claims. (Cl. 166—21)

My invention relates to means for disintegrating mud and particularly to a means and method for removing the mud sheath formed during rotary well drilling operations.

There are three systems of well drilling in general use, the most widely adopted being the "rotary" method.

In rotary drilling, a centrally apertured bit is attached to a hollow pipe which is rotated by a suitable power source about its longitudinal axis. The bit is provided with teeth of various shapes designed to bite the rock away in small pieces, and is lubricated by a continuous stream of mud pumped down through the hollow pipe and bit.

The stream returns to a surface sump, carrying the rock particles or "cuttings" with it, by passing upwardly in the bore on the outside of the pipe. The mud is used to carry abrasive material in suspension and to cool the bit. The mud column also controls the oil and gas pressures encountered, and has other important functions.

As the drill is driven deeper into the earth, a wall of partially dried mud is gradually built up around the outside of the bore. The heat encountered, especially in deep wells, may cause a filtering or "baking" action, and it is frequently found that the mud wall becomes so hard and impervious that it must be removed before the oil can flow into the bore. This removal is hence very important in determining the size and output of the well.

One of the common methods of removal involves treating the wall with an acid which will cause it wholly or partially to decompose, permitting the mud to slough off and be carried away in suspension by the fluid in the hole. Four of the factors governing the type of acid which is suitable for such use are: the rate of disintegration of the wall; safety in handling; chemical inertness toward steel casing; and cost. Hydrochloric (muriatic) acid has been widely used. It is relatively inexpensive, and reacts rapidly with the mud, but is difficult to handle in the concentration necessary for treatment and tends to attack the casing and drill pipe in the hole unless inhibited.

Inhibiting the acid consists in adding thereto a substance which will reduce as far as possible the reaction of the acid with the casing, while at the same time not interfering with the break-down of the mud. Such a substance could be a salt of any metal lying below hydrogen in the electromotive series. One of the best and cheapest inhibitors is cuprous chloride. Others are described in United States Patent 1,877,504 to Grébe and

Sanford, which claims the use as inhibiting agents of arsenic acid, arsenic tri-oxide, and other soluble arsenates and arsenites, as well as a variety of other substances. Such inhibitors, however, are at best a compromise. Even with their use, it is necessary to introduce the inhibited acid to the bore in undesirable concentrations. As the reaction progresses, the acid becomes continually weaker; while a comparatively rapid reaction may occur at first, it tapers off rapidly. The time required for a treatment is usually from five to eighteen hours, but is dependent on a number of factors, including the wall thickness, the depth of hole, and others.

My invention overcomes the difficulty experienced with even the most successful of the previously known methods by the use of a weak acid, together with a substance which will combine therewith in the bore in such a way as to produce continually a fresh supply of a strong acid. The concentrations thus secured will break down the mud wall rapidly without deleterious effects on the casing. In pursuance of this method, I preferably introduce in solution, acetic acid and magnesium chloride, which will react in the bore to form an inert salt and hydrochloric acid.

The fundamental reaction in the chemical breakdown of a mud sheath is that between the acid and calcium carbonate, which is an important constituent of nearly all native clays. The calcium carbonate is dispersed throughout the mud; it combines with acid to form an unstable compound, carbonic acid, which again breaks down into water and carbon dioxide gas. The mud becomes honeycombed by the decomposition of the calcium carbonate, so that the remainder of the wall is easily penetrated by and sloughs off with the fluid circulating or standing in the hole.

It will be seen from the above description that the primary object of my invention is to provide more effective means for removing the mud sheath from well bores. Other objects are: to provide a continuously replenished supply of acid in a well bore; to maintain the concentration of acid always at its most effective value; to provide means for breaking down a mud wall at a constant rate; to introduce chemicals reacting with the mud wall of a well bore in a form non-reactive with the drilling tools; to provide means for increasing the reactive power of acetic acid relative to the mud wall; to provide for more complete penetration of the mud wall by the disintegrating agent; to provide a rapidly reacting agent in a non-corrosive form; to provide a mud

sheath disintegrator which may be handled without danger by operators; and to provide a disintegrating agent in more economical form.

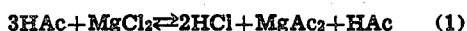
My invention possesses numerous other objects and features of advantage, some of which, together with the foregoing, will be set forth in the following description. It is, therefore, to be understood that my invention is applicable to other substances, and that I do not limit myself, in any way, to the exact showing of the present application, as I may adopt various other apparatus embodiments, utilizing the method, within the scope of the appended claims.

Removal is accomplished by pumping the solution of my invention into the bore, either directly or through the drill stem. The solution is allowed to remain in the hole for about ten hours. This time is, of course, a variable, depending on the percentage of carbonates in the wall, the permeability and the thickness, the temperature in the hole, and the pressure head due to the overlying fluid column. Where ordinary acid treatment is used, the usual range of times is from five to eighteen hours, so it will be seen that my method compares very favorably with the prior art in this respect.

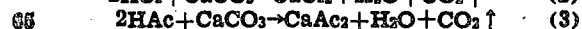
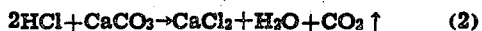
If the wall is to be removed along only a portion of the bore, the solution is "spotted" in place by displacing the mud or liquid in that portion of the hole.

My departure from the previous art lies in the use of acetic acid instead of hydrochloric acid, and the addition of substances thereto which will increase the reactive rate with the mud. I prefer to use magnesium chloride for this purpose, the most effective proportions being 4.0% magnesium chloride and 25% of glacial acetic acid, by weight.

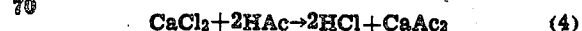
A mild reaction occurs when the solution is mixed, due to the small proportion of magnesium chloride present. Some magnesium acetate and hydrochloric acid is formed, leaving surplus acetic acid. Using the abbreviation "Ac" to represent the acetate radical (CH_3COO), this initial reaction may be written:



The mixed solution represented by the right half of the Equation 1 then begins to react with the mud in the formation. The hydrochloric acid reacts with the calcium carbonate to form calcium chloride and carbonic acid. The latter is unstable and breaks down into water and carbon dioxide; the former provides a source of the chloride radical for subsequent reaction with one excess acetic acid. At the same time, the acetic acid reacts with the calcium carbonate to form calcium acetate and carbonic acid. The latter breaks down into water and carbon dioxide, and the former remains inert as did the magnesium acetate previously formed. These reactions may be written:



The surplus acetic acid remaining is still available for reaction with the mud directly, as in Equation 3, and through intermediate combination with the calcium chloride of Equation 2:



The hydrochloric acid produced as in Equation 4 will in turn react with the mud as in Equation 2, the process continuing until all the acetic acid is spent.

The continual replenishment of the hydrochloric acid as it is consumed makes possible a comparatively rapid breakdown of the mud wall without there being present at any time a corrosive concentration, while the reactive power is much greater than if dilute hydrochloric alone was used.

The proportions suggested above have been found to be the most economical for a positive reaction. An increase in the amounts of glacial acetic acid and magnesium chloride present has little effect on the rate of reaction, while a decrease causes a marked decrease in the rate of disintegration.

I have found that the breakdown may be speeded by the addition to the solvent of a wetting agent, which will reduce the surface tension of the solution and permit it to penetrate the mud wall more freely. One such wetting agent which is satisfactory is known by the trade-mark "Aerosol OT", the composition of which is not known exactly to me, although it is believed to be an ester of a sulfonated bi-carboxylic acid. The proper proportion is 1 to 2 parts of the commercial 10% strength solution to 1,000 parts of solvent, by weight, or 1 to 2 parts of full strength "Aerosol OT" to 10,000 parts of mud solvent, by weight.

Another means of increasing the completeness of the reaction is to add more calcium carbonate to the drilling mud. Experience in the field indicates, however, that the method is entirely satisfactory with "Ventura New Mud," "Ventura Reclaimed Mud," "Aqua Gel," "Baroid," and various other drilling mud mixtures.

While magnesium chloride is believed to be the most satisfactory substance to add to the acetic acid solution, other compounds could be used to produce similar results. Any salt formed from a weak alkali and a strong acid could be used, subject to the further limitations, that it be soluble in the initial solution, and that all the reaction products be similarly soluble. Chlorides are preferred because the hydrochloric acid is the most active. The limitation as to solubility eliminates all the other alkalis but strontium. Strontium chloride could be substituted for the magnesium chloride, in the same proportions. Its cost, however, is greater, rendering it less economical to use at present.

It is also apparent that other weak acids might be substituted for acetic acid, provided that the same requirements as to solubility specified above, are met. Such a substitute would be readily reactive with the mud, inert toward the steel pipe and tools, be low in cost, and react with the magnesium chloride to liberate hydrochloric acid through the reaction period.

The safety in handling the solution I have described may be judged from the fact that it may be placed in the mouth for a while with no unpleasant results. This is an indication of how my invention may reduce industrial hazards by eliminating the corrosive concentrations which operators must handle in other acid treatments.

The reactions described above are not the only ones which enter the complete destruction of the wall: various other components of the mud are decomposed by the acid, but those given are felt to be the most important. The honey-combing of the wall produced through the chemical changes makes it possible for the remaining mud to slough off and be carried in suspension by the water or fluid being pumped out of the bore in the usual manner.

It will be apparent to those skilled in the art that I have invented a disintegrating solution which meets the requirements as to speed, safety, inertness toward tools and casing, and low cost.

- 5 It provides a non-corrosive solution which will react in the bore to provide a continuous supply of acid reacting rapidly with the bore, and a method of treatment which eliminates the industrial hazard always present in handling very
10 strong acids.

What I claim is:

1. The method of disintegrating the mud sheath within a well bore which comprises treating the mud with a solution including, by weight,
15 substantially 25% of glacial acetic acid, and 4.0% of magnesium chloride.

2. The method of disintegrating the mud sheath within a well bore which comprises injecting a solution including, by weight, substantially 25% of glacial acetic acid, 4.0% of magnesium chloride, and from 0.01% to 0.02% by weight of an ester of a sulfonated bi-carboxylic acid.

3. The method of removing a mud sheath from a bore which comprises adding weak acid and a salt in solution to the bore, said acid having a relatively inert nature relative to the bore casing but reacting relative to the mud sheath, and combining in situ with said salt to release
25 an acid strongly reacting with constituents of said sheath, permitting the solution to remain therein for about ten hours, and removing the resultant solution from the bore.

4. A method of treating a mud wall in a bore
35 having a casing therein, which comprises pumping therein a solution having 25% by weight of an acid not appreciably reactive with said casing

and 4% by weight of a soluble salt of a weak alkali and a strong acid, said non-reactive acid and said soluble salt being reactive to form an inert soluble salt and an acid strongly reactive with said mud wall, permitting the reactions to
5 continue for about ten hours, and pumping out the end products resulting from said reactions.

5. The mud wall disintegrating treatment which comprises placing in contact therewith a solution comprising one to two parts in ten thousand of a wetting agent, four per cent of a soluble salt of a weak alkali and a strong acid, and twenty-five per cent of an acid only slightly reactive with steel, permitting said acid and salt to react to form an inert soluble salt and an acid highly
15 reactive with said mud, assisting said highly reactive acid to penetrate said mud thoroughly, maintaining contact between said mud and said solution for about ten hours, and pumping the resultant products out of said hole.

6. A mud wall disintegrating solution, comprising a soluble salt formed from a weak alkali and a strong acid, and an acid relatively inert with respect to steel but able to combine with said salt adjacent said wall to form a strong acid and other
25 soluble salts.

7. A mud wall disintegrating solution, comprising a soluble salt formed from a weak alkali and a strong acid, an acid relatively inert with respect to steel but adapted to combine with said
30 salt to form a strong acid and other soluble salts, and an agent adapted to reduce the surface tension of said solution.

8. A mud wall disintegrating solution, including by weight 25% of glacial acetic acid, 4.0% of
35 strontium chloride, and a wetting agent.

VERNON B. ZACHER.