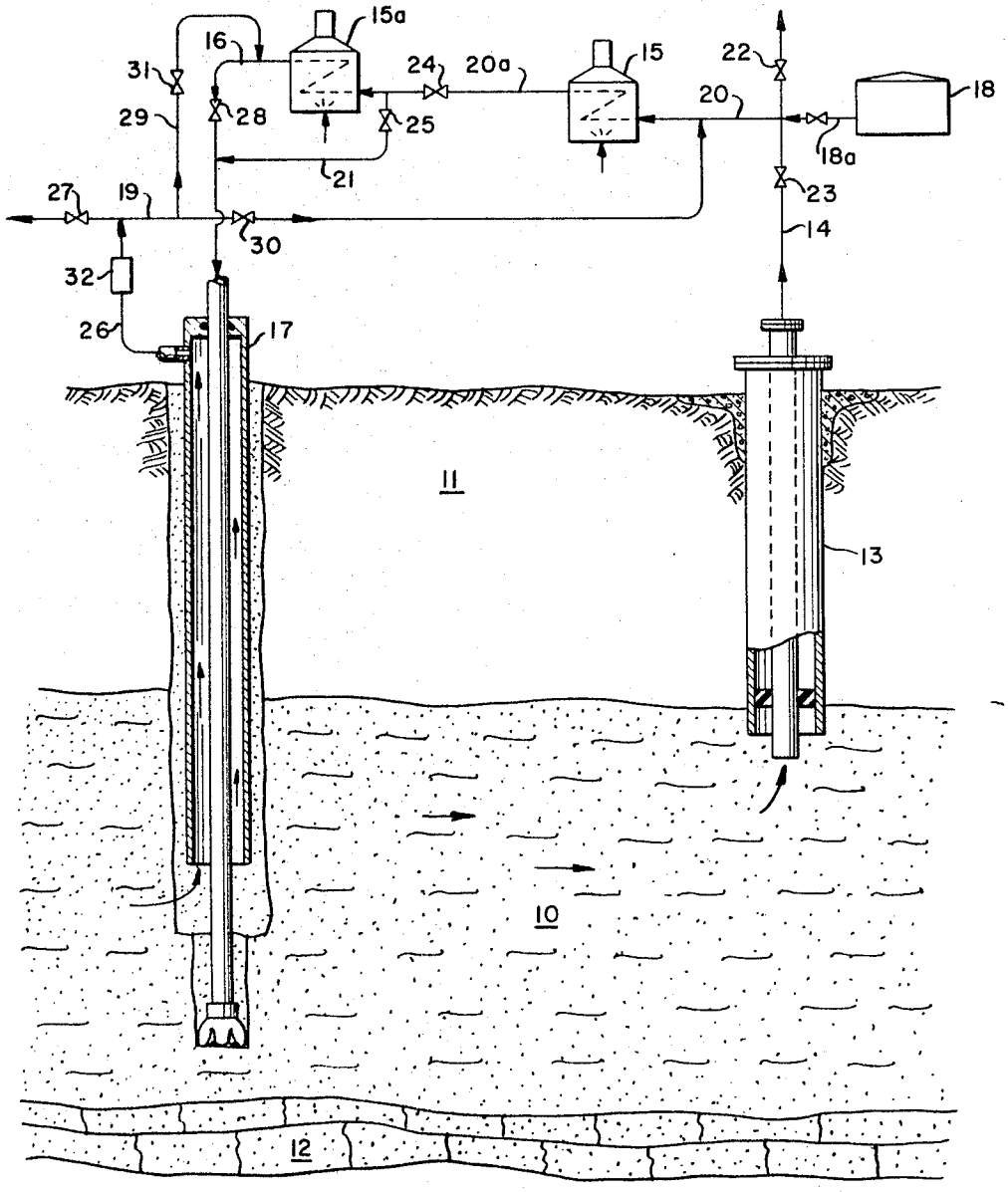
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PROCESS OF DRILLING A WELL WITH HOT SOUR GAS DRILLING FLUID

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PROCESS OF DRILLING A WELL WITH HOT SOUR GAS DRILLING FLUID

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ABSTRACT OF THE DISCLOSURE

An improved method of drilling boreholes and preventing sulfide stress corrosion cracking of equipment by use of hot sour gases maintained at a temperature of at least 150° F.

The present invention relates to an improved method of drilling boreholes using gaseous drilling means in the process for recovering hydrocarbons from underground formations. More particularly, the present invention is directed to a process of drilling wells using as the drilling fluid hot sour gas.

It is known that in drilling boreholes into earth formations such as in establishing wells for recovering hydrocarbon fluids therefrom, that drilling fluids are essential in the operation. Such drilling fluids are generally liquids and may be oil, water or oil-in-water or water-in-oil emulsions. One of the main functions of the drilling fluid or mud is to aid in removing drilled cuttings from the borehole. In recent years compressed gases, such as compressed air or natural gas, have been used extensively for this purpose because of their many advantages over liquid drilling compositions, such as increased penetration rate, increased bit life, less interference with later electrical logging, less permeability and productivity impairment of productive intervals, and the like. Thus, air or gas drilling is about twice as fast as water drilling, and water drilling is, in turn, about twice as fast as mud (i.e., either water or oil, plus weighting material) drilling. Normally greater penetration rates are afforded by either air or gas drilling, when no significant water intrusion is encountered while drilling into the borehole, and this provides important savings per foot of hole drilled, in comparison with any liquid drilling. However, major disadvantages of air drilling even when water influx into the borehole is not a serious factor are the high cost of compressed air, the problem of combustion and fire, the requirement of special equipment necessary for successfully accomplishing air drilling, and inhibition of corrosion of drilling equipment, e.g., drill pipe, casing and the like which become exceedingly grave when using air drilling.

An object of the present invention is directed to an improved and efficient method of gas drilling of boreholes. Another object of the present invention is to reduce the cost of drilling by use of a novel gas drilling means. Still another object of the invention is to protect against corrosion, rusting and sulfide stress corrosion cracking of drilling equipment in contact with a particular gaseous drilling composition. Still another object of the present invention is to provide means of increasing drilling rate and the drilling operation in general without the danger of combustion and fire hazard during the operation. Other objects will be apparent from the description of the invention such as to provide improved and efficient means for conveying, during gas drilling operations, undesired solids and liquids from the drilling zone to the surface.

It has now been discovered that gas drilling of formations can be effectively accomplished by using hot sour gas as the gaseous drilling fluid. By hot sour gas is meant a hydrocarbon such as is recovered from underground formations and having a hydrogen sulfide content of at least 0.005 of 1% and up to 95 mole percent and generally between about 0.05 of 1% and 25 mole percent and the balance being low molecular weight hydrocarbons and in some cases amounts of up to 55 mole percent of other components such as organic acids, CO_2, S and the like. By the term "hot" is meant that the sour gas as used in the drilling operation is maintained at a temperature of at least 150° F. and preferably above 200° F. and higher such as between 200° F. and 450° F. or higher. It has been a surprising discovery that when using a hot sour gas at above 150° F. and preferably above 200° F. that the generally undesirable features of gas drilling, such as are encountered with compressed air drilling, are essentially obviated and rather provide the following advantages:

The basic benefit is the discovery that hot sour gas at above 150° F. does not corrode or embrittle or cause sulfide stress corrosion cracking of metal parts with which it comes in contact, unlike hydrogen sulfide-containing fluids and liquids at atmospheric temperatures or lower. By means of the present invention it is now possible to use conventional drilling and casing strings without the danger of sulfide corrosion cracking and embrittlement. Thus, with hot sour gas not only effective drilling is accomplished but also normally vulnerable items, e.g., tubing and casing made of API grades N–80, P–105 and P–110 steels when maintained in contact with hot sour gas at about 150° F. or hotter, become resistant to sulfide embrittlement or sulfide stress corrosion cracking. Thus, by the basic discovery of the present invention such tubulars are made suitable for high-temperature service in wells, whereas normally they are inadequately for virtually all sulfide environments. Also since sulfide embrittlement can be successfully prevented by use of hot sour gas these high strength tubulars in the lower sections of deep wells provide greater collapse resistance at less cost.

The cost of acquiring and heating sour gas is appreciably less than the cost of compressing air. For example, gas drilling in wells of 14,000 to 15,000-foot depth costs about $25,000 less per well than air drilling. Accordingly, a saving of $175,000 or about $2 per foot has been effected while drilling some 87,000 feet of hole in seven wells, JM Field, Crockett County, Texas. This represents a 20% reduction in drilling cost. Similar savings are expected with hot sour gas in gas drilling in other predominantly sour gas areas since the source products are available at the drilling site and all that is required is heating it to the required temperature and using it as the drilling fluid.

Hot sour gas is safer than air drilling, inasmuch as combustible mixtures of hydrocarbons and air are avoided when drilling through productive intervals. Thus, where gaseous drilling is feasible, possibly severe and costly downhole fires incurred with air drilling are eliminated with hot sour gas drilling.

Also, it has been found that with hot sour gas drilling there is less weight-loss corrosion of drill pipe and casing than with air drilling, especially whenever limited water incursion necessitates mist drilling.

The sour gas, which on heating to above 150° F., is used for drilling can be obtained from any suitable source and by any recovery means. Generally, in drilling in sour gas fields for recovery of the gas for further processing to remove carbon dioxide, sulfur, hydrogen sulfide and the like in order to obtain a suitable sweet gas, a portion of the sour gas as recovered can be heated and used as the drilling fluid.

If sour gas of sufficient volume and at temperature of not less than 150° F. is available at the drilling site, no extraneous heat is required for successful sour gas drilling. However, if the available sour gas source does not meet these requirements, the drawing shows a suitable equipment hookup for providing gas at the required temperature of not less than 150° F.

The drawing illustrates a drilling process of the present invention. As shown, sour gas from formation **10** which is confined by overburden **11** and underburden **12** is recovered therefrom through well **13** and a portion of the sour gas is directed through line **14** keeping valve **23** open and valve **22** closed or from tank **18** through line **18***a* keeping valves **22** and **23** closed into lines **20** and **20***a* and into heaters **15** and **15***a* where it is heated to at least 150° F. and the hot sour gas is directed therefrom through line **16** into well **17** wherein it functions as the hot sour gas drilling fluid.

Sour gas can also be recovered from well **17** through line **26** keeping valve **27** closed and a portion circulated through lines **19**, **29** and **16** keeping valves **28** and **30** closed into heater **15***a* and directed through line **21** keeping valve **24** closed into well **17**. Also, the sour gas from line **26** can be directed through line **19** keeping valves **27** and **31** closed into line **20** and through both heaters **15** and **15***a* keeping valve **25** closed and passed through line **16** into well **17**. The foregoing procedures involving recovery of sour gas from well **17** would require compression of the recovered sour gas to sufficient pressure by means of compression **32**, preferably upstream of either heater **15** or **15***a*, to overcome friction losses and reinject the heated sour gas into well **17**. Well **13** can be closed when the sour gas is recovered from well **17** and a portion of the sour gas after being heated to above 150° F. is utilized as the drilling fluid.

The process of the present invention functions most efficiently when there is no influx water encountered during the drilling operation or when the influx is kept at a minimum. In areas where water is encountered, suitable preventive measures can be taken such as removing the water by conventional mist drilling in which the influx water is removed from the drilling zone by use of foaming agents which can be added to the hot sour gas to form a misty foam in the borehole. Still another method to combat water influx into the borehole is to inject into the well a slug of Portland cement or any of several other materials capable of blocking the permeability of the zone from which water is intruding. After the water problem has been taken care of by the above means or any other suitable means, hot sour gas drilling can be used with great effectiveness. Also, the hot sour gas can be used in mist form in conjunction with inorganic aqueous solutions, water and petroleum oil and if desired form corresponding mist spray systems.

In addition to the significant benefit mentioned above, further advantages are illustrated by the following examples:

EXAMPLE I

Heated sour gas at 150–200° F. (99 grains of hydrogen sulfide per 100 s.c.f.) was used to drill 2,537 feet of 6⅝ inch hole in an 18,000-foot well, West Waha Field, Reeves County, Texas. This test further confirmed the benefit of using heated sour gas as a drilling fluid, for in the 13,090 to 15,627-foot interval a saving of approximately $37,000 was realized compared with the cost of conventional mud drilling.

EXAMPLE II

Hot sour gas was also used in drilling Mitchell 110–1, Brown-Bassett Field, Crockett County, Texas, in which some 6,700 feet have been drilled by this procedure. Drilling cost reductions of some $15,000 were realized in this well as a result of the much faster drilling rate afforded by the sour gas drilling process.

The present invention may be effectively employed when drilling into formations for recovery of gas, oil and non-hydrocarbon products such as sulfur, etc. Also, the means of injecting the hot sour gas downwardly into the borehole through the drill stem and upwardly through the borehole outside the drill stem can be reversed. Furthermore, means for heating the sour gas can be varied from that described above, as for example, by providing heating or thermal devices in the drill pipe assembly in the borehole in order to keep the sour gas drilling fluid above 150° F. Finally, the process of the present invention is simple and excepting the gas heater(s) when necessary, requires only equipment and manpower normally available and used in conventional liquid drilling operations.

We claim as our invention:

1. A process of drilling a well through a nonwater-bearing formation which comprises circulating in a well borehole as a drilling fluid a hot sour gas maintained at a temperature of at least above 150° F. to lubricate the bit, inhibit corrosion and embrittlement of the piping equipment and aid in removing the bit cuttings from the borehole of the well to the surface.

2. The process of claim **1** wherein the hot sour gas is maintained between 150° F. and about 450° F.

3. The process of claim **2** wherein the temperature of the circulating hot sour gas is maintained above 200° F.

4. The process of claim **1** wherein the hot sour gas is maintained as a mist with a petroleum oil.

5. The process of claim **1** wherein the hot sour gas is maintained as a mist.

6. The process of claim **1** wherein the hot sour gas has a hydrogen sulfide content of at least 0.005 of one mole percent.

7. The process of claim **6** wherein the hydrogen sulfide content of the hot sour gas is between about 0.05 of one percent and 95 mole percent.

8. The process of claim **1** wherein the hot sour gas is maintained as a mist in combination with an inorganic aqueous solution.

9. The process of claim **1** wherein influx water is prevented from entering the drilling zone by addition to the hot sour gas of a foaming agent sufficient to form with the hot sour gas a foaming mist which functions as a barrier to water intrusion.

10. A process of drilling a well encountering water influx from a permeable zone, said water entering into the well borehole, comprising blocking the permeable zone with a blocking agent to prevent water intrusion and thereafter drilling the well without causing corrosion and embrittlement of the drilling equipment, and equipment used in the drilling process and well formation, by using as the drilling fluid in contact with the equipment a hot sour gas at between 150° F. and about 450° F.

11. The process of claim **10** wherein the blocking agent is a slug of cement.

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