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LUBRICITY ADDITIVES FOR DRILLING FLUIDS
David B. Sheldahl, Griffith, Ind., and John H. Striegler,
Richardson, Tex., assignors to Atlantic Richfield Co.,
New York, N.Y.

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6 Claims

ABSTRACT OF THE DISCLOSURE

A composition and method for preventing catastrophic vibration of a drill string during slim hole drilling wherein there is employed an additive composed of sulfurized lard oil, mineral oil, and halogenated paraffin.

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a division of application Ser. No. 108,170, filed Jan. 20, 1971, now Pat. No. 3,712,393.

BACKGROUND OF THE INVENTION

Heretofore in rotary drilling a wellbore in the earth, the drilling bit and the drill string (drill pipe and drill collars) which supports the bit in the wellbore are both conventionally rotated at rates of from about 100 to about 250 r.p.m. Such drilling rigs, in the petroleum industry, generally drill boreholes having diameters of from about 8 $\frac{1}{2}$ to about 13 $\frac{3}{4}$ inches. Because of the drilling of deeper and deeper wellbores, etc. there is a need for drilling fluids of improved lubricity.

As an exploratory tool, it can be desirable to employ what is known as a "slim hole" drilling technique wherein the borehole has a diameter of up to about 6 inches, preferably from about 2 to about 5 inches. With slim hole drilling it is desirable to use higher than conventional rotation rates for the bit. For example, rotation rates of at least 400 r.p.m. and as high as 3000 r.p.m. are desirably employed to achieve shorter drilling time.

By drilling small diameter boreholes with high rotation speeds, larger numbers of exploratory wells can be drilled more economically. In addition, the rig used is lighter thereby allowing for more economical movement of the rig from one drilling location to another, particularly inaccessible locations.

However, an omnipresent problem with the high rotation rates in a small diameter borehole has been what is termed "catastrophic" vibration of the drill pipe. At rotation rates of greater than 400 r.p.m. the drill pipe tends to bounce from one side of the borehole to the other at a faster and faster rate until catastrophic transverse vibration sets in and results in failure of the drill pipe, usually by twisting off one section of drill pipe from an adjacent section of drill pipe at their coupling joint.

Thus, slim hole drilling using the most economical rotation rate for the drilling bit and pipe is not feasible unless catastrophic vibration during drilling is avoided.

SUMMARY OF THE INVENTION

It has now been found that improved drilling fluid lubricity is obtained and that catastrophic vibration during high speed rotation can be prevented by the use of a composition consisting essentially of sulfurized lard oil, mineral oil, and halogenated paraffin, the composition containing greater than 2 weight percent total halogen and greater than 5 weight percent total sulfur. As used herein, weight percent recitations are based upon the total weight of the composition unless otherwise specified.

This invention therefore relates to a composition useful in a well drilling fluid and a rotary drilling method, particularly a slim hole drilling method.

Accordingly, it is an object of this invention to provide a new and improved composition useful in a drilling fluid to increase the lubricity thereof. It is another object to provide a new and improved rotary drilling method. It is another object to provide a new and improved slim hole drilling method.

Other aspects, objects, and advantages of this invention will be apparent to those skilled in the art from this disclosure and the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

The lard oil used in the composition of this invention can be present in amounts of at least about 40, preferably from about 40 to about 80, weight percent, the mineral oil in amounts of at least about 10, preferably from about 10 to about 50, weight percent, and the halogenated paraffin in amounts of at least about 1, preferably from about 1 to about 20, weight percent.

Substantially any lard oil can be employed in any sulfurization process, a particularly desirable material being that which has a gravity (degrees API) of from about 9.5 to about 12, a viscosity (SUS at 210° F.) of from about 360 to about 600, and at least about 10.5 weight percent sulfur based on the weight of the lard oil.

Substantially any mineral oil can be employed, a particularly useful oil being that having a gravity (degrees API) of from about 22 to about 25, a Saybolt viscosity at 100° F. of from about 55 to about 60, and a pour point, degrees F., maximum of about -50.

Substantially any halogenated paraffin can be employed, the paraffin containing one or more of the halogens, i.e., chlorine, bromine, iodine, and fluorine, preferably chlorine. A particularly suitable material is chlorinated paraffin having a specific gravity (60/60° F.) of from about 1.16 to about 1.20, from about 40 to about 46 weight percent chlorine based on the weight of the chlorinated paraffin, a viscosity (SUS at 210° F.) of from about 150 to about 280, and substantially no free chlorine.

The composition of this invention can be formed by blending the three components in any desired order with one another at sub-ambient, ambient, or super-ambient temperatures and pressures until a substantially homogeneous mixture is obtained. Suitable properties for the final composition can be a gravity (degrees API) of from about 11.5 to about 12.5, a viscosity (SUS at 100° F.) of from about 1300 to about 1500, at least about 5 weight percent, preferably at least about 6 weight percent, total sulfur, and at least about 3 weight percent, preferably at least about 3.5 weight percent, total halogen. The maximum amounts of sulfur and halogen are dictated only by practical considerations such as how much sulfur the particular lard oil used can be made to pick up in the particular sulfurization process used.

Other conventional materials can be included in the composition of this invention, e.g. corrosion inhibitors, wear inhibitors, oxidation stabilizers, odor stabilizers, and the like. Two or more of these materials can be employed as desired.

Corrosion inhibitors can be used in amounts which vary widely but generally in an effective corrosion inhibiting amount. These materials include alkali metal sulfonates and alkaline earth metal sulfonates such as sodium sulfonate and calcium sulfonate, particularly overbased calcium sulfonate. Effective wear inhibiting amounts of at least one of monothiophosphates and polythiophosphates (2 to 10 sulfuratons) of zinc, cadmium, tin, iron, cobalt, nickel, vanadium, chromium, manganese, molybdenum,

tungsten, titanium, and zirconium, can be employed, particularly zinc dithiophosphate. These additives can each be employed in an amount of from about 1 to about 30 weight percent and can be incorporated before, during, or after mixing of the other components.

The composition of this invention is normally employed in the drilling fluid utilized in the drilling operation. It has been found that whether a drilling fluid is susceptible to catastrophic vibration during high speed rotation is related to the scar width value obtained by subjecting the drilling fluid to a scar width test as hereinafter defined. The smaller the scar width, the greater the lubricity of the drilling fluid and, therefore, the less there is of a likelihood of catastrophic vibration while utilizing the drilling fluid in a high speed operation. Thus, the more the scar width value of a given drilling fluid can be decreased, the more likely it is that a drilling operation can be carried out with that drilling fluid without encountering catastrophic vibration.

The composition of this invention, when added to a drilling fluid, be it a water base (salt water or fresh water) or an oil base or invert drilling fluid, can substantially reduce the scar width value of the drilling fluid below the scar width value of that drilling fluid when it does not contain the composition of this invention. Generally, the composition of this invention is employed in the drilling fluid in an amount effective to substantially reduce the scar width value of the drilling fluid and generally the scar width value is reduced by at least about 0.01 of an inch. This is a substantial decrease in scar width and indicates a substantial increase in lubricity and in ability to prevent catastrophic vibration of drill pipe during high speed rotation, particularly in a small diameter wellbore.

Depending upon the particular drilling apparatus employed, the method of operating that apparatus, the composition of the drilling fluid, the size and depth of the wellbore, and the like, the amount of composition of this invention which is employed will vary widely. Generally, at least about 0.1, preferably from about 0.2 to about 10, weight percent of the composition is employed in the drilling fluid and can be incorporated in the drilling fluid by mixing at sub-ambient, ambient, or super-ambient conditions of temperature and pressure until a substantially homogeneous mixture is obtained.

A scar width value for drilling fluid is obtained using an EP Mud Tester model 211 which is available commercially from the Baroid Division of the National Lead Company. This tester is designed to measure the lubricating properties of drilling fluids by mounting a hardened steel test cup (Rockwell C scale hardness of 58-62) on a rotating shaft and forcing a steel wear block (Rockwell C scale hardness of 58-62) against the test cup with a predetermined load while the test cup and wear block are immersed in the drilling fluid being tested. The load is applied with a torque arm that is operatively connected to the wear block, the torque arm containing a torque gauge calibrated in inch pounds. The friction load is read on an ammeter scale indicating the electrical current consumption of the driving motor. The motor is run at 1400 r.p.m. which amounts to a surface velocity of the test cup of 507 feet per minute, the test cup diameter being 1.378 inches. Each test cup is used only once and a fresh spot is selected on the wear block for each run.

In the actual test itself, a friction load corresponding to three amps is applied with the torque arm and the run continued for 20 seconds holding the ammeter reading constant by increasing the load applied to the torque arm. The width of the scar formed on the wear block by the test cup is then measured and reported in inches. Each test is carried out under ambient conditions of temperature and pressure using sufficient drilling fluid to completely immerse the test cup.

It has been found that by employing the composition of this invention in the manner described hereinabove, substantially smaller scar widths are obtained with a given

drilling fluid as compared to scar widths obtained by the use of commercially available extreme pressure (EP) lubricant additives.

All of the materials useful in the composition of this invention are available commercially and are well-known in the art and therefore will not, for sake of brevity, be discussed in detail as to their source of availability or method of preparation.

EXAMPLE

A composition according to this invention was formed by blending 32 weight percent naphthenic mineral oil available commercially as Sintex Pale Oil and having the physical properties of API gravity of 22 to 25, and Saybolt viscosity at 100° F. of 55 to 60; 60 weight percent sulfurized lard oil commercially available as Union Base and having the physical properties API gravity of 9.5 to 11.5, viscosity (SUS at 210° F.) of 360 to 450, no less than 10.5 weight percent total sulfur based on the lard oil; and 8 weight percent chlorinated paraffin commercially available as Paroil 142 having the properties of specific gravity (60/60° F.) of 1.16 to 1.20; 40 to 46 weight percent chlorine based on the chlorinated paraffin, viscosity (SUS at 210° F.) of 150 to 280, and no free chlorine. The composition was formed by adding the components in the above listed order to a blending kettle and mixing same for 1 hour at temperatures in the range of from 160 to 170° F.

A drilling fluid composition was made up by mixing 350 cubic centimeters (350 grams) of distilled water and 14 to 15 grams of bentonite at ambient conditions of temperature and pressure until a homogeneous mixture was obtained. The combination of water and bentonite in the above amounts constituted the volume of drilling fluid employed in each scar width test for each composition discussed hereinbelow.

Various additives were employed in a separate volume of the above drilling fluid by mixing the particular additive with the volume of drilling fluid at ambient conditions of temperature and pressure until a substantially homogeneous mixture was obtained.

The mixture of drilling fluid and additive was then tested for its scar width in the manner disclosed hereinabove, keeping the friction load during each 20 second test at 3 amps.

In all 10 runs were made, one run being the drilling fluid with no additive, 4 runs being the drilling fluid with commercially available EP additives, and 5 runs being the drilling fluid with additives according to this invention. In run 1 the drilling fluid with no additive was employed. In runs 2 and 3 different amounts of a commercially available additive identified as crude tall oil containing 0.2 weight percent chlorine and 4.4 weight percent sulfur was employed. In runs 3 and 4 different amounts of a commercially available additive identified as coal tar having 1.7 weight percent chlorine and 4.9 weight percent sulfur was employed. Runs 6 and 7 employed different amounts of the composition of this invention. Run 8 employed the composition of this invention with the addition of 1 weight percent zinc dithiophosphate. Run 9 employed the composition of this invention with the addition of 10 weight percent sodium sulfonate and 2 weight percent water. Run 10 employed the composition of this invention with the addition of 20 weight percent overbased calcium sulfonate. The results are as shown in the following table:

Run:	Scar width, inches
1—Drilling fluid (D.F.) only	0.16
2—D.F. plus 4 gm. commercial additive	0.04
3—D.F. plus 8 gm. commercial additive	0.028
4—D.F. plus 4 gm. commercial additive	0.04
5—D.F. plus 8 gm. commercial additive	0.03
6—D.F. plus 6 gm. invention composition	0.02
7—D.F. plus 3 gm. invention composition	0.025
8—D.F. plus 6 gm. invention composition plus Zn dithiophosphate	0.03

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TABLE—Continued

Run:	Scar width, inches
9—D.F. plus 6 gm. invention composition plus 10 weight percent Na sulfonate and 2 weight percent water	0.03
10—D.F. plus 6 gm. invention composition plus overbased Ca sulfonate	0.025

It can be seen from the above data that the composition of this invention decreased the scar width of the drilling fluid even below that obtained with commercially available additives and therefore increased the lubricity of the drilling fluid and also increased the ability of the drilling fluid to prevent catastrophic vibration during drilling over what can presently be achieved with commercially available additives.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A composition useful in a drilling fluid to increase the lubricity thereof, said composition consisting essentially of at least about 40 weight percent sulfurized lard oil, at least about 10 weight percent mineral oil, and at least about 1 weight percent halogenated paraffin, said composition containing greater than 2 weight percent total halogen and greater than 5 weight percent total sulfur.

2. A composition according to claim 1 wherein said lard oil is present in an amount of from about 40 to about 80 weight percent, said mineral oil is present in an amount of from about 10 to about 50 weight percent, and said paraffin is chlorinated and is present in an amount of from about 1 to about 20 weight percent.

3. A composition according to claim 1 wherein said composition has a gravity (degrees API) of from about 11.5 to about 12.5, a viscosity (SUS at 100° F.) of from about 1300 to about 1500, at least about 5 weight percent total sulfur, and at least about 3 weight percent total chlorine.

4. A composition according to claim 2 wherein said mineral oil is a naphthentic oil which has a gravity (degrees API) of from about 22 to about 25, and a Saybolt vis-

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cosity (100° F.) of from about 55 to about 60, said lard oil has a gravity (degrees API) of from about 9.5 to about 11.5, a viscosity (SUS at 210° F.) of from about 360 to about 450, and at least about 10.5 weight percent sulfur based on the weight of the lard oil, said paraffin is chlorinated and has a specific gravity (60/60° F.) of from about 1.16 to about 1.20, from about 40 to about 46 weight percent chlorine based on the weight of the chlorinated paraffin, a viscosity (SUS at 210° F.) of from about 150 to about 280, and substantially no free chlorine.

5. A composition according to claim 1 wherein there is additionally present at least one of (1) an effective rust inhibiting amount of at least one of alkali metal sulfonates and alkaline earth metal sulfonates, and (2) an effective wear inhibiting amount of at least one of mono- and polythiophosphates of Zn, Cd, Sn, Fe, Co, Ni, V, Cr, Mn, Mo, W, Ti, and Zr.

6. A composition according to claim 1 wherein there is additionally present at least one of Na sulfonate, Ca sulfonate, and Zn dithiophosphate, each being present in an amount in the range of from about 1 to about 30 weight percent.

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HERBERT B. GUYNN, Primary Examiner

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