(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 March 2002 (21.03.2002)

PCT

(10) International Publication Number
WO 02/22759 A1

(51) International Patent Classification[7]: C09K 7/02, 7/00

(21) International Application Number: PCT/US01/28363

(22) International Filing Date:
12 September 2001 (12.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/231,565 11 September 2000 (11.09.2000) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 02/22759 A1

(54) Title: MUD SYSTEM AND METHOD

(57) Abstract: A novel mud system and method reduce torque on drilling surfaces and coat geological formations to reduce the chances of formation reaction. The mud system comprises a fluid having weighting materials and a viscosifier. An additive in the form of water repellent particles is interspersed in the fluid. The water repellent particles comprise natural graphite having a particle size of less than 25 microns, a silicate material having a particle size of less than 15 microns, a silicone material, and processed wax treated with polyglycol. A method for reducing torque on drilling surface includes providing a drilling fluid, combining the above-identified additive with the drilling fluid, and allowing the drilling fluid and the additive to fill and level contact areas.

MUD SYSTEM AND METHOD

FIELD OF THE INVENTION

The present invention relates to drilling muds, which include compositions for reducing friction and torque, particularly in connection with oil drilling.

BACKGROUND OF THE INVENTION

Drilling mud is used in the sinking of boreholes including deep boreholes sunk in the search for hydrocarbons. The drilling mud lubricates the drill pipe and acts as a carrier for excavated drill cuttings. The drilling mud is pumped down the drill pipe through nozzles in the drill bit at the bottom of the borehole and up the annulus between the drill pipe and the borehole wall. Drilled cuttings generated by the drill bit are transported by the drilling mud to the surface of the borehole where they are separated from the drilling mud and discarded. The drilling mud may then be cleaned and re-used.

In addition to its function as a carrier for cuttings, a drilling mud operates to lubricate the drill pipe and bit as well as the wall of the borehole, thereby reducing torque, overpull, and wear as well as the sticking of the drill pipe in the borehole. The drilling mud further provides a hydrostatic balance with the geological structure being drilled thereby minimizing the possibility of cave-ins and keeping high pressure hydrocarbons from entering the borehole before a casing is run. The drilling mud additionally forms an impermeable membrane on the borehole to prevent the liquid phase in the drilling fluid from migrating to the geological formation, causing clays and shales to swell. In addition, the drilling mud acts to cool the drill bit and other high pressure wear areas. The drilling mud should possess a suitable viscosity so as to suspend the drill cuttings when the drilling mud pumps are stopped. To enhance these functions, the drilling mud may incorporate additives such as hydrocarbon oil lubricants and polymers for controlling flow characteristics of the drilling mud.

A satisfactory drilling mud should be chemically inert, non-toxic, and nonpolluting. Oil based muds are known to have superior lubricating qualities to water based muds, but generally have unacceptable toxicity and pollution levels.

In recognition of this fact, U.S. Patent No. 5,401,719 discloses a drilling mud which excludes components that are harmful to the environment. The drilling mud additive of the aforementioned patent further improved the lubricating qualities of water based drilling muds to approach those of oil based products. However, this prior art system suffers from various deficiencies. Although the lubrication of the disclosed additive improved upon that of prior water based additives, it is still desirable to improve the lubricating and water repellent properties of the additive.

A further difficulty of pre-existing systems, including that of the aforementioned U.S. patent, is the necessity of continuous operator monitoring. Continuous monitoring has been necessary because previous systems have been insufficiently water repellent to coat the formation thereby preventing chemical reaction. The possibility of the occurrence of a chemical reaction renders continuous operator monitoring necessary.

SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide a chemically inert, non-polluting, nontoxic mud system.

It is a further object of the invention to provide a mud system having improved lubricating and water repellent properties.

It is still a further object of the invention to provide a mud system which eliminates the need for continuous operator monitoring of drilling operations.

To achieve the foregoing objects, and in accordance with the purpose of the invention as embodied and broadly described herein, there is provided a mud system that comprises a water based fluid and water repellent particles interspersed in the water based fluid. The water repellent particles comprise a combination of graphite, a silicate material, a silicone material, and processed wax treated with polyglycol. The system coats a geological formation such that it is sealed from the drilling fluid.

In yet another aspect, a method of the invention comprises the steps of providing a drilling fluid, combining an additive with the drilling fluid, and allowing the drilling fluid and the additive to fill and level contact areas, thereby reducing

torque values. The additive comprises water repellent particles interspersed in the drilling fluid, the water repellent particles comprising a combination of graphite, a silicate material, a silicone material, and processed wax treated with polyglycol.

These and other objects and advantages of the preferred embodiments will become apparent through the detailed description of the invention and its preferred embodiments.

DETAILED DESCRIPTION

According to an embodiment of the invention, a drilling fluid is provided which is preferably water-based in order to minimize polluting effects. The water-based drilling fluid of this embodiment includes weighting minerals to increase fluid density and viscosifiers to enhance viscosity. Suitable weighting materials include, but should not be limited to barite, calcium carbonate, ferrous oxide, and hematite. Suitable viscosifers include biodegradable environmentally friendly materials including, but not limited to carboxy methyl cellulose (CMC) and polyanionic cellulose (PAC) polymers. An additive is combined with the drilling fluid in order to enhance water repellency and minimize surface tension. The additive is preferably chemically inert and exhibits low surface tension characteristics of approximately 20 Dynes/cm^2. All components of the additive are chemically inert, non toxic, and nonpolluting.

In a preferred embodiment, the additive includes natural graphite, a silicate material, a silicone material, and a processed wax treated with polyglycol. The graphite component is preferably 100% natural crystalline flake graphite having a particle size of less than 25 microns. However, synthetic and/or amorphous graphite can also be used. The silicate material components falls within the micaceous mineral group and may include koalinite or phlogophite and preferably has a particle size smaller than 15 microns and more preferably less than one micron. The processed wax is a non sticky, brittle waxy solid treated with a polyglycol. The processed wax exhibits pliable and coating properties. When the graphite is impregnated with the processed wax, the combined materials act as an initial binding to metal to form a thin pliable film on the metal components in

the borehole. The silicone component is a dimethyl polysiloxane based emulsion listed in the Merek Index as symethycone, and is also known as PMDS. The dimethyl polysiloxane enhances the water repellency or hydrophobic nature of the impregnated graphite and silicate particles. When dispersed in a drilling fluid, these particles increase surface tension between the predominately water wet surface in the borehole. Surfaces with a difference in surface tension tend to repel each other, thereby enhancing lubrication. Furthermore, when the particles are dispersed in the fluid, the fluid forms a membrane that coats the geological formation to seal it from the drilling fluid and prevent formation reaction.

The graphite and silicate particles combined may constitute between 70% to 80%, and preferably about 75% of the mass of the additive. The PMDS composition may be up to 22% of the mass and the processed wax may range from 1% to 3% of the mass of the additive. The specific gravity of the additive is preferably between 1.6 and 2.0 kg/dm^3. The pH of the additive is preferably between 8.0 and 8.5 (10% by weight in water).

The above-described additive composition is a powder type lubricant that is added to the above-described drilling fluid. Lubrication is effected by filling, dressing and leveling action, thereby separating the opposing contact surfaces, increasing the actual load bearing area, and thereby decreasing the actual load. Reduced load values result in lower friction and torque values or simultaneously protecting the opposing surfaces. As opposed to a liquid type lubricant, powder type lubricants fill and level uneven surfaces to increase the load bearing area and lower the load per unit area. The pliable particles of the above-described additives have an affinity for metal and coat metal surfaces forming a thin layer. As the particles of the additive have a very low surface tension, the difference in surface tension of the thin layer between the drill string and borehole improves lubrication and consequently minimizes rotary torque and friction.

Additionally, the above-described powder type lubricant is stable in temperatures in excess of 500 °F, whereas liquid type lubricants generally are not. Furthermore, the additive lowers the high temperature/high pressure filtrate values in any drilling fluid and has an effect on long term filtration rates and

minimizing filtrate invasion. The additive further has a direct reduction effect on seepage losses.

A further benefit of the above-described additive is the stabilization of rheological properties. This stabilization leads to greater hole cleaning efficiency. Water based drilling fluids and in particular viscous fluids or salt containing fluids are susceptible to air entrapment. The surface area of the dispersed air forms an emulsion that contracts and expands with changes in pressure and temperature. This fluctuation in rheology and density is undesirable and is minimized by the additive described above.

Additionally, the above described additive has a strong defoaming action and maximizes air and gas breakout. The additive minimizes the viscosifying effect of the entrapped air and stabilizes the viscosity after the entrapped air is removed. Due the above described release of air and gases and the coating ability of the additive, the corrosion rate of the metal surfaces is very low. Due to reduction in surface tension, the invention imparts an effective defoaming action thereby ensuring air and gas removal. This action ensures a de-serated drilling fluid and protects polymeric additives from being damaged by high temperature oxygen degradation. The additive further helps to extend the temperature stability of the polymers by providing improved heat transmission and transfer medium, thereby increasing the temperature range of polymers.

The adhesive properties of the additive causes it to coat and smear the entire surface of the casing and drill string and to establish a presence throughout the borehole wall thereby minimizing downhole frictional forces. The filling and coating action of the additive creates smoother surfaces and thereby reduces wear between surfaces and the borehole. The smoother surfaces additionally cause a reduction in torque and drag and eliminate previously existing downhole vibrations and shock. The smoother surfaces further reduce wear on the drill string and the drilling tools and bit, thereby reducing premature metal and seal failures. By preventing borehole problems as described above, the system optimizes logging operations and cementing operations.

Because the particles of the additive are predominantly water repellent and create a water repellent film that coats clay type material in the well bore, the

additive assists in physical inhibition. The particles of the additive are forced into pores or microfractors in the clay by differential pressure and downhole dynamics. This process forms a seal and reduces fluid invasion into the clay formation. The particles of the additive thereby stabilize mechanically troublesome shales.

With regard to drilled solids, the coating effect of the additive reduces dispersion of the solid and the drilling fluid. Furthermore, the drilled solids are firmer and in better physical condition due to the reduction in degradation caused by the protective coating. The improved condition of the drill solids allows more accurate visual analysis and evaluation by geologists.

Additionally, the above described additive has positive effects on drilling equipment. Due to the coating effect of the water repellent particles, membranes also known as thin filter cakes eliminate pipe sticking tendencies. Due to lubrication properties, the additive enhances conditions for gaining maximum performance from directional tools and drill string design. The lubrication effect further protects tools and reduces premature failures of steering, measuring, and telemetric downhole tools.

The low surface tension of the particles of the additive creates several additional positive effects. First, the particle cause reduction or elimination of bit and bottom hole assembly balling between metal and drilled claimed minerals. Thus, the time for tripping, logging, and casing run operations is shortened. Additionally, diamond and PDC bits can be used because of the surface tension effect with optimum performance comfortable to that in oil based muds. The low surface tension further insures maximum lift-off and reduces formation damage and clean up time.

The non-polluting, environmentally friendly, and chemically inert properties provide great advantages over oil based mud systems. Legislation governing the use of hydrocarbon based drilling fluids increases the demand for the development of such a product. Because the particles of the additives are totally chemically inert, they are not absorbed into the food chain or any form of aquatic life. The system is extremely low or totally free of hydrocarbon content. In particular, the additive has less than 25 ppm residual.

The system described above also maximizes the usage of available drilling horsepower. In the case of offshore drilling operation from existing platforms, it provides the operator with far more options to reach reserves of hydrocarbon previously unreachable. The fluid system further gives the operators both land and offshore, the option to utilize smaller drilling package design that can alter the economics of bringing hydrocarbon reserve into production. Finally, the drilling fluid can be used without any chemistry knowledge or chemical additive management.

It will be apparent to those skilled in the art that various modifications and variations can be made in the system and method of the present invention without departing from the spirit and scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided that they come within the scope of the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A mud system comprising:

a drilling fluid comprising weighting materials and a viscosifier; and

water repellent particles interspersed in the drilling fluid, the water repellent particles comprising a combination of graphite, a silicate material, a silicone material, and processed wax treated with polyglycol, wherein the system coats a geological formation such that it is sealed from the drilling fluid.

2. The system of claim 1, wherein the water repellent particles have a surface tension no greater than 25 Dynes/cm^2.

3. The system of claim 1, wherein the graphite has a particle size of no greater than 25 microns and the silicate material has a particle size of no greater than 15 microns.

4. The mud system of claim 1, wherein the weighting materials comprise at least one of barite, calcium carbonate, ferrous oxide, and hematite.

5. The mud system of claim 1, wherein the viscosifier comprises a biodegradable environmentally friendly material.

6. The mud system of claim 5, wherein the viscosifier comprises one of CMC and PAC polymers.

7. The mud system of claim 1, wherein the graphite comprises natural graphite.

8. The mud system of claim 1, wherein the silicate material comprises one of koalinite and phlogophite.

9. The mud system of claim 1, wherein the processed wax is solid, brittle, and non-sticky.

10. The mud system of claim 1, wherein the processed wax has a particle size of less than one micron.

11. The mud system of claim 1, wherein the processed wax is treated with polyglycol.

12. The mud system of claim 1, wherein the graphite is impregnated with the processed wax so as to form a thin pliable film which binds to metal.

13. The mud system of claim 1, wherein the silicone component comprises simethycone.

14. The mud system of claim 1, wherein the graphite and silicate materials comprise 70 to 80 percent of the mass of the composition and the processed wax comprises from 1 to 3 percent of the mass of the composition.

15. The mud system of claim 1, wherein the specific gravity is between 1.6 and 2.0kg/dm^3 and the pH is 8.0 to 8.5.

16. A mud system comprising:

a drilling fluid comprising weighting materials and a viscosifier; and

water repellent particles interspersed in the drilling fluid, the water repellent particles comprising a combination of graphite having a particle size no greater than 25 microns, a silicate material having a particle size no greater than 15 microns, a silicone material, and processed wax treated with polyglycol, wherein the water repellent particles have a surface tension no greater than 25 Dynes/cm^2 such that the system coats a geological formation such that the geological formation is sealed from the drilling fluid.

17. A method for reducing torque in a borehole used for drilling, the method comprising the steps of:

providing a drilling fluid;

combining an additive with the drilling fluid, the additive comprising water repellent particles interspersed in the fluid, the water repellent particles comprising natural graphite, a silicate material, a silicone material, and processed castor oil wax treated with polyglycol; and

allowing the drilling fluid and the additive to fill and level contact areas, thereby reducing torque values and to coat the geological formation, thereby reducing chances of formation reaction.

18. The method of claim 17, wherein the step of providing a drilling fluid comprises providing weighting materials comprising at least one of barite, calcium carbonate, ferrous oxide, and hematite.

19. The method of claim 17, wherein the step of providing a drilling fluid comprises providing a viscosifier including a biodegradable environmentally friendly material.

20. The method of claim 19, wherein providing a viscosifier comprises providing one of CMC and PAC polymers.

21. The method of claim 17, wherein the step of combining an additive comprises providing natural graphite.

22. The method of claim 17, wherein the step of providing an additive comprises providing a silicate material containing one of koalinite and phlogophite.

23. The method of claim 17, wherein the step of providing an additive comprises providing solid, brittle, and non-sticky wax.

24. The method of claim 1, wherein the step of providing an additive comprises providing processed wax having a particle size of less than one micron.

25. The method of claim 24, further comprising treating the processed wax with polyglycol.

26. The method of claim 1, further comprising impregnating the graphite with the processed wax so as to form a thin pliable film which binds to metal.

27. The mud system of claim 1, wherein the silicone component comprises simethycone.

28. The method of claim 17, further comprising providing an additive wherein the graphite and silicate materials comprise 70 to 80 percent of the mass of the composition and the processed wax comprises from 1 to 3 percent of the mass of the composition.

29. The method of claim 17, further comprising providing an additive wherein the specific gravity is between 1.6 and 2.0kg/dm^3 and the pH is 8.0 to 8.5.

30. The method of claim 17, further comprising providing an additive wherein the graphite has a particle size of no greater than 25 microns and the silicate material has a particle size of no greater than 15 microns.

31. The method of claim 17, wherein the water repellent particles have a surface tension no greater than 25 Dynes/cm^2.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/28363

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :C09K 7/02, 7/00
US CL :507/140, 127

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 507/140, 127

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST, CAPLUS
search terms: drilling fluid, graphite, silicate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,401,719 A (DEBEER) 28 March 1995, see abstract	1-31
A	WO 98/49116 A1 (CROSFIELD LIMITED) 05 November 1998, see abstract.	1-31

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search	Date of mailing of the international search report
27 NOVEMBER 2001	14 DEC 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer PHILIP C. TUCKER Telephone No. (703) 308-0651

Form PCT/ISA/210 (second sheet) (July 1998)★