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Determining the Sand Content in Various Compositions of Drilling Mud

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Abstract :- Drilling is an important part of the oil industry and penetration rate must be enhanced to ensure speedy completion of drilling operation. Weight on bit, Rotary speed, drill bit type, formation characteristics and mud properties are the basic factors that affect the penetration rate of a bit. Regular determination of the sand content of drilling mud is necessary because these particles can be highly abrasive, and can cause excessive wear of pump parts, drill bits, and pipe connections, excessive sand may also result in the deposition of a thick filter cake on the walls of the hole, or it may settle in the hole around the tools when circulation is temporarily halted, interfering with the operation of drilling tools of settling casing. The sand content test for set is used in the test for sand content determination using Bariod sand content set.

Keywords:- Bentonite, drilling mud, Fly ash

I. INTRODUCTION

Drilling fluid, or drilling mud, is a critical component in the rotary drilling process. Its primary functions are to remove the drilled cuttings from the borehole whilst drilling, and to prevent fluids from flowing from the formations being drilled, into the borehole. It has however many other functions, these will be discussed below. Since it is such an integral part of the drilling process many of the problems encountered during the drilling of a well can be directly, or indirectly, attributed to the drilling fluids. These fluids must therefore be carefully selected and/ or designed to fulfill their role in the drilling process. The cost of the mud can be as high as 10-15% of the total cost of the well. Although this may seem expensive the consequences of not maintaining good mud properties may result in drilling problems which will take a great deal of time and cost to resolve. In view of the high cost of not maintaining good mud properties an operating company will usually hire a service company to provide a drilling fluid specialist (mud engineer) on the rig to formulate, continuously monitor, and if necessary modify the mud [1]. The main objective of drilling fluids is the successful completion of oil & gas wells. The primary functions of a drilling fluid are:

- To transport the drilled solids from the bottom of the hole to the surface.
- To suspend the drilled solids and weighting materials when the mud is under static condition.
- To provide a thin impermeable cake to seal pore and other openings in the formation and there by restricting the movement of fluids.
- To contain formation pressure.
- To support the weight of casing and drill string.
- To transmit hydraulic horse power to the bit.
- To assist in evaluation of the formation.
- Remove cuttings from the well-bore.
- Prevent formation fluids lowing into the well-bore. Maintain well-bore stability.
- Cool and lubricate the bit. Transmit Hydraulic Horsepower to bit.

The drilling fluid must be selected or designed so that the physical and chemical properties of the fluid allow these functions to be fulfilled. However, when selecting the fluid, consideration must also be given to:

- The environmental impact of using the fluid.
- The cost of the fluid.
- The impact of the fluid on production from the pay zone.

In geotechnical engineering, drilling fluid is used to aid the drilling of boreholes into the earth. Often used while drilling oil and natural gas wells and on exploration drilling rigs, drilling fluids are also used for much simpler boreholes, such as water wells. Liquid drilling fluid is often called drilling mud. The three main categories of drilling fluids are water-based muds (which can be dispersed and non-dispersed), non-aqueous muds, usually called oil-based mud, and gaseous drilling fluid, in which a wide range of gases can be used. The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole. The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion.Water-based drilling mud most commonly consists of bentonite clay (gel) with additives such as barium sulfate (barite), calcium carbonate (chalk) or hematite. Various thickeners are used to influence the viscosity of the fluid, e.g. xanthan gum, guar gum, glycol, carboxymethylcellulose, polyanionic cellulose (PAC) or starch. In turn, deflocculates are used to reduce viscosity of clay-based muds; anionic poly-electrolytes (e.g. acrylates, polyphosphates, lignosulfonates (Lig) or tannic acid are frequently used. Red mud was the name for a Quebracho-based mixture, named after the color of the red tannic acid salts; it was commonly used in the 1940s to 1950s and then was made obsolete when lignosulfonates became available. Other components are added to provide various specific functional characteristics as listed above. Some other common additives include lubricants, shale inhibitors, fluid loss additives (to control loss of drilling fluids into permeable formations). A weighting agent such as barite is added to increase the overall density of the drilling fluid so that sufficient bottom hole pressure can be maintained thereby preventing an unwanted (and often dangerous) influx of formation fluids [2].

1.1 Water-based fluids

Water-based fluids (WBFs) are used to drill approximately 80% of all wells. The base fluid may be fresh water, seawater, brine, saturated brine, or formate brine. The type of fluid selected depends on anticipated well conditions or on the specific interval of the well being drilled. For example, the surface interval typically is drilled with a low-density water- or seawater-based mud that contains few commercial additives [3]. These systems incorporate natural clays in the course of the drilling operation. Some commercial bentonite or attapulgite also may be added to aid in fluid-loss control and to enhance hole-cleaning effectiveness. After surface casing is set and cemented, the operator often continues drilling with a WBF unless well conditions require displacing to an oil- or synthetic-based system. WBFs fall into two broad categories: no dispersed and dispersed.

1.1.1 Nondispersed systems

Simple gel-and-water systems used for top hole drilling are nondispersed, as are many of the advanced polymer systems that contain little or no bentonite. The natural clays that are incorporated into nondispersed systems are managed through dilution, encapsulation, and/or flocculation. A properly designed solids-control system can be used to remove fine solids from the mud system and help maintain drilling efficiency. The low-solids, nondispersed (LSND) polymer systems rely on high- and low-molecular-weight long-chain polymers to provide viscosity and fluid-loss control. Low-colloidal solids are encapsulated and flocculated for more efficient removal at the surface, which in turn decreases dilution requirements. Specially developed high-temperature polymers are available to help overcome gelation issues that might occur on high-pressure, high-temperature (HP/HT) wells. With proper treatment, some LSND systems can be weighted to 17.0 to 18.0 ppg and run at 350°F and higher [4].

1.1.2 Dispersed systems

Dispersed systems are treated with chemical dispersants that are designed to deflocculate clay particles to allow improved rheology control in higher-density muds. Widely used dispersants include lignosulfonates, lignitic additives, and tannins. Dispersed systems typically require additions of caustic soda (NaOH) to maintain a pH level of 10.0 to 11.0. Dispersing a system can increase its tolerance for solids, making it possible to weight up to 20.0 ppg. The commonly used lignosulfonate system relies on relatively inexpensive additives and is familiar to most operator and rig personnel. Additional commonly used dispersed muds include lime and other cationic systems [5]. A solids-laden dispersed system also can decrease the rate of penetration significantly and contribute to hole erosion.

2. Additives for Drilling Fluids

Just as drilling fluids are integral to the bore well drilling process, additives that are very much a part of their composition, have a unique role to play. Most of these additives have distinct properties that specifically help in countering specific challenges encountered during the drilling process. They help in accomplishing the drilling work with efficiency and precision. They also help in minimizing human hazards. Some of the significant compounds that work well as additives have been detailed out below.

2.1 Bentonite

Bentonite is absorbent aluminium phyllosilicate clay consisting mostly of montmorillonite. It was named by Wilbur C. Knight in 1898 after the Cretaceous Benton Shale near Rock River, Wyoming.The different types of bentonite are each named after the respective dominant element, such as potassium (K), sodium (Na), calcium (Ca), and aluminium (Al). Experts debate a number of nomenclatorial problems with the classification of bentonite clays. Bentonite usually forms from weathering of volcanic ash, most often in the presence of water. However, the term bentonite, as well as similar clay called tonstein, has been used to describe clay beds of uncertain origin. For industrial purposes, two main classes of bentonite exist: sodium and calcium bentonite. In stratigraphy and tephrochronology, completely devitrified (weathered volcanic glass) ash-fall beds are commonly referred to as K-bentonites when the dominant clay species is illite. In addition to montmorillonite and illite another common clay species that is sometimes dominant is kaolinite. Kaolinite-dominated clays are commonly referred to as tonsteins and are typically associated with coal [6]. The main uses of bentonite are for drilling mud, binder (e.g. foundry-sand bond, iron ore pelletizer), purifier, absorbent (e.g. pet litter), and as a groundwater barrier. As of around 1990, almost half of the US production of bentonite was used for drilling mud. Bentonite is used in drilling fluids to lubricate and cool the cutting tools, to remove cuttings, and to help prevent blowouts. Much of bentonite's usefulness in the drilling and geotechnical engineering industry comes from its unique rheological properties. Relatively small quantities of bentonite suspended in water form a viscous, shear-thinning material. Most often, bentonite suspensions are also thixotropic, although rare cases of rheopectic behaviour have also been reported. At high enough concentrations (about 60 grams of bentonite per litre of suspension), bentonite suspensions begin to take on the characteristics of a gel (a fluid with a minimum yield strength required to make it move). So, it is a common component of drilling mud used to curtail drilling fluid invasion by its propensity for aiding in the formation of mud cake [7].

Figure 1: Bentonite

2.2 CMC

This is an organic colloid (Sodium Carboxyl Methyl Cellulose). The long chain molecules can be polymerized into 3 different grades (high, medium and low viscosity). It is thought that CMC controls % by wedging long chain polymers into the formation and plugging the pores [8]. CMC works well in most water-based muds, but is less effective in high salt concentrations (>50,000 ppm).

Figure 2: CMC

2.3 PAM (Polyacrylamide)

PAM is a polymer (-$CH_2CHCONH_2$-) formed from acrylamide subunits. It can be synthesized as a simple linear-chain structure or crossed linked, typically using N.N'-methylenebisacrylamide. In the cross-linked form, the possibility of the monomer being present is reduced even further. It is highly water-absorbent, forming a soft gel when hydrated, used in such applications as polyacrylamide gel electrophoresis, and can also be called ghost crystals when cross-linked, and in manufacturing soft contact lenses. In the straight-chain form, it is also used as a thickener and suspending agent.

Figure 3: Polyacrylamide

2.4 Baryte

Baryte or barite (BaSO4) is a mineral consisting of barium sulfate. The baryte group consists of baryte, celestine, anglesite and anhydrite. Baryte is generally white or colorless, and is the main source of barium. Baryte and celestine form a solid solution (Ba,Sr)SO4. Baryte occurs in a large number of depositional environments, and is deposited through a large number of processes including biogenic, hydrothermal, and evaporation, among others. Baryte commonly occurs in lead-zinc veins in limestones, in hot spring deposits, and with hematite ore. It is often associated with the minerals anglesite and celestine. It has also been identified in meteorites. 77% of baryte worldwide is used as a weighting agent for drilling fluids in oil and gas exploration to suppress high formation pressures and prevent blowouts. As a well is drilled, the bit passes through various formations, each with different characteristics. The deeper the hole, the more baryte is needed as a percentage of the total mud mix. An additional benefit of baryte is that it is non-magnetic and thus does not interfere with magnetic measurements taken in the borehole, either during logging-while-drilling or in separate drill hole logging. Baryte used for drilling petroleum wells can be black, blue, brown or gray depending on the ore body. The baryte is finely ground so that at least 97% of the material, by weight, can pass through a 200-mesh (75-μm) screen, and no more than 30%, by weight, can be less than 6 μm diameter. The ground baryte also must be dense enough so that its specific gravity is 4.2 or greater, soft enough to not damage the bearings of a tricone drill bit, chemically inert, and containing no more than 250 milligrams per kilogram of soluble alkaline salts.

Figure 4: Baryte

2.5 Fly ash

Fly ash, also known as "pulverised fuel ash" in the United Kingdom, is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

Figure 5: Fly ash

3. Sand Content Test Kit

The sand content kit is a simple, accurate and inexpensive sieve analysis apparatus for determining the sand content of drilling muds Sieve analysis is the preferred method for sand content determination because of the reliability of the test and simplicity of equipment. The volume of sand, including that of void spaces between grains, is usually measured and expressed as a percentage by volume of the drilling fluid. The sand content kit consists of a special 200-mesh sieve 2½ inches in diameter, fastened inside a collar upon which a small funnel is fitted on either end. This is used with a 10 ml glass measuring tube, graduated to read from 0 to 20% the percentage sand by volume. The collar and funnel are made of polyethylene and the screen is made of brass. A 500ml wash bottle and carrying case are included.

Figure 6: Sand content test kit

Figure 7: Baroid sand content tube

II. PROCEDURE

a) Pour mud into the baroid sand content tube until it fill up to the mark labeled ” mud to here” then add 100 ml of De-ionised water to the mark labeled water to here cover mouth of the tube with thumb and shake vigorously.
b) Pour this mixture through the screen, being careful to wash everything out of the tube with clear water through the same screen. Wash sand retained on screen with a stream of water to remove all mud and shape particles
c) Fit funnel down over top of the screen, invert slowly turning tip of funnel into mouth of tube, and wash sand back into tube with a fine spray of clear water on the back side of the screen . Allow the sand to settle.
d) Observe the quantity of sand settled in the calibrated tube as the sand content of the mud.

III. OBESRVATION

Additives	Weight in first run(gm)	Weight in second run(gm)	Weight in third run(gm)	Weight in fourth run(gm)
Bentonite	3	5	8	10
Baryte	0.3	0.4	0.6	0.7
CMC	0.4	0.5	0.8	0.9
PAM	0.5	0.6	0.9	1
Sand content (%)	6	10	13	16.5

Additives	Weight in first run(gm)	Weight in second run(gm)	Weight in third run(gm)	Weight in fourth run(gm)
Fly ash	3	5	8	10
Baryte	0.5	0.6	0.7	0.8
CMC	0.4	0.5	0.6	0.7
PAM	0.5	0.6	0.7	0.8
Sand content (%)	4	5.5	9	12

IV. RESULTS & CONCLUSION

In the current experiment fly ash and bentonite has been used to find the sand content also different additives are used to mode the drilling mud with bentonite well as fly ash so from the experimental results fly as gives less sand content .here sand content is reduced using the fly ash maintaining the same density and weight percentage. If sand content is reduced the amount of slurry return back to slurry bit is comparatively reduced preventing the wastage of drilling mud hence providing cost affected drilling mud.

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