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Oil, Water, Solid and Clay Content Determination in Various Concentration of Bentonite

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Abstract: *Drilling is a single important aspect of oil and gas sector for without drilling, there is no access to the natural resources available below the earth crust. Drilling process should be conducted safely at least cost and minimum or no damage to the environment. One of the important materials used in drilling is the drilling fluids commonly called drilling mud. Design and production of this drilling fluid becomes utmost important because of its role in drilling. In this case, industries in this sector adjust the properties of the drilling fluid with the aid of the right types of additives which are also imported to suit the formation requirements of the area to be drilled. This investigation often explains poor mud system performance and indicates whether the mud needs to be conditioned by adding water, treating it with a chemical thinner, or removing a particular contaminant. The idea behind the current work is to determine the oil, water, solid and clay content in drilling mud using additives as STTP (sodium tri-polyphosphate)* $Na_5P_3O_{10}$*, starch and base as bentonite, barite, and distilled water.*
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I. Introduction

The petroleum industry includes the global processes of exploration, extraction, refining, transporting (often by oil tankers and pipelines), and marketing of petroleum products. The largest volume products of the industry are fuel oil and gasoline (petrol). Petroleum (oil) is also the raw material for many chemical products, including pharmaceuticals, solvents, fertilizers, pesticides, synthetic fragrances, and plastics. Petroleum is vital to many industries, and is of importance to the maintenance of industrial civilization in its current configuration, and thus is a critical concern for many nations. Oil accounts for a large percentage of the world’s energy consumption, ranging from a low of 32% for Europe and Asia, to a high of 53% for the Middle East. Other geographic regions' consumption patterns are as follows: South and Central America (44%), Africa (41%), and North America (40%). The world consumes 30 billion barrels (4.8 km^3) of oil per year, with developed nations being the largest consumers. The United States consumed 25% of the oil produced in 2007. The production, distribution, refining, and retailing of petroleum taken as a whole represents the world's largest industry in terms of dollar value. Governments such as the United States government provide a heavy public subsidy to petroleum companies, with major tax breaks at virtually every stage of oil exploration and extraction, including the costs of oil field leases and drilling equipment. The industry is usually divided into three major components: upstream, midstream and downstream. Midstream operations are usually included in the downstream category. The upstream sector includes searching for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil or raw natural gas to the surface.

1.1. DRILLING FLUIDS

The drilling fluid is related either directly or indirectly to almost every drilling problem. This is not to say that the drilling fluid is the cause or solution of all drilling problems, but it is a tool that can often be used to elevate a problem situation. Many have thought that a magic additive would solve all of their problems and that the drilling fluid could somehow make up for poor drilling practices. This is simply not the case. It is a part of the drilling process and should be used to complement all other facts of the operation. Selection and application of the drilling fluid are key factors in the success of any drilling operation. The first objective in planning a mud program is the selection of a mud that will minimize the amount of lost time in the drilling operation. Such a mud will usually be economical regardless of its cost per barrel. Generally, a good drilling fluid is simple and contains a minimum number of additives. This allows easier maintenance and control of properties. It is desirable to have a mud system that is flexible enough to allow changes to be made to meet changing requirements as they occur. Each change in the mud should be planned well in advance of the time it is required. This will allow current treatment of the mud consistent with future requirements. Planning of the mud program begins with acquisition of all pertinent geologic and offset well information. This includes pore pressure and fracture gradient profiles, formation characteristics, intervals of possible borehole instability, location of soluble salt beds, and the possibility of sour gas or saltwater flows. Good information is an absolute necessity for good engineering. This necessitates communication between those persons concerned with the different parts of the operation. There are a number of functions of a drilling fluid. The more basic of these are listed below:

- Balance formation pressure.
- Carry cuttings and sloughing's to the surface and clean beneath the bit.
- Cool and lubricate bit and drill string.
- Seal permeable formations.
- Stabilize borehole and corrosion control.

In addition to these functions, there are several other functions with which the drilling fluid should not interfere:

- Formation evaluation.
- Completion operations and Production operations

1.1.1. WATER-BASED MUD OR FLUIDS (WBM)

Water itself can be used as a drilling fluid. However, to maintain a better circulation of the Cuttings, WBM requires some degree of viscosity. The viscosity of WBM is generated by the addition of clay or polymers. There are two main purposes of adding clay which are first, increasing viscosity of the mud so that improves the lifting capacity of cuttings and second, Building a filter cake (mud cake) in permeable zones to prevent fluid loss.

1.1.2. OIL BASED DRILLING FLUIDS (OBFs)

Oil-based systems were developed and introduced in the 1960s to help address several drilling problems:

- Formation clays that react, swell, or slough after exposure to WBFs
- Increasing down hole temperatures
- Contaminants
- Stuck pipe and torque and drag

OBF in use today are formulated with diesel, mineral oil, or low-toxicity linear olefins and paraffin's. The olefins and paraffin's are often referred to as "synthetics" although some are derived from distillation of crude oil and some are chemically synthesised from smaller molecules. The electrical stability of the internal brine or water phase is monitored to help ensure that the strength of the emulsion is maintained at or near predetermined value. The emulsion should be stable enough to incorporate additional water volume if a down hole water flow is encountered. Barite is used to increase system density, and specially-treated organophilic bentonite is the primary viscosifier in most oil-based systems. The emulsified water phase also contributes to fluid viscosity. Organophilic lignitic, asphaltic and polymeric materials are added to help control HP/HT (High pressure/High temperature) fluid loss. Oil-wetting is essential for ensuring that particulate materials remain in suspension. The surfactants used for oil-wetting also can work as thinners. Oil-based systems usually contain lime to maintain an elevated pH, resist adverse effects of hydrogen sulfide (H_2S) and carbon dioxide (CO_2) gases, and enhance emulsion stability. Shale inhibition is one of the key benefits of using an oil-based system. The high-salinity water phase helps to prevent shales from hydrating, swelling, and sloughing into the wellbore. Most conventional oil-based mud (OBM) systems are formulated with calcium chloride brine, which appears to offer the best inhibition properties for most shales. The ratio of the oil percentage to the water percentage in the liquid phase of an oil-based system is called its oil/water ratio. Oil-based systems generally function well with an oil/water ratio in the range from 65/35 to 95/5, but the most commonly observed range is from 70/30 to 90/10. The discharge of whole fluid or cuttings generated with OBFs is not permitted in most offshore-drilling areas. All such drilled cuttings and waste fluids are processed, and shipped to shore for disposal. Whereas many land wells continue to be drilled with diesel-based fluids, the development of synthetic-based fluids (SBFs) in the late 1980s provided new options to offshore operators who depend on the drilling performance of oil-based systems to help hold down overall drilling costs but require more environmentally-friendly fluids. In some areas of the world such as the North Sea, even these fluids are prohibited for offshore discharge.

II. 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 as follows.

1.2. BARYTE

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 1:- Baryte

1.3. BENTONITE

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.

Figure 2:- Bentonite

1.4. STPP

Sodium triphosphate (STP), also sodium tripolyphosphate (STPP), or tripolyphosphate (TPP), is an inorganic compound with formula $Na_5P_3O_{10}$. It is the sodium salt of the polyphosphate penta-anion, which is the conjugate base of triphosphoric acid. It is produced on a large scale as a component of many domestic and industrial products, especially detergents.

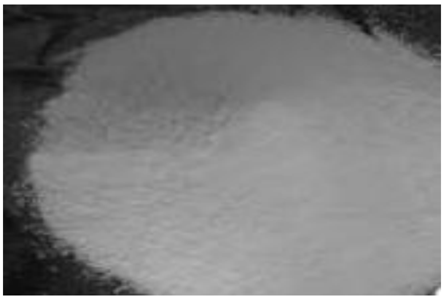

Figure 3:- STTP

1.5. STARCH

Oil Drilling Starch Starch is used for reducing fluid loss in a variety of water based drilling fluids and has beneficial secondary effects on mud rheology. In drilling wells, a liquid (mud) is pumped into the hole to clean and cool the drill bit and to flush to the surface the drill bit cuttings and suspending the drill cuttings while drilling is paused. The most important physical characteristics of the drilling fluid is the viscosity and the water holding/retaining characteristics.

Figure 4:- Starch

III. Oil And Water Retort Kit

The retort provides a means for separating and measuring the volumes of water, oil and solids contained in a sample of drilling fluid. A known volume of sample is heated to vaporize the liquid components which are then condensed and collected in a graduated cylinder. Liquid volumes are determined from reading the oil and water phases on the graduated cylinder. The total volume of solids, both suspended and dissolved, is obtained by noting the difference of the total sample volume versus the final liquid volume collected. Calculations are necessary to determine the volume of suspended solids since any dissolved solids will be retained in the retort. Relative volumes of low-gravity solids and weight materials may also be calculated.

Equipment details:-

Sample up: Either 10 ml, 20 ml or 50 ml
Capacity Condenser: Sufficient mass to cool the water and oil vapors below their vaporization temperature prior to leaving the condenser chamber. 20 ml and 50 ml condensers are fitted with the Ultra-Torr connection to prevent stripping of the condenser threads and retard evaporation. Keep the Ultra-Torr o-ring lubricated with a small amount of grease.
Heating Element: Sufficient wattage to raise the temperature of the sample to above its vaporization point within API Specifications, without causing the solids to boil over.
Thermostat: Capable of limiting the temperature of the Retort to 930°F ± 70° F (500 ± 20°C) OFITE retorts are calibrated to heat a sample between 930 and 1000 F per API specifications. Any manual adjustments made to the thermostat are a safety hazard and will void the factory warranty.
Liquid Receiver: Graduated cylinder or tube, transparent and inert to oil, water or salt solutions and temperatures of up to 90°F (32°C).
Fine Steel Wool: Steel Wool.
Grease: Never-Seez. Used for a thread seal and lubricant at high temperatures.
T-handle drill: Cleaning Retort Chamber/Condenser passage.
Pipe Cleaner: Cleaning Retort Chamber/Condenser passage.
Spatula: Shaped to fit the inside dimensions of the sample cup.

Figure 5:- Oil and water retort kit

3.1. VISCOSITY

To measure the viscosity we have two methods: 1^{st} is marsh funnel for higher quantity and 2^{nd} is viscosity cup for low quantity up to 100 ml in the work we have used viscosity cup method for 100 ml. Prepare the sample as required and pour the fluid in the cup by closing its hole which is present at the bottom of the cup with the finger. Remove the finger and start the stopwatch and note the time required to empty the cup.

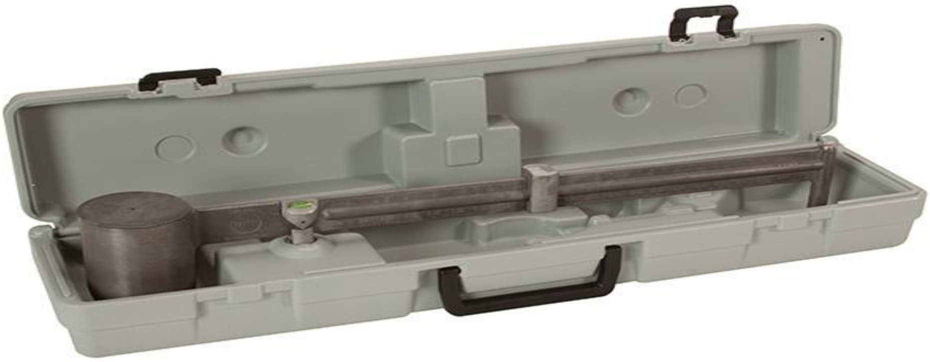

Figure 6:-Mud balance

3.2. pH

The pH can be measured by two ways one litmus paper and ph meter and pH meter is accurate in the both methods.

Figure 7: pH meter

II. PROCEDURE

a) Lift retort assembly, out of insulator block. Using the spatula as a screwdriver, remove the mud chamber from the retort.
b) Pack the upper chamber with very fine steel wool.
c) Fill mud chamber with mud and replace lid, allowing excess to escape. (This is a point where error is often introduced. Be sure that no air is trapped in the chamber. An accurate charge of mud is essential).
d) Wipe off excess mud and screw mud chamber into upper chamber.
e) Replace retort in insulator block and put insulation cover in place.
f) Add a drop of wetting agent to graduate and place under drain of condenser; then turn heater on.
g) Heat mud until oil stops coming over or until the pilot light goes out on thermostatically controlled units. For diesel oil this time will be about 15 minutes with the thermo stated retorts and about 20 minutes in the uncontrolled units at 110 volts. Low or high voltage will cause variations in time required. Crude oils may require longer heating periods.

III. OBSERVATION

samples	Water based mud (sample1)	Sample 2	Oil based mud (sample1)	Sample 2
Barite	300gm	300gm	150gm	150gm
Bentonite	46gm	46gm	46gm	46gm
Water	200ml	200ml	N/A	N/A
Oil	N/A	N/A	200ml	200ml
STTP(Sodium tri-polyphosphate)	8gm	N/A	8gm	N/A
Starch	N/A	8gm	N/A	8gm
Viscosity (time) in sec	60.8 cp	60.8 Cp	326.4 cp	327.1 cp
Water Content	19ml	20ml	5ml	4ml
Solid Content	25gm	23gm	36gm	38gm
Liquid Content	19ml	19.5ml	N/A	N/A
Oil Content	N/A	N/A	17ml	18ml
PH value	8.0 to 8.9	8.7	6.2	6.0 to 6.8
Specific gravity	1.95 & 123 lb/cu ft	1.88 & 114 lb/ cu ft	1.4 & 85 lb/cu ft	1.41 & 82 lb/ cu ft

Table 1: Readings of tests

IV. Result

The difference between two mud's are found water based mud's are having low viscosity and high density and the solid content on this mud decrease while adding in WBM but solid content is increasing in OBM adding starch. Water content is increased adding starch in WBM as in OBM the water content is decreased. Oil content is increased as adding starch in OBM.

V. Conclusion

Biodiesel based drilling fluids can be considered as environmental friendly drilling fluids which may not cause harmful threat to the marine organisms in the drilling area with respects to their level of toxicity and degradation rate. Therefore, the environmental effect regarding marine ecosystem could be reduced by substituting commercial used oil based drilling fluid with biodiesel based drilling fluids with certain limitations. It is a well-known fact that the performance of drilling fluid is influenced by its properties such as mud viscosity, density, pH, Oil, Water, and Solid content among others. In this study, soybean oil was used as a base fluid in oil-based mud (OBM) formulation.

1. The formulated soyabean OBM has a Bingham plastic rheological model with low yield point and gel strength, mud property desirable for turbulent flow at low pump pressure for effective hole cleaning.
2. The soybean OBM has relatively high density and can be increased with densifiers to desirable values during equivalent circulating density (ECD) predictions in order to obtain a successful drilling operation.
3. The water based mud's can be used in low fluid loss region where as oil based can be used in high fluid loss region
4. The water based mud's can be used in high formation pressure region where as oil based can be used in low formation pressure region.

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