

Determination of Oil, Water, Solid and Clay Content in Various Concentrations of Bentonite & Sodium Silicate

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ABSTRACT: 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) $\text{Na}_5\text{P}_3\text{O}_{10}$, sodium silicate and base as bentonite, barite, distilled water. The mud used in this work is barite and bentonites at different samples to know the difference in their specific gravity, viscosity, surface density, and PH of the samples when chemical additives are added in the mud. Also comparing these values with the oil based mud's which is prepared with biodiesel to reduce the impact of toxicity and make the environment friendly drilling fluids.

KEYWORDS : Biodiesel, Mud density, Viscosity, STTP, Sodium Silicate.

1. INTRODUCTION

The upstream of the petroleum industry has thrived on the few available oil based mud (OBM) especially diesel for a while now. In recent times, following the outcomes of the past researches carried out, synthetic oils are now considered more environmentally friendly than the conventional diesel or mineral oil based mud. It is established that mud is, in varying degrees toxic. It is also difficult and expensive to dispose of it in an environmentally friendly manner. It is imperative to propagate the use of environmentally friendly and biodegradable sources of oil to formulate our OBM, thereby making it less expensive and environmentally safe. It should equally carry out the basic functions of the drilling mud such as maintenance of hydrostatic pressure, removal of cuttings, cooling and lubricating the drill string and also to keep newly drilled borehole open until cementing is carried out. Also, Oil based mud are used for many other reasons, including increased lubricity, enhanced shale inhibition, and greater cleaning abilities with less viscosity. Oil-based mud must withstand greater heat without breaking down. The use of oil-based mud has special considerations.

These include cost, environmental considerations such as disposal of cuttings in an appropriate place to isolate possible environmental contamination. Based on these, the type of oil used must be taken into consideration when formulating OBM. Oil-based mud can be a mud where the base fluid is a petroleum product such as diesel fuel or other forms of oils. Stakeholders in the oil and gas industry have been tasked with the challenge of finding a solution to this problem by formulating optimum drilling fluids and also reduce the handling costs and negative environmental effects of the conventional diesel oil based drilling fluid. Oil based mud contain oil as the continuous phase and water dispersed in it. They typically contain less than 5% (by volume) of water. Oil-based mud are usually a mixture of diesel fuel and asphalt, however can be based on produced crude oil and mud They are considered to have the most deleterious effect on the local environment (especially diesel) and so their use has been gradually phased out in the

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North Sea during recent years . Alternative types of drilling fluids have been developed as a consequence of increasingly strong environmental protection legislation. These drilling fluids have been designed to have less negative impact on the environment, i.e. they are more easily degradable and less toxic than mineral oil-based drilling fluid. Numerous studies of the environment around oil-based cutting piles have indicated significant negative impacts on the bent hic fauna and flora . Too much toxin in the oil based drilling fluids in use today actually goes on to constitute a nuisance in the environment. Petro-diesel does not biodegrade easily, so toxins can persist for years in the environment and lead to an accumulated concentration over time with environmental impacts including: (i) decreased plant and animal growth (ii) disrupted reproductive cycles (iii) localized death of plants and animals (iv) disruption of migratory routes used by water birds and marine life . Hence, we need more environments friendly oil based mud than the ones currently available. The cost of the available oil based mud is high. This however, is because of the fact that diesel is the main oil used for the drilling fluids.

We need to generate or discover more affordable oil for use as a drilling mud in order to reduce the cost of production and exploration in a reservoir. With more dedication in this aspect, there should be more cost effective and environment friendly mud that would sufficiently replace diesel in the petroleum industry as the leading OBM. Within the last few years, the development of the biodiesel industry as an alternative energy source to meet the challenges of the future energy needs in Indonesia is growing rapidly. Along with the increased production of biodiesel, the glycerol production is also increasing. Glycerol is by-product of transesterification process of vegetable oil to produce biodiesel. The average amount of crude glycerol produced from biodiesel production process is about 10% . Drilling fluid is one of the solution in glycerol application. A preliminary study has shown the physio-characteristic of glycerol with satisfying result. According to this background, a study of glycerol application in drilling fluid was conducted with an objective to develop glycerol to be applied in drilling industries.

1.1 Drilling Fluid:

Drilling Fluids (muds) are complex heterogeneous fluids, consisting of several additives that were employed in drilling of oil and natural gas wells.

In addition, drilling fluids are also now required to perform following functions:

- Clean the rock formation beneath the bit for rock cuttings.
- Cool and clean the bit.
- Manage formation pressure to maintain well-bore stability until the section of borehole has been cased.
- Minimize reservoir damage.
- Have minimum negative impact to the environment.

In order to ensure proper functionality of drilling fluid appropriate drilling fluid is selected.

Barite heavyweight additive is a barium sulfate material used to weight drilling muds and cement slurries. Barite additive is effective at bottom hole temperatures (BHTs) between 80°F and 500°F (27°C and 260°C).

1.2 Water-Based Mud (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.

1.3 Oil-Based Mud (OBM):

Oil-based mud's use crude or refined oils as the continuous phase and water as emulsified phase. Common types of OBM are oil mud which has less than 5% water and invert emulsion mud which has water concentration greater than 5%.

1.4 Viscosity:

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress .For liquids, it corresponds to the informal concept of "thickness"; for example, honey has a much higher viscosity than water.

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Viscosity is a property of the fluid which opposes the relative motion between the two surfaces of the fluid in a fluid that are moving at different velocities. When the fluid is forced through a tube, the particles which compose the fluid generally move more quickly near the tube's axis and more slowly near its walls; therefore some stress is needed to overcome the friction between particle layers to keep the fluid moving. For a given velocity pattern, the stress required is proportional to the fluid's viscosity. A fluid that has no resistance to shear stress is known as an ideal or inviscid fluid. Zero viscosity is observed only at very in super fluids. Otherwise, all fluids have positive viscosity, and are technically said to be viscous or viscid. In common parlance, however, a liquid is said to be viscous if its viscosity is substantially greater than that of water, and may be described as mobile if the viscosity is noticeably less than water. A fluid with a relatively high viscosity, such as pitch, may appear to be a solid.

1.5 pH:

PH is a numeric scale used to specify the acidity or basicity of an aqueous solution. It is approximately the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions. More precisely it is the negative of the logarithm to base 10 of the activity of the hydrogen ion.

Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7, being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively.

1.6 Density:

The density, or more precisely, the volumetric mass density, of a substance is its mass per unit volume. The symbol most often used for density is ρ . Mathematically, density is defined as mass divided by volume. Where ρ is the density, m is the mass, and V is the volume. In some cases (for instance, in the United States oil and gas industry), density is loosely defined as its weight per unit volume, although this is scientifically inaccurate – this quantity is more specifically called specific weight. For a pure substance the density has the same numerical value as its mass concentration. Different materials usually have different densities, and density may be relevant to buoyancy, purity and packaging. Osmium and iridium are the densest known elements at standard conditions for temperature and pressure but certain chemical compounds may be denser. To simplify comparisons of density across different systems of units, it is sometimes replaced by the dimensionless quantity "relative density" or "specific gravity", i.e. the ratio of the density of the material to that of a standard material, usually water. Thus a relative density less than one means that the substance floats in water. The density of a material varies with temperature and pressure. This variation is typically small for solids and liquids but much greater for gases. Increasing the pressure on an object decreases the volume of the object and thus increases its density. Increasing the temperature of a substance (with a few exceptions) decreases its density by increasing its volume. In most materials, heating the bottom of a fluid results in convection of the heat from the bottom to the top, due to the decrease in the density of the heated fluid. This causes it to rise relative to more dense unheated material. The reciprocal of the density of a substance is occasionally called its specific volume, a term sometimes used in thermodynamics. Density is an intensive property in that increasing the amount of a substance does not increase its density; rather it increases its mass.

1.7 STTP (Sodium tri-polyphosphate):

Sodium triphosphate (STP), also sodium tripolyphosphate (STPP), or tripolyphosphate (TPP) [1] is an inorganic compound with formula $\text{Na}_5\text{P}_3\text{O}_{10}$. 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. Environmental problems associated with eutrophication are attributed to its widespread use.

The majority of STPP is consumed as a component of commercial detergents. It serves as a "builder," industrial jargon for a water softener.

Sodium tripolyphosphate is produced by heating a stoichiometric mixture of disodium phosphate, Na_2HPO_4 , and monosodium phosphate, NaH_2PO_4 , under carefully controlled conditions. STPP is a preservative for seafood, meats, poultry, and animal feeds [5]. It is common in food production as E number E451. In foods, STPP is used as

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an emulsifier and to retain moisture. Many governments regulate the quantities allowed in foods, as it can substantially increase the sale weight of seafood in particular



Fig.1 STTP (Sodium tri-polyphosphate)

1.8 Sodium Silicate:

Sodium silicate is the common name for compounds with the formula $(\text{Na}_2\text{SiO}_2)_n\text{O}$. A well-known member of this series is sodium metasilicate, Na_2SiO_3 . Also known as waterglass or liquid glass, these materials are available in aqueous solution and in solid form. The pure compositions are colourless or white, but commercial samples are often greenish or blue owing to the presence of iron-containing impurities. They are used in cements, passive fire protection, textile and lumber processing, refractories, and automobiles. Sodium carbonate and silicon dioxide react when molten to form sodium silicate and carbon dioxide. Sodium silicate is a white powder that is readily soluble in water, producing an alkaline solution. It is one of a number of related compounds which include sodium orthosilicate (Na_4SiO_4), sodium pyrosilicate ($\text{Na}_6\text{Si}_2\text{O}_7$), and others.

All are glassy, colourless, and soluble in water. Sodium silicate is stable in neutral and alkaline solutions. In acidic solutions, the silicate ion reacts with hydrogen ions to form silicic acid, which when heated and roasted forms silica gel, a hard, glassy substance. Sodium silicate is frequently used in drilling fluids to stabilize borehole wells and to avoid the collapse of bore walls.

It is particularly useful when drill holes pass through argillaceous formations containing swelling clay minerals such as montmorillonite.



Fig.2 Sodium Silicate

II. SAMPLE

2.1 Water based mud (WBM) :

To prepare sample of water based mud(WBM) Take 300gms of Barite ,46gms of Bentonite,8 gms of STTP and 200ml of distilled water initially and mix it for 5 min so that no solids are present in the fluid. Prepare another sample of 300gm barite, 46gm of bentonite, 8 gms of sodium silicate and 200ml of distilled water initially and mix it.

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Fig. 3 Water based mud

2.2 Oil based mud (OBM) :

To prepare sample of oil based mud(OBM) Take 150gm of Barite , 46gm of bentonite,8 gms of STTP and 200ml of biodiesel initially and mix it for 8 min so that no solids are present in the fluid. Prepare another sample of 150gm of Barite, 46gm of bentonite,8 gms of Sodium silicate and 200ml of biodiesel initially and mix.



Fig. 4 Biodiesel oil based mud

III. EXPERIMENTAL PROCEDURE

3.1 Oil & Water Retort Kit :

The Retort provides a method for measuring the percentage (%) of oil, water, and solids (suspended and dissolved) contained in a sample of water-based or oil-based drilling fluids and cuttings. Knowledge of oil, water, and solid content is fundamental to proper control of mud properties when considering oil/water ratios, rheology, density, filtration, and salinity. Knowledge of solids in drilling fluids is essential to evaluation of viscosity control and solids control equipment. A retort, sometimes called a still, is used to determine the quantity of liquids and solids in a drilling fluid. In a retort test, a measured sample of fluid is placed in a cup and heated until the liquid components have been vaporized. The vapours are passed through a condenser and collected in a graduated cylinder or centrifuge tube that has been calibrated to record the volume of the condensed liquids at 20°C.

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Fig. 5 Retort Kit



Fig. 6 Retort Kit (Water based mud)



Fig. 7 Retort Kit (Oil based mud)

3.2 Viscosity:

To measure the viscosity we have two methods 1 is marsh funnel for higher quantity and method 2 viscosity cup for low quantity up to 100ml in the work we have used viscosity cup method for 100ml. 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 .now remove the finger and start the stopwatch and note the time required to empty the cup

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Fig. 8 Viscosity cup

3.3 pH:

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



Fig. 9 pH meter

3.4 Density:

To find density of any fluid mud balance can be used keep the scale on the fulcrum with the help of knife edge now fill the cup with fluid and place the lid on it so that extra fluid flow out of the cup move the rider according water bubble so the it comes in center now note the readings of the rider

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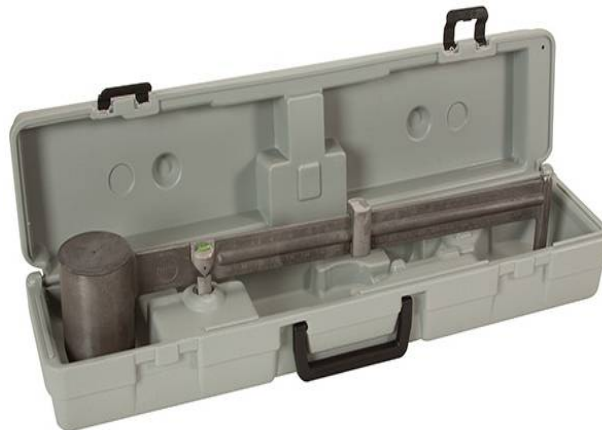


Fig. 10Mud Balance

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
Sodium Silicate	N/A	8gm	N/A	8gm
Viscosity (time) in sec	58.8 cp	59.8 Cp	323.4 cp	326.1 cp
Water Content	18ml	20ml	5ml	4ml
Solid Content	24gm	22gm	35gm	37gm
Liquid Content	18ml	18ml	N/A	N/A
Oil Content	N/A	N/A	15ml	16ml
PH value	8.0 to 8.5	8.5	6.0	6.0 to 6.5
Specific gravity	1.90 & 122 lb/cu ft	1.85 & 112 lb/cu ft	1.35 & 85 lb/cu ft	1.30 & 80 lb/cu ft

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 sodium silicate in WBM but solid content is increasing in OBM adding sodium silicate. Water content is increased adding sodium silicate in WBM as in OBM the water content is decreased. Oil content is increased as adding sodium silicate in OBM.

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Sodium tri polyphosphate is used to increase viscosity and sodium silicate used to increase PH value and hardness control agent WBM density is high when compared to oil based mud's since the density of oil is less when compares to water.

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, Solid content among others. In this study, soybean oil was used as a base fluid in oil-based mud (OBM) formulation.

- (i) The formulated soybean 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.
- (ii) 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.
- (iii) The water based mud can be used in low fluid loss region where as oil based can be used in high fluid loss region.
- (iv) The water based mud can be used in high formation pressure region where as oil based can be used in low formation pressure region.

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