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Determination of Mud and Rheology of Biodiesel Using Xantan Gum and PAM

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Abstract :- The idea behind the current work is to determining the mud and biodiesel rheology (surface tension, viscosity) by using Xanthan Gum and PAM (polyacrylamide) ($-CH_2CHCONH_2-$).The mud used in this work is barite and bentonites at different samples to know the difference in their specific gravity, viscosity, surface tension, and PH of the samples when chemical additives are added. And comparing this value 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:- Bio diesel, mud rheology, viscosity, surface tension, xanthan Gum, PAM

I. 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 is 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 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 environment 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%. Lower prices and increased production quantities will cause glycerol be not worth selling, giving rise to environmental problems caused by glycerol waste. This can be overcome by processing glycerol into more useful products as an alternative solution to increase its commercial value. 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. Drilling Fluid

Drilling fluid or drilling mud is a component which was initially used to circulate cuttings from the borehole to the surface. Other functions of drilling fluid are maintain wellbore stability, prevent formation fluids flowing into the wellbore, and control formation pressure [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% [2].

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. 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.

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 7.0 are acidic and solutions with a pH greater than 7.0 are basic. Pure water is neutral, at pH7.0, being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14.0 for very strong acids and bases respectively

6. Surface tension

Surface tension is the elastic tendency of a fluid surface which makes it acquire the least surface area possible. Surface tension allows insects (e.g. water striders), usually denser than water, to float and stride on a water surface. At liquid-air interfaces, surface tension results from the greater attraction of liquid molecules to each other than to the molecules in the air. The net effect is an inward force at its surface that causes the liquid to behave as if its surface were covered with a stretched elastic membrane. Thus, the surface becomes

under tension from the imbalanced forces, which is probably where the term "surface tension" came from. Because of the relatively high attraction of water molecules for each other through a web of hydrogen bonds, water has a higher surface tension compared to that of most other liquids. Surface tension is an important factor in the phenomenon of capillarity. Surface tension has the dimension of force per unit length or of energy per unit area. The two are equivalent, but when referring to energy per unit of area, it is common to use the term surface energy, which is a more general term in the sense that it applies also to solids In materials science, surface tension is used for either surface stress or surface free energy.

7. 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, 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, density is loosely defined as its weight per unit volume, although this is scientifically inaccurate-this quantity is more specifically called 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 be denser.

8. Xanthan Gum

Xanthan gum is a polysaccharide secreted by the bacterium Xanthomonas campestris,used as a food additive and rheology modifier commonly used as a food thickening agent and a stabilizer (in cosmetic products, for example, to prevent ingredients from separating). It is composed of pentasaccharide repeat units, comprising glucose, mannose, and glucuronic acid in the molar ratio 2:2:1. It is produced by the fermentation of glucose, sucrose or fructose. After fermentation period, the polysaccharide is precipitated from a growth medium with isopropyl alcohol, dried, and ground into a fine powder. Later, it is added to a liquid medium to form the gum.

Fig. 1 Xanthan Gum

9. PAM (polyacrylamide)

PAM is a polymer ($-CH_2CHCONH_2-$) formed from acryl amide subunits. It can be synthesized as a simple linear-chain structure or cross-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.

Fig. 2 PAM (polyacrylamide)

II. Sample

1. Water based mud (WBM)

To prepare sample of water based mud (WBM) Take 100gm of Barite, 30gm of Bentonite and 100ml of distilled water initially and mix it for 5 min so that no solids are present in the fluid. Increase the quantity of bentonite by 60 and 100 respectively Prepare another sample of 100gm barite , 30gm of bentonite ,100ml of distilled water add 10gm of PAM in one sample and 1gm of Xanthan Gum in another and both (Xanthan Gum , PAM) in one sample

Fig. 3 water based mud

2. Oil based mud (OBM)

To prepare sample of oil based mud (OBM) Take 10gm of Barite, 5gm of bentonite and 150 ml of biodiesel initially and mix it for 8 min so that no solids are present in the fluid. Prepare another sample of 10 gm barite, 5gm of bentonite, 150ml of biodiesel add 5gm of PAM in one sample and 0.3gm of Xanthan Gum in another and both (Xanthan Gum, PAM) in one sample

Fig. 4 Biodiesel oil based mud

III. EXPERIMENTAL PROCEDURES

1. Surface tension

Surface tension is measured in tensiometer with the help of platinum ring of 1cm diameter attach the ring to the hook available and place the sample below the ring so that the ring touches the upper surface of the sample as shown in Fig. 5 below and slowly increase the pressure of the hook so that the ring pulls up wards and tension creates apply the pressure on the ring until the ring gets separate from the above surface of the sample and note the readings

Fig. 5 Tensiometer

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

Fig.6 Viscosity cup

3. pH

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

Fig. 7 pH meter

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.

Fig. 8 The Mud balance

Table.1 Observations

Samples	Water based mud (sample1)	Sample 2	Sample 3	Sample 4	Sample 5	Oil based mud (sample1)	Sample 2	Sample 3	Sample 4	Sample 5
Barite	**100gm**	**100gm**	**100gm**	**100gm**	**100gm**	**N/A**	**10gm**	**10gm**	**10gm**	**10gm**
Bentonite	**30gm**	**60gm**	**100gm**	**30gm**	**30gm**	**N/A**	**5gm**	**5gm**	**5gm**	**5gm**
Water	**100ml**	**100ml**	**150ml**	**100ml**	**250ml**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Oil	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**100ml**	**150ml**	**150ml**	**150ml**	**150ml**
Xanthan Gum	**N/A**	**N/A**	**N/A**	**N/A**	**0.3gm**	**N/A**	**N/A**	**0.3gm**	**N/A**	**0.3gm**
PAM	**N/A**	**N/A**	**N/A**	**10gm**	**10gm**	**N/A**	**N/A**	**N/A**	**5gm**	**5gm**
Viscosity (time) in sec	**27.392 cp**	**21.998 cp**	**5.55 cp**	**10.076 cp**	**194.7 cp**	**369.6 cp**	**323.4 cp**	**277.4 cp**	**231.4 cp**	**323.4 cp**
Surface tension(dynes /cm)	**67 dynes/ cm**	**65 dynes/ cm**	**90 dynes/ cm**	**69 dynes/ cm**	**80 dynes/ cm**	**41.3 dynes / cm**	**35 dynes/ cm**	**42 Dynes/ Cm**	**44 Dynes/ Cm**	**45 dynes/ cm**
PH value	**7.0 to 7.4**	**7**	**7**	**7.5**	**9 to 10**	**5.5 to 6**	**6 to 6.5**	**6**	**5.5**	**5.5to6**
Specific gravity	**1.60 & 100 lb/cu ft**	**1.68 & 107 lb/ cu ft**	**1.57 & 98lb/ cu ft**	**1.54 & 96 lb/ cu ft**	**1.20 & 82 lb/ cu ft**	**N/A**	**0.89 & 56 lb/ cu ft**	**0.91& 58 lb/ cu ft**	**0.93 & 58 lb/ cuft**	**0.90 & 56 lb/cu ft**
Density	**1.6g/cm^3**	**1.7g/ cm^3**	**1.568g/ cm^3**	**1.536g/ cm^3**	**1.312g/ cm^3**	**0.688g/ cm^3**	**0.896g/ cm^3**	**0.912g/ cm^3**	**0.938g/ cm^3**	**0.896 g/cm^3**

V. RESULT

The difference between two mud's are found water based mud's are having low viscosity and high density and the surface tension on this mud increases while we keep on adding Xanthan Gum and PAM ,since Xanthan Gum is used to increase the viscosity of fluid where as is also used PAM to increase the viscosity if fluid Oil based mud's are having high viscosity where as decrease when Xanthan Gum is added in WBM the density is high when compared to oil based mud's since the density of oil is less when compares to water.

VI. 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 during drilling operation is influenced by its properties such as mud viscosity, density, pH, and filtration loss, 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's 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's can be used in high formation pressure region.

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