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Evaluating the Rheological Properties of a Synthentic Based Mud Formulated from Avocado Pear Oil

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Abstract

With the oil and gas sector increasingly focusing on deep offshore drilling in challenging conditions, there is a requirement to create drilling fluids that can perform exceptionally well in such environments. It is crucial to take into account the proper disposal of drilling fluid waste in compliance with environmental regulations. Synthetic-based muds have been suggested as a viable substitute for oil-based muds. Also, the majority of studies on synthetic-based muds have concentrated on base oils that are not indigenous to the area. This study investigates the characteristics of a synthetic-based mud derived from avocado pear oil, which is a readily available and abundant resource, and determines its appropriateness for utilisation in offshore drilling activities. Avocado pear oil was obtained, subjected to transesterification, and utilised in the creation of synthetic-based muds with oil-to-water ratios of 70:30, 75:25, and 80:20, respectively. After 24 hours, it was discovered that the electrical stability remained above 400 at temperatures of 1500 °F. The sample with an oil-water ratio of 80:20 exhibited the maximum plastic viscosity at 1500 °F after 24 hours, indicating superior rheological performance at high temperatures compared to the other samples. The sample with an oil-water ratio of 80:20 exhibited the most minimal mud filter cake in comparison to all other samples, making it the optimal choice for preventing formation damage. The pH level exceeded 8, indicating its suitability for drilling operations.

Introduction

Drilling mud is a vital component in the drilling of oil and gas wells. It serves several functions, such as maintaining wellbore stability, lubricating the drill bit, and carrying cuttings to the surface. The properties of drilling mud are crucial to the success of any drilling operation. The drilling mud must have specific physical properties to ensure the efficient performance of its functions. Consequently, there is a constant demand for high-performance drilling muds that can function effectively in challenging drilling environments. One of the critical components of drilling mud is the base fluid. Historically, mineral oil has been the most commonly used base fluid. However, environmental concerns and regulatory restrictions have led to a shift towards synthetic-based muds (SBMs) in recent years. SBMs are environmentally friendly and have demonstrated superior performance in many drilling operations. In this study, we aim to evaluate the properties of a SBM formulated from avocado pear oil as a potential base fluid. Avocado pear oil is natural oil extracted from the pulp of the avocado pear fruit. It is rich in monounsaturated fatty acids, such as oleic acid, and contains essential vitamins, minerals, and antioxidants. It has several health benefits, such as reducing the risk of heart disease, improving eye health, and aiding weight loss.

The use of avocado pear oil as a base fluid in drilling mud has been reported in some studies. However, the properties of drilling mud formulated from avocado pear oil have not been extensively investigated. This study seeks to address this gap in the literature by evaluating the rheological and physical properties of drilling mud formulated from avocado pear oil. The rheological properties of drilling mud are essential to its performance. It affects the carrying capacity, hole-cleaning efficiency, and suspension capacity of the mud. Therefore, it is necessary to evaluate the rheological properties of the drilling mud formulated from avocado pear oil to determine its suitability as a base fluid. Physical properties such as density, viscosity, and thermal stability are also crucial to the performance of drilling mud. Density affects the pressure exerted by the mud on the formation, while viscosity affects its ability to carry cuttings to the surface. Thermal stability is crucial to prevent the breakdown of the mud under high-temperature conditions. This study aims to evaluate the rheological and physical properties of a SBM formulated from avocado pear oil. The results of this study will provide valuable information on the suitability of avocado pear oil as a base fluid in drilling mud. It will also contribute to the body of knowledge on the use of natural oils as base fluids in drilling mud.

Statement of Problem

As the oil and gas industry moves towards deep offshore drilling in harsh conditions, there is a need to develop drilling fluids that can excel in these environments. Additionally, it is important to consider the safe disposal of drilling fluid wastes in accordance with environmental policies. Synthetic-based muds have been proposed as a promising alternative to oil-based muds. However, most research on synthetic-based muds has focused on base oils that are not native to the region. This study aims to evaluate the properties of a synthetic-based mud formulated from avocado pear oil, a locally available and abundant resource, and assess its suitability for use in offshore drilling operations.

Aim & Objectives

The objectives of this study on evaluating the properties of a synthetic-based mud formulated from avocado pear oil are:

1. To determine the rheological properties of the mud, including viscosity, yield point, and gel strength, and evaluate their impact on hole cleaning and cutting transport.
2. To assess the filtration properties of the mud, including fluid loss and filter cake thickness, and evaluate their effect on wellbore stability and formation damage.
3. To investigate the lubricity and shale inhibition properties of the mud and assess their impact on drilling efficiency and wellbore stability.
4. To evaluate the environmental properties of the mud, including toxicity and biodegradability, and assess its suitability for disposal in accordance with government regulations.
5. To compare the performance of the synthetic-based mud formulated from avocado pear oil with that of other conventional used mud systems, TY oil-based muds, in terms of, efficiency, and environmental impact.

Literature Review

Definition Of Terms

Mud rheology is represented by Plastic Viscosity PV, Yield Point, YP, Apparent Viscosity, AV. For Newtonian fluid, the viscosity is independent of shear rate while shear rate is a function for non-Newtonian fluid.

1. **Plastic Viscosity (PV)**: Plastic viscosity measures the resistance to flow in drilling mud due to inter-particle friction. It's determined by subtracting the 300rpm reading from the 600rpm reading on a rheometer. Unit: centipoise (cp).
2. **Yield Point (YP)**: Yield point assesses the mud's ability to transport cuttings from the annulus to the surface, based on electrochemical forces between particles. It's calculated by subtracting the plastic viscosity from the 300rpm reading. Unit: pounds per 100 square feet (lb/100ft^2).
3. **Electric Stability (ES)**: Electric stability evaluates the emulsion stability and oil-wetting capability of oil-based drilling fluid muds. It's determined by applying a voltage ramped sinusoidal electrical signal across flat-plate electrodes immersed in the mud. A threshold voltage (>400 volts) indicates sufficient stability.
4. **Gel Strength**: Gel strength measures the resistance of drilling mud to flow, observed by slowly turning a viscometer's driving wheel until the gel breaks. Gel strength can be assessed after various time intervals, typically 10 seconds (initial gel strength) and 10 minutes.
5. **Apparent Viscosity**: Apparent viscosity describes the relationship between plastic viscosity and yield point, unaffected by changes in either property. It reflects the overall resistance to flow exhibited by the drilling mud.

Related Works

Different researchers have conducted different studies to evaluate the effectiveness of oil-based muds formulated from various types of Vegetable oils. These research works were focused on technical performance, Economic and Environmental comparisons of these formulated oil-based muds with the industry standard, Diesel oil and the commercial synthetic based muds. Yassin *et al.* 1991 formulated an environmentally safe oil-based drilling fluid. The use of palm oil derivative which is harmless to the environment was considered as an alternative based fluid. Tests revealed that palm oil derivative methyl ester of crude palm oil CPO and methyl ester of distilled Palm Fatty Acid is a suitable alternative to formulate oil-based drilling mud with the necessary rheological properties, compatible with existing mud additives and non-toxic to the marine life. Mckee *et al.* 1995 carried out study on a new synthetic based drilling fluid which will be able to emulate the oil-based mud performance while complying with environmental legislation. Comparisons with oil-based mud in the Laboratory showed that the system can provide similar performance at low water ratio, high mud weight, and high temperature and in the presence of contaminates. Field data also demonstrated that the system gave good penetration with minimum mud maintenance and low retention of the synthetic base fluid on cuttings discharged to the sea. Dosunmu et. al, (2010) developed an environmentally friendly oil-based mud using Palm oil and Groundnut oil with standard additives. They exhibited high viscosity and progressive gel characteristics. When the humus beds planted with corn were exposed to diesel, palm oil and groundnut oil, the corn exposed to diesel lost its greenness and died while that exposed to palm oil and groundnut retain its greenness, exhibiting a 20% and 12% average growth rate without losing all its greenness. Palm oil-based mud demonstrated strong progressive gel characteristics before hot rolling. Fadairo *et al.* 2012 harnessed oil developed from Jatropha and Canola seeds as the base fluid for drilling mud samples. The mud samples formulated alongside Diesel mud sample was tested for toxicity, filtration, pH, viscosity and density to ascertain their suitability properties for drilling operation and their degree of safety to the environment. From experiments carried out, Jatropha not only had the lowest viscosity but also proved to be safer and best fit for plant life and soil microorganisms as against Diesel which happened to be the most toxic among the three samples. It was postulated that Jatropha oil-based mud could potentially replace conventional diesel oil-based mud. Soomro *et al.*, (2020) studied the effect of synthesized bio-diesel on the rheological properties of Canola oil biodiesel based mud drilling mud and compared with the conventional diesel oil based mud properties. The biodiesel has slightly more favorable properties for using as a base fuel in drilling fluid, its rheological properties showed that drilling fluid having bio-diesel as base fuel have more optimistic and favorable properties for drilling in shale formations as it performed far well than diesel based mud up to a temperature of 100°C. Fadairo *et al.* (2021), studied the suitability of non-edible neem seed oil as the continuous phase for formulation of eco-friendly invert emulsion oil based drilling fluid as an alternative to conventional diesel-based drilling mud. The preliminary results show that neem oil biodiesel is a potential alternative to conventional organic oil in formulating oil-based drilling mud in terms of technical and environmental analysis. The rheological and lubricity tests results indicate that the neem oil biodiesel-based drilling muds are comparable with conventional diesel-based drilling muds. The shear stress/rate relationship for the conventional diesel-based drilling mud exhibits Bingham plastic model with a constant slope, the temperature effects on the two muds indicates the stability of the two formulated muds exhibit reduction in the shear stress/rate relationship as the temperature is raised.

Methodology

Avocado Pear Oil Ester Extraction Procedure

The avocado pear oil used in this study was extracted from the fleshy part of matured avocado pears using the cold-pressed method. The avocado pears were sourced from a local market in Delta state Nigeria and were sorted to ensure that only mature and good quality ones were selected for oil extraction. The flesh of the avocado pear was separated from the seed, washed with distilled water, and dried to remove excess moisture.

The dried flesh was then blended using a high-speed blender for about 5 minutes until a smooth consistency was obtained. The blended avocado was placed in a hydraulic press, and pressure was applied to the mixture to extract the oil. The extracted oil was then collected and allowed to settle for 24 hours to remove any sediments and impurities.

Table 1—Name of esters produced.

S/N	Oil sample	Alcohol	Name of Ester
1	Avocado pear oil (APO)	Methanol	Avocado pear oil methyl ester (APOME)

Table 2—Materials and equipment required.

Materials	Equipment
1. Avocado pear oil (APO)	1. Graduated Beaker
2. Methanol	2. Measuring cylinder
3. NaOH Pellets	3. Compact cloud and pour point cryostat
4. Water	4. Thermostatic hot plate
5. Butane gas	5. Magnetic bar and stirrer
	6. Digital weighing balance.
	7. Ostwald viscometer
	8. Thermometer
	9. Density bottle

Experimental Procedures

The transesterification reaction was run on a batch mode. Four processes are involved in the production of ester derivatives of methyl ester of Avocado pear oil methyl ester (APOME). They are

1. Preparation of sodium alkoxides
2. Transesterification
3. Phase separation
4. Water washing (Purification).

Preparation Of Sodium Alkoxides

A solution of sodium methoxide (CH_3ONa) was prepared by adding NaOH pellet into a beaker containing the Methanol. The mixture was stirred continuously using a magnetic stirrer until the pellets dissolve completely to form sodium methoxide. It was heated to 50°C and held constant at this temperature.

Transesterification

This procedure calls for combining the oil with an alkanol; in this instance, methanol served as the alkanol. The mixture was then heated to 80°C while being stirred with a magnetic stirrer The broad name used to describe the significant class of chemical reactions in which one ester is changed into another by the exchange of the alkoxy group is transesterification. Alcoholysis is the transesterification process that occurs when the initial ester reacts with an alcohol.

Figure 1—Transesterification reaction process of APO

Phase Separation

At the end of 45minutes, the reaction reached completion separation and phase separation was achieved by immersing the reaction beaker in cold water bath. Also, water was added into the system at 15% by volume of the oil used in the reaction and the entire systems were re-stirred for 5minutes to prevent further reaction due to unreacted catalyst and alcohol. The mixture was allowed to settle for 4 hours toseparateintotwolayersasshowninFigure3.3. The lower layer being the glycerol and the upper layer is ester.

Figure 2—Phase Separation of APO ester and its Glycerol

Water Washing

This is purification of the produced ester by washing with water at 30% of the ester volume to remove the excess catalyst, glycerol and impurities that can promote further reaction as shown in Figure 3. The water gently swirled into the ester for 10minutes and allowed to settle for 6 hours. The crystal-clear upper layer ester derivatives of APO were decanted and safely stored in a glass.

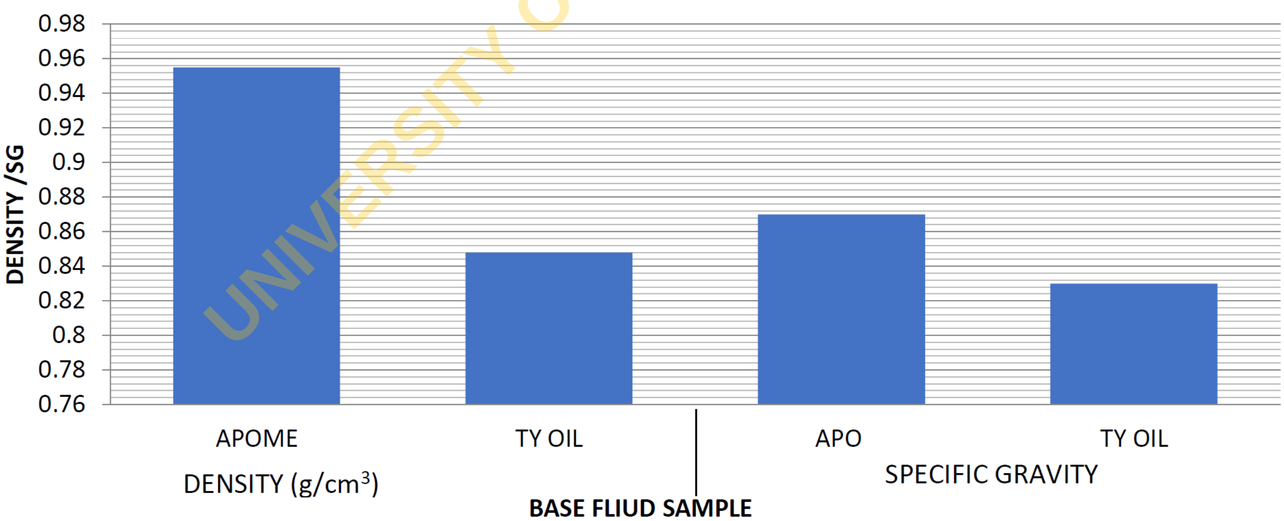

Figure 3—Base Fluids Specific Gravity

Characterisation Of The Ester And The Control Sample

The methyl ester derivatives of APO produced are named as shown in Table 3. The sample were characterized for their density (specific gravity), Kinematic and dynamic viscosity, cloud point, Pour point and flash point. The list and specification of equipment used for all tests are presented in the appendix.

Table 3—Composition and procedure for the formulation of Avocado pear oil synthetic based mud at 10ppg

Mixing Order	Additives	Unit	OWR			Mixing Duration (min)
			A= 70:30	B = 75:25	C = 80:20	
1	Base oil	ml	205	220	236	-
2	Org. Clay	g	1	1	1	10
3	Lime	g	0.5	0.5	0.5	10
4	1^0 Emulsifier	G	10	10	10	15
5	2^0 Emulsifier	G	6	6	6	15
6	Brine		109mL H_2O + 8.7g $CaCl_2$	93mL H_2O + 8.7g $CaCl_2$	77.2mL H_2O + 34.7g $CaCl_2$	30
7	Fluid Loss	G	5	5	5	10
8	Barite	G	-	-	-	20

Formulation Of Muds

The muds were formulated following the concept of maintaining equal component proportions, except for the primary emulsifier and barite, in each base fluid sample. This strategy was chosen with the underlying goal of maintaining the same oil-water ratio and liquid phase product concentrations in all part of the circulating system. The low quantity of barite in the A was due to high specific gravity of their base fluids while quantity of primary emulsifier varies in each mud sample due to poor emulsion experienced in some of the mud samples. The basic components used to prepare the mud are shown in Table 3.

Procedure

With the aid of a Multi mixer, the quantity of components listed in Table 3, was mixed sequentially. The entire systems were stirred long enough to obtain a homogenous mixture and the steps were repeated for other oil–water ratio samples. The six mud samples were aged at room temperature for 24 hours.

Mud Tests

The mud samples shown in Figure 3 were tested for their rheological properties, thixotropic, volumetric properties, emulsion stability, oil/water/solids content and HPHT filtration properties.

Result And Discussion

The results of the compositional analysis of the SBF, SBF's characterization and the mud tests are shown below. In this research work, three muds samples of various oil water ratios were formulated from avocado pear methyl esters and three mud samples were also formulated from TY oils. They are labelled A, B, C, D E and F in order to make the presentation of results organized. That is;

Avocado pear methyl esters Mud, 70:30 = A
Avocado pear methyl esters Mud, 75:25 = B
Avocado pear methyl esters Mud, 80:20 = C
TY oils, oil base mud, 70:30 = D
TY oils, oil base mud 75:25 = E
TY oils, oil base mud 80:20 = F

Base Fluid Characterization

The base fluids (ester and TY oils) are characterized in terms of their specific gravity, viscosity, pour point, cloud point, and flash point. The use of these fluids for mud formulation depends heavily on these characteristics. Tables and figures below display the results. The results show that the methyl ester can provide better fire safety, transportation, and storage than TY oils because it has a significantly higher flash point than TY oils.

Density And Specific Gravity

Due to the ester's fatty acid, free, and bound glycerin contents, the density of the avocado-pear methyl ester is higher than that of TY oils. Avocado pear methyl ester's specific gravity value compares favorably to TY oils. The properties of the two oil samples are comparable and meet API specifications, as shown in Table 3 and Figure 3

MUD pH

The cation-exchange capacity present in the Avocado pear methyl ester SBM is suitable for drilling processes. The pH of the base fluid compares favorably with TY oils. The result is shown in Table 4 and figure 4.

Table 4—Base Fluid Specific Gravity

TEMP °C	DENSITY (g/cm3)		SPECIFIC GRAVITY	
300C	APOME	TY OIL	APO	TY OIL
	0.955	0.848	0.870	0.830

Table 5—Mud Samples pH

MUD SAMPLES	A	B	C	D	E	F
MUD pH	8.64	8.76	8.86	6.8	6.85	6.89

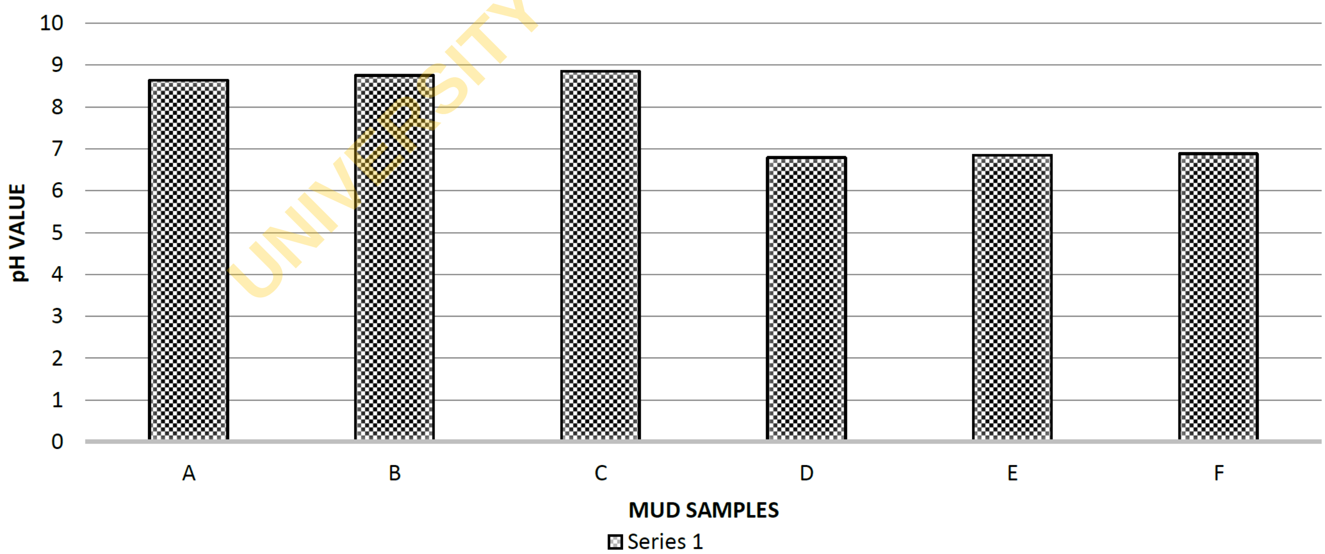

Figure 4—A plot of mud samples pH

Table 6—Avocado pear methyl ester oil IR spectra interpretation.

FUNCTIONAL GROUP	CONJUGATION PRESENT OR ABSENT	BAND WIDTH RANGE (CM-1)	STRENGTH OF BAND	BAND WITH OBSERVED (CM-1)	FUNCTIONAL GROUP CONFIRMED
C=O Stretch (Ester group)	Absent	1765-1735	Strong	1744.5 Strong	C=O Stretch confirmed

FUNCTIONAL GROUP	CONJUGATION PRESENT OR ABSENT	BAND WIDTH RANGE (CM-1)	STRENGTH OF BAND	BAND WITH OBSERVED (CM-1)	FUNCTIONAL GROUP CONFIRMED
=C-H Stretch (Alkene)	Absent	3100-3000	Medium to Weak	3004.5 Weak	=C-H Stretch Confirmed
C=C Stretch (Alkene)	Absent	1680-1620	Weak to Medium	1654.5 Weak	C=C Stretch Confirmed
=C-H bend Alkane	Absent	995-685	Strong	725.75 Strong	=C-H Stretch Confirmed
C-H Stretch (Alkane)	Absent	2990-2850	Medium to Strong	2926.8, 2863.3 Medium	C-H Stretch Confirmed

Table 7—Base fluid viscosities

Temp °C	Base fluid viscosities			
	Kinematic (cst)		Dynamic (cp)	
30°C	APO	TY OIL	APO	TY OIL
	2.75	2.92	2.62	2.78

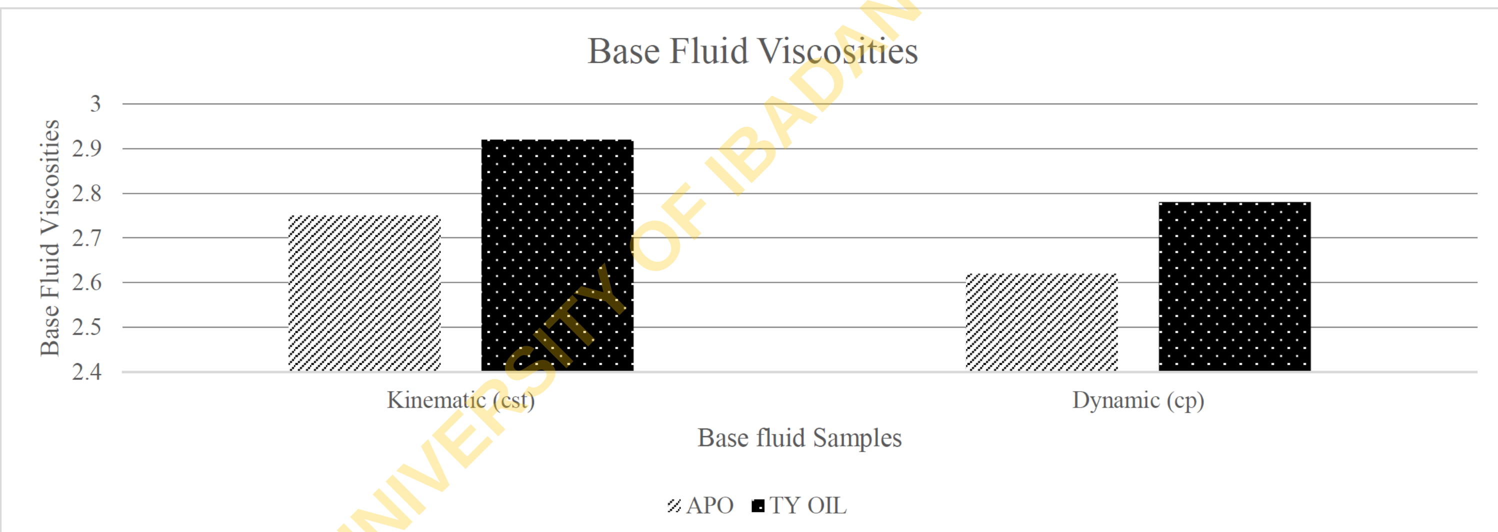

Figure 5—Base fluid viscosities

Pour, Cloud, Flash And Fire Points

Low Pour and Cloud points were obtained for the Avocado pear methyl esters as compared to that of TY oils This indicate a better rheology and freeze stability of water- in-oil emulsions formed by this ester at cooling conditions. The flash point describes the tendency of a fluid to form a flammable mixture with air. It measures the ignition properties of fluid samples which help to control its storage and transportation at elevated temperature. High flash point of base fluid samples is favorable to mud application. High Flash point of base fluid sample is favorable to mud application. The flash point of the ester derivatives is quite high and compares favorably to TY oil as shown in Table 4.5.

Mud Test Results

The results of various tests carried out on the mud samples are presented as follows.

From the results in Table 8, the mud weight of avocado pear methyl esters mud decreases as the water-oil ratio increases. Sample A has the highest mud weight before barite was added to the six samples to bring them up to 10ppg. The specific gravity of the base fluid is very critical to the mud weight and the results showed that mud weight increases with increasing base fluid specific gravity.

Table 8—Pour, Cloud, Flash and Fire points of base fluid samples.

TEMP °C	APO	TY OIL
POUR POINT	-5°C	-18°C
CLOUD POINT	-2°C	-6°C
FLASH POINT	300°C	75°C
FIRE POINT	315°C	85°C

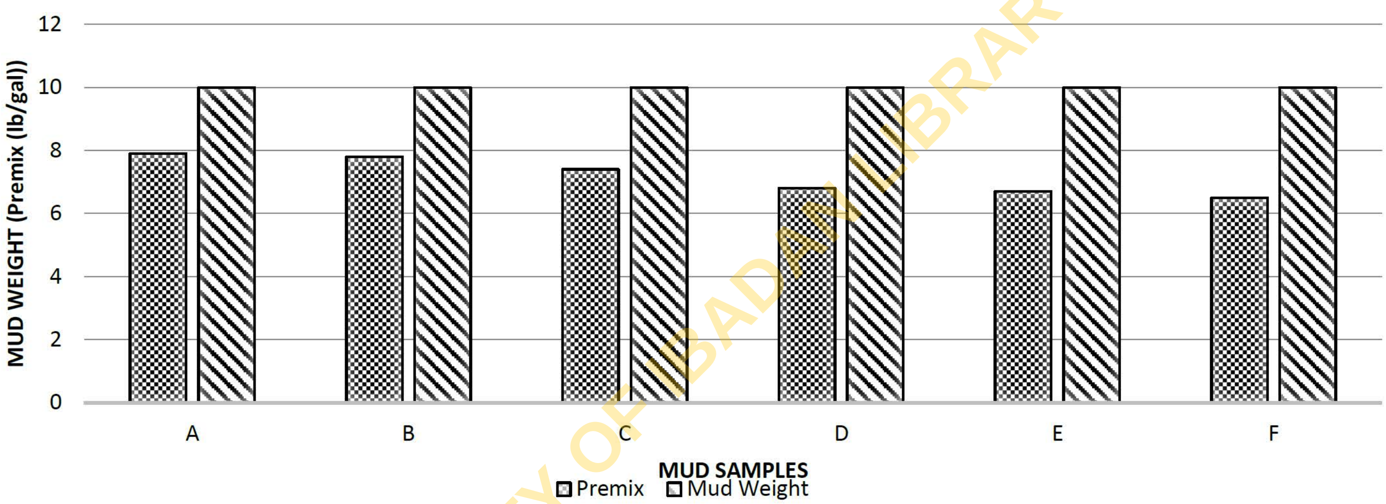

Figure 6—Weight of mud samples (Premix and at 10ppg)

Electrical Stability (ES)

The ES values show the stability of the mud, water, and oil emulsion. These numbers show how well the mud emulsifies with oil and how easily it wets oil with water, respectively. When it comes to OBMs, a high ES number (>400 volts) is preferred since it denotes stability, whereas a low ES value denotes instability and the requirement to add emulsifier to the system. The outcomes, though, are not wholly quantitative. The extent to which muds are electrically stable is determined by their chemical makeup and shear history. As a result, it is improper to extrapolate the oil wet condition of a mud from a single ES test. Only trends in ES values should be considered when deciding how to treat patients and how well the muds are working. The ES test findings in Table 9 and Figure 9 demonstrate how favorably the ester-formulated muds compare to the TY oil mud.

Table 9—Weight of mud samples. (Premix and at 10ppg)

MUD SAMPLES	A	B	C	D	E	F
MUD WEIGHT (ppg)	10	10	10	10	10	10
(Premix (lb/gal))	7.90	7.80	7.4	6.8	6.7	6.5

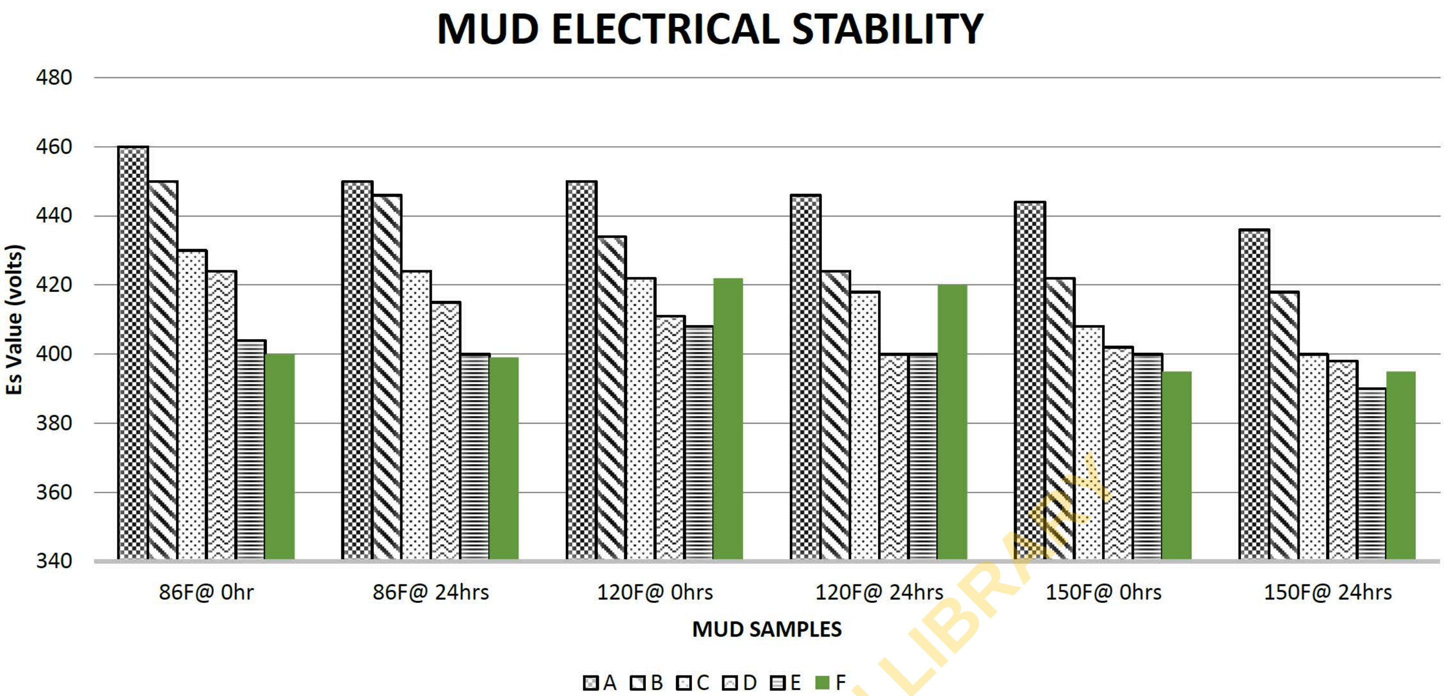

Figure 7—Mud Electrical stability

Rheological Properties

Rheological properties refer to the behavior of fluids under various conditions like temperature, pressure, and flow rate. Based on the results, the rheological properties of Avocado Pear Methyl Ester Mud (samples A, B, and C) are comparing favorably to that of TY oils (oil-based mud samples D, C, and F).

Plastic Viscosity

TY oil base mud has a slightly higher plastic viscosity compared to avocado pear oil methyl-ester base mud. This indicates that TY oil base mud has a higher viscosity, which would offer a greater resistance to fluid flow that will results in increased circulating pressures that can cause loss of circulation and increased pumping cost. The avocado pear oil methyl ester base mud APOME with low viscosity is a good prospect for drilling in the sense that its low viscosity will offer less resistance to fluid flow and therefore would lead to a turbulent flow at low pump pressure which will result in good hole cleaning.

Table 10 and figure 10 demonstrate how avocado pear oil methyl ester APOME compare favorably with the conventional oil used in the industry TY oil.

Table 10—Electrical stability (ES) of mud samples.

MUD SAMPLES/ TEMP °C	ELECTRICAL STABILITY (ES)					
	86°F @ 0hr	86°F @ 24hr	120°F@ 0hrs	120°F@ 24hrs	150°F@ 0hrs	150°F@ 24hrs
A	460	450	450	446	444	436
B	450	446	434	424	422	418
C	430	424	422	418	408	400
D	424	415	411	400	402	398
E	404	400	408	400	400	390
F	400	399	422	420	395	385

Table 11—Plastic Viscosity (PV) of mud sample

MUD SAMPLES TEMP °C	PLASTIC VISCOSITY (cp)						
	86°F Premix	86°F @ 0hr	86°F @ 24hrs	120°F@ 0hrs	120°F@ 24hrs	150°F@ 0hrs	150°F 24hrs
A	20	27	22	14	10	13	10
B	16	20	22	18	16	16	13
C	18	33	24	18	16	16	13
D	17	26	32	26	24	22	18
E	14	19	28	22	18	20	16
F	16	21	30	24	20	20	17

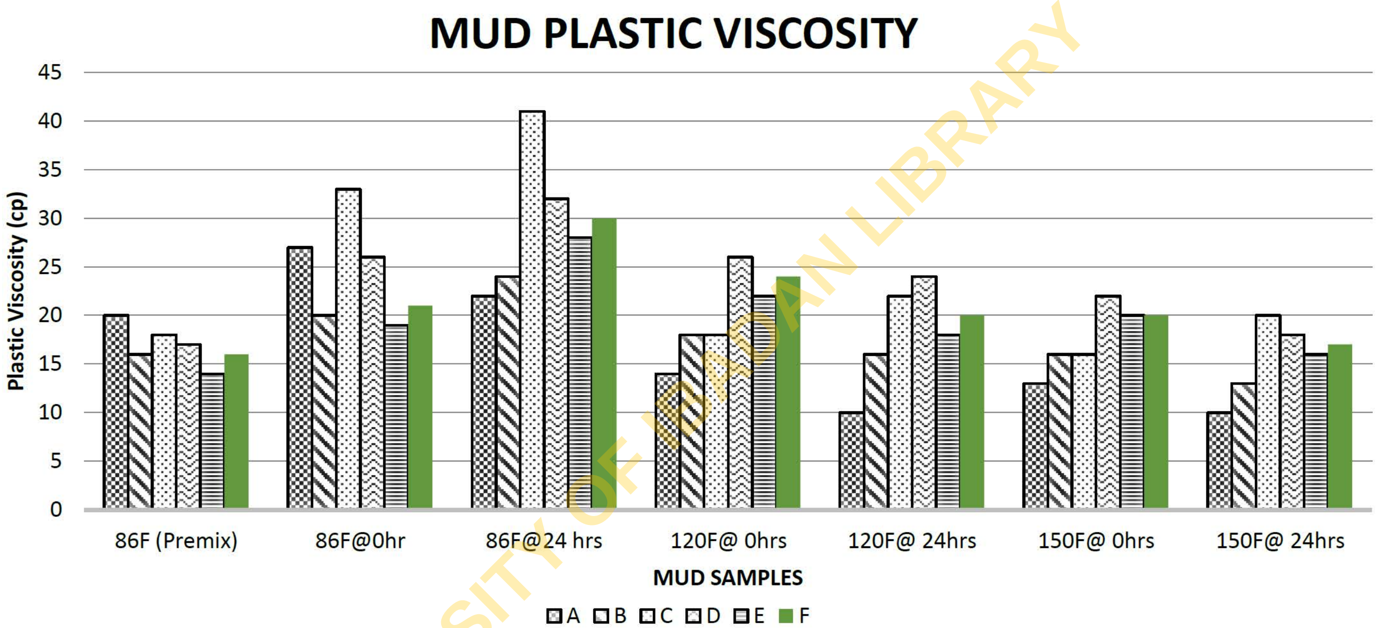

Figure 8—Mud plastic viscosity

Yield Point

The yield point YP is used to evaluate the ability of a mud to lift cuttings out of the annulus. A high yield point YP implies non- Newtonian fluid; one that carries cuttings better than fluid of similar density but lower yield point YP. Additionally, frictional pressure loss is directly related to yield point YP. It is important to state here that excessive high yield point YP leads to high pressure losses while the drilling mud is being circulated.

Table 12—Yield point (YP) of mud samples.

MUD SAMPLES TEMP °C	YIELD POINT (lb/100 sqft)						
	86°F Premix	86°F @ 0hr	86°F @ 24hrs	120°F@ 0hrs	120°F@ 24hrs	150°F@ 0hrs	150°F 24hrs
A	5	8	9	7	8	4	5
B	4	6	7	3	4	4	3
C	20	22	11	14	11	10	6
D	9	11	16	10	15	6	9
E	6	10	12	8	11	5	7
F	21	23	18	16	13	12	8

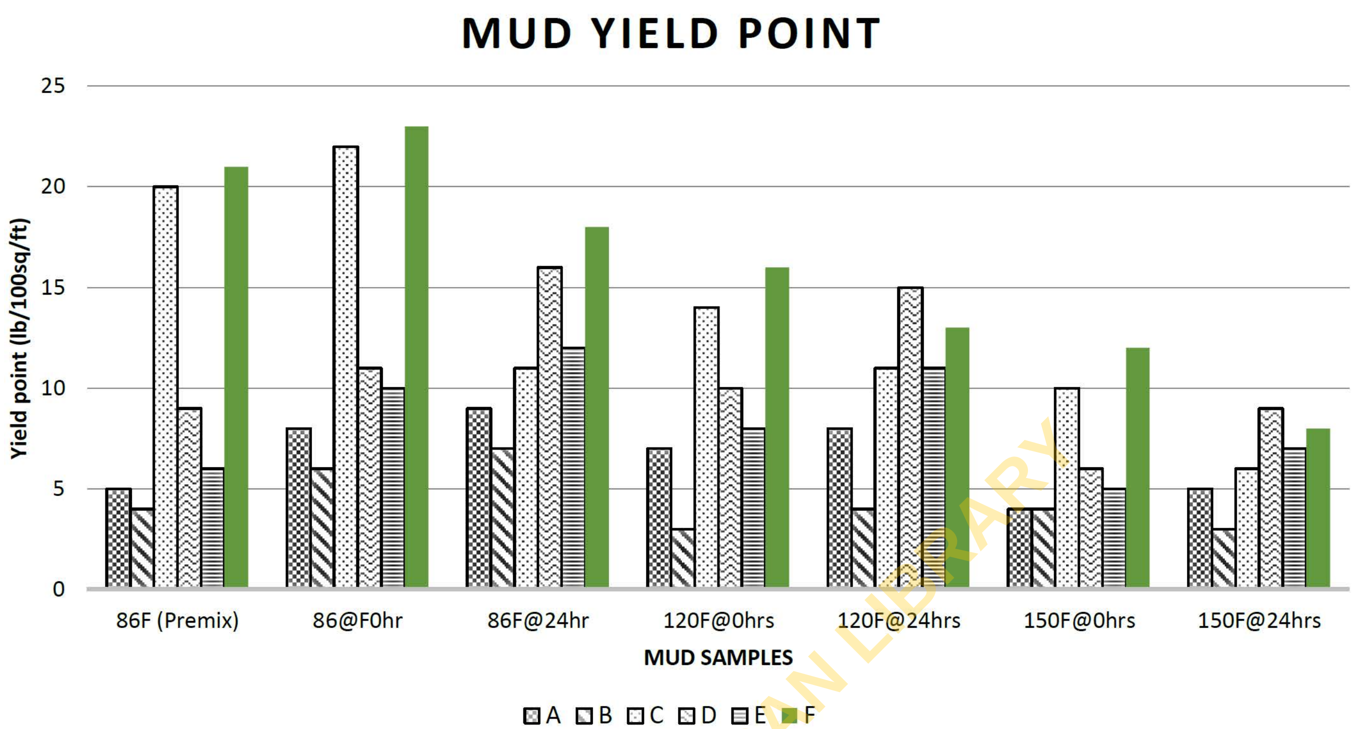

Figure 9—Mud yield point

High Pressure/High Temperature (HTHP) Filtration

The results of the research indicate that the HTHP filtration properties of the avocado pear methyl ester mud samples favorably compared to those of the TY oils oil-based mud samples. This is significant because HTHP filtration properties are an important aspect of drilling mud performance. Drilling mud is a vital component in the drilling process as it helps to cool and lubricate the drill bit, prevents the formation from collapsing, and brings rock cuttings to the surface. In the oil and gas industry, efficient drilling mud performance is crucial to ensure safe, productive, and cost-effective drilling operations.

Gel Strength

The gel strength of the mud samples was also determined using the Fann V-G viscometer. The peed selector knob was rotated to stir the mud sample for the seconds, and then it was rotated at 3 rpm and the power was immediately shut off. As soon as the sleeve stopped rotating, the power was turned on after 10 seconds and 10 minutes respectively. At 3 rpm, the maximum dial was recorded for each case as gel strength of the mud samples at 10 seconds and 10 minutes. Thus, the results are presented in table 13 below.

Table 13—HPHT static filtration properties of mud samples

MUD SAMPLES	CAKE THICKNESS (mm)	FILTRATE VOLUM Vs(x2) ml
A	2.0	7.5
B	1.6	6.4
C	1.2	4.8
D	2.5	9.4
E	1.8	6.8
F	1.4	5.3

Table 14—Gel Strength (GS) of Mud Samples

MUD SAMPLES/ TEMP °F	GEL STRENGTH (GS) (lb/100sqft)									
	86°F Premix		86°F @ 0 hr		86°F @ 24hrs		120°F @ 24hrs		150°F @ 24hrs	
Time Duration	10sec	10min	10sec	10min	10sec	10min	10sec	10min	10sec	10min
A	9	9	10	11	10	11	7	9	9	8
B	5	6	7	8	7	8	7	8	8	7
C	4	5	6	6	9	10	5	6	6	5
D	5	5	5	6	5	7	5	5	5	5
E	4	4	4	6	4	6	4	4	4	4
F	4	4	4	5	4	4	4	4	4	4

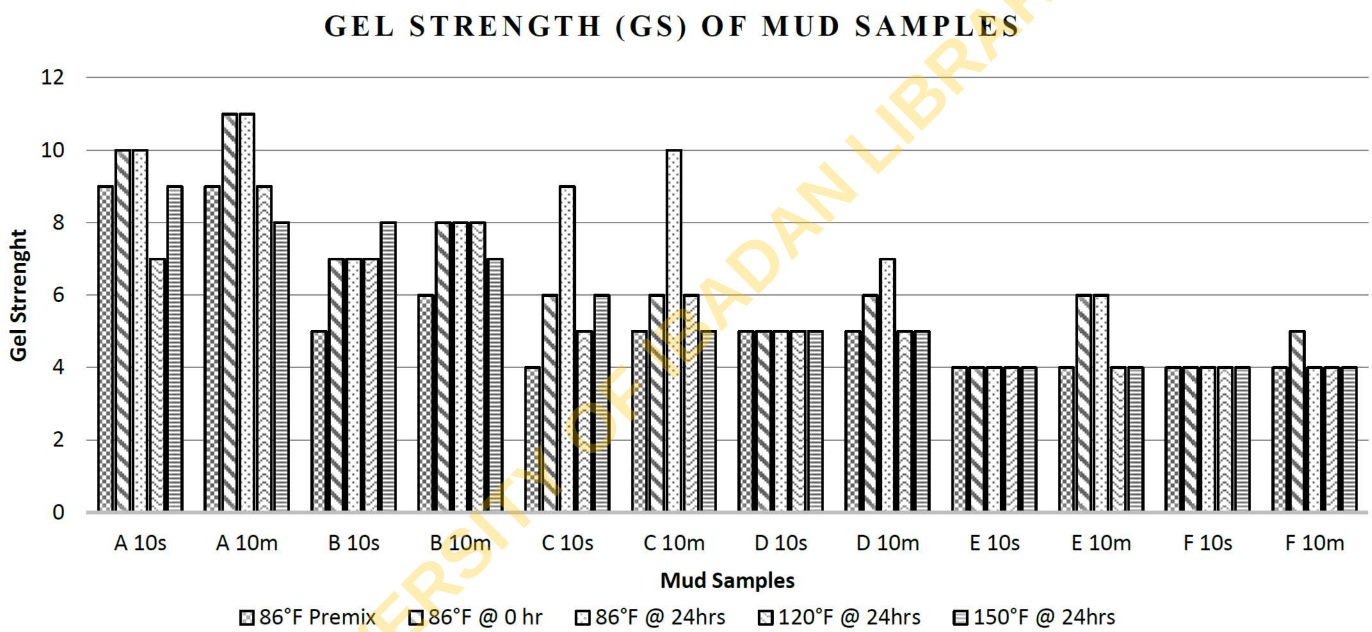

Figure 10—Mud gel strength

The figures above show the gel strength of the mud samples formulated from the avocado pear methyl ester and the conventional oil used in the industry TY oil. These figures represent the gel strength at different temperatures.

Conclusion And Recommendation

The research findings suggest that the use of avocado pear methyl ester mud samples can offer comparable drilling mud performance to traditional oil-based muds while providing a more sustainable and environmentally friendly option. It will likely be relevant in the oil and gas industry, where the demand for sustainable alternatives is increasingly significant.

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, avocado pear oil was used as a base fluid in synthetic-based mud (SBM) formulation. The formulated avocado pear SBM properties were compared with TY oil. While the formulated avocado pear SBM has very good potentials as synthetic-based drilling mud when compared with TY oil mud.

The results of the test carried out indicated that the rheological properties of the mud samples were in the range of the API recommendation, it can be said that biodiesel synthetic base mud possesses a great chance of being among the feasible replacement for oil-based mud.

Recommendation

Further investigation should be carried out aimed at;

1. Determining the optimum alcohol-oil ratio for transesterification that will improve the SBMs properties.
2. Harnessing Local Additives with the local base fluids in order to improve the rheology of the mud samples and promote the use of local materials.
3. Determining the optimum amount of mud components required to give the best mud properties.
4. There is also potential for advanced research into sustainable development to limit the adverse effects of the ester formulated muds to the environment, their toxicity and elastomers compatibility.

Finally, the formulated mud should be subjected to real field conditions to further understand their rheology. The knowledge of drilling fluid rheology under elevated temperature and pressure is useful to understand changes in the mud's properties in a real well field trials.

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