

Experimental Based Investigation For Rheologic Characteristics Of Vegetable Oil Base Mud

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Abstract: Drilling fluid choice plays important role for the victorious drilling operations. The economical role of drilling mud depends upon the rheological properties of base fluid . Diesel oil is generally utilize as base fluid within the formulation of oil base mud however because of its aromatic and least concentration of n-olefins composition extremely affected to plants and surroundings. The Esters area unit non-petroleum spinoff of vegetable oils which biodegrades simply, aerobically once cutting is discharged. During this study three completely various oil (corn oil, mustard oil, local canola vegetable oil,) be used to investigate their rheological characteristics of the oil base muds samples. According to API standards , 13B-1 routine testing were used to investigate the rheological characteristics of mud samples .There were twelve oil mud samples has been prepared with completely different oil water ratios of 90/10, 80/20 and 70/30 to calculated the rheological characteristics with the assistance of OFITE Model 800 measuring device.

Keywords: *Drilling fluid, vegetable oil base mud , Environment Impact ,Rheological properties, physiochemical properties*

1. Introduction

The success of drilling engineer is acquired by the drill the hole with the low value imprint and low environment issue Drilling mud is essential part of the drilling process also called as circulating fluids . The purpose of drilling mud is to hold and lift up the drill cuttings from bottom to surface, beside that it lubricate the bit, and make mud cakes at formation wall [1,2]. Drilling mud is that the mixture of various chemicals admixture, and additives used to optimize the performance of the mud. The characteristics of drilling mud rely upon several factors such as reservoir characteristics (temperature, pressure and formations) .

The flow characteristics of drilling mud assure the drill cutting removal of the rocks. The flow behavior of based mud depicted the effectiveness of base fluid [4]. Typical formulation of oil based mud create severe environmental issues in entire world [5]. There are various international environment agency which are working on environmental issues occurred due to oil based mud and presenting different new alternative ways to exploration companies to overcome such types of issues[6,7] .As oil and gas business stakeholders were attempting to seek out completely different various to OBMS that ought to be acceptable and apply in nearly at all place of the globe. It's terribly huge duty for exploration companies and researchers to develop the environment friendly oil base mud which might cut back the environmental issues as developed due to diesel oil based mud.

The effective preparation of oil base mud is huge challenge throughout drilling process that consequence the productive drilling operation effective mud flow characteristics will give minimum borehole problems. As the base oil usually diesel employed in oil base mud extremely affected to plants and surroundings because of its composition [8] . The disposal of the diesel base mud rock cutting is particularly tough into the formation as a result of huge toxicant nature of diesel have communal impact on surroundings. Vegetable oil is the best suited alternative of the diesel oil base mud, as vegetable oil is non toxicant in composition thus it's best suited candidate concerning technically and environment friendly OBM development.

2. Literature Review

Drilling mud is additionally called as drilling fluid ,and used as circulation liquid during drilling process .beside that there are various application of drilling mud used throughout drilling operations [9]. The drilling mud composition depend on the dispersed phase .there are mainly two type of drilling mud available mostly used in the petroleum industry .

- Water based mud
- Oil base mud

2.1 Water based mud

The Water based Mud (WBM) is type of mud which is mostly compose of water as continuous phase , principally, water base mud system is unvaried mixture of water, clays and numerous additives . The chemical characteristic of mud depend upon the presence of solid types within the developed mud .The two main varieties of solid occurred, one is active and second is inactive solids. The uniqueness of active solids measure that it will simply respond with water section and chemical whereas inactive solids have property that they doesn't mix with water section and additionally dissolve chemical up to significant edge [10,11]

2.2 Oil base mud

The type of mud within which oil is employed as base fluid. Oil-based system was initially started in 1960. There's many benefits of Oil base mud (OBM) utilized in Clay type formation which will not swell on interaction whereas water base mud (WBM) produce swelling problem. Oil base mud offer wonderful temperature well bore stability and high penetration rate. Oil-based mud is usually set with diesel oil, or low-toxic linear olefins and paraffin etc, chosen as base fluid in OBM attributable to its smart potency of sustaining the temperature and smart ability to lifting rock chips at surface. Due to the elevated toxic composition of the diesel based mud makes it unsuitable for consume in numerous at onshore and offshore locations. Environmental legislation and management become very strict regarding environment issues created due to utilization of diesel oil base mud [12,13]. The normally well can be highly effected by the generation of the rock cutting above 1500 tones which posses the 15% oil retention . [14].It should to be demand of mud conditioning prior to disposal of the mud . There's 10 to 40USD required for discarding of a barrel of oil base mud cuttings [15,16]. The properties of diesel fuel illustrate toxicity in nature and non perishable that influence on the water ground beds (aquifer channels) and surroundings thus oil business is looking oil base drilling mud which is biodegradable in nature having less combined impact on environment and surroundings . currently diesel oil is substituted with non aromatic oils because of low toxic in nature , biodegradable in nature so there ought to be want of such fluid that can attuned with environmental conditions such as pseudo oil base mud

2.2.1 Pseudo Oil based Mud

Such type mud system in which the base oil is prepared by synthesis for the mud preparation is called as Pseudo Oil |based mud and regarded to execute as non toxic oil based mud .The base fluids embody Linear Alpha Olefins (LAO), traditional esters, Isomerizes, Olefins (IO) and ether and organic compound base fluids. Esters are non-petroleum derivative of vegetable oils contain non aromatics hydrocarbons. The major advantage of associate ester-

based fluid is its biodegradation in nature either aerobically from a mud cuttings disposal purpose and the utilization of the ester based drilling fluid substance has been conferred as a potential answer to the environmental issues generated by use of diesel oil based muds [17,18].Due to excellent characteristics of vegetable oils ,it is now days used every region of world as a based fluid in the formulation of oil base mud

3. Experimental work

3.1 Material selection

In this study we select three different types of vegetable oils(corn oil, mustard oil and local canola oil) as base fluid and other additive used in the formulation of mud as shown in table no 1 shows.

Table no 1: Additive name and their functions

Additive Name	Function
Barite	It provide mud weight
Lime	Stabilize emulsion and control alkalinity
Organophilic clay	It create the gelling characteristics in mud
CaCl ₂	It Provide osmotic wellbore stability.
Caustic Soda	It maintained the alkanity (PH) of mud
Primary and Secondary emulsifier	It form water and oil emulsion in mud

3.2 Equipment used

The rheological properties of mud samples are investigated with the help of equipment shown in table no 2

Table no 2: Equipment with their functions

SNO	Equipment name	Function
1	Hamilton Multimixer	It provide ample energy for mud to mix
2	OFITE Model 800 Viscometer	It determine the rheological properties of drilling mud
3	OFITE Electrical Stability Meter	It is used to measure the emulsion stability between oil and water

3.3 Formulation of vegetable oil base mud and diesel oil base mud

There were 12 mud samples were prepared having three different oil water ratios(90/10,80/20,and 70/30) by using different oils(corn, mustard, local canola and diesel) The formulation of prepared oil base mud samples are shown in table no.3, 4 and 5

Table no 3: Formulation of 90:10 OWR Oil based mud

Mud component	Mustard oil based mud	Corn oil based mud	Local canola oil based mud	Diesel oil based mud
Oil (ml)	315	315	315	315
Primary emulsifier (ml)	5	5	5	5
Secondary emulsifier(ml)	3	3	3	3
Lime(gm)	4	4	4	4
CaCl ₂ (gm)	17	17	17	17
Water(ml)	45	45	45	45
Bentonite(gm)	20	20	20	20
Caustic soda (gm)	1	1	1	1
Barite (gm)	100	100	100	100

Table no 4 :Formulation of 80:20 OWR Oil Based mud

Mud component	Mustard oil based mud	Corn oil based mud	Local canola oil based mud	Diesel oil based mud
Oil (ml)	280	280	280	280
Primary emulsifier (ml)	6	6	6	6
Secondary emulsifier(ml)	4	4	4	4
Lime(gm)	4	4	4	4
Water(ml)	70	70	70	70
CaCl ₂ (gm)	17	17	17	17

Mud component	Mustard oil based mud	Corn oil based mud	Local canola oil based mud	Diesel oil based mud
Bentonite (gm)	20	20	20	20
Caustic soda (gm)	1	1	1	1
Barite (gm)	70	70	70	70

Table no 5 : Formulation of 70:30 OWR Oil Based mud

Mud component	Mustard oil based mud	Corn oil based mud	Local canola oil based mud	Diesel oil based mud
Oil (ml)	245	245	245	245
Primary emulsifier (ml)	8	8	8	8
Secondary emulsifier(ml)	6	6	3	6
Lime(gm)	4	4	4	4
CaCl ₂ (gm)	17	17	17	17
Water(ml)	105	105	105	105
Bentonite(gm)	20	20	20	20
Caustic soda (gm)	1	1	1	1
Barite (gm)	55	55	55	55

4. Results and Discussion

The rheological investigation of 12 oil base mud samples has been carried out with the help of viscometer. The plastic viscosity and yield point of mud can be determine with the help of following equations .

$$PV = 600 \text{ RPM reading} - 300 \text{ RPM reading} \quad (1)$$

$$YP = 300 \text{ RPM reading} - \text{Plastic Viscosity (PV)} \quad (2)$$

Table 4.1 Rheological analysis of Different Oil base Mud at 90/10 OWR

OIL / WATER RATIO : 90/10				
BASE OIL	Mustard Oil base mud	Local Canola Oil mud	Diesel Oil base mud	Corn Oil base mud
600 RPM	80	100	76	105
300RPM	54	67	51	70
Plastic viscosity(cp)	26	33	25	35
Yield point (lb/ft ²)	28	34	26	35
Emulsion stability (volts)	650	550	700	500

OIL/ WATER RATIO : 70/30				
BASE OIL	Mustard Oil base mud	Local Canola Oil mud	Diesel Oil base mud	Corn Oil base mud
600 RPM	62	83	58	77
300RPM	40	56	39	52
Plastic viscosity(cp)	22	27	19	25
Yield point(100lb/ft ²)	18	29	20	27
Emulsion stability (volts)	450	380	500	360

Table 4.2 Rheological analysis Results of Different Oil base Mud at 80/20 OWR

OIL/ WATER RATIO : 80/20				
BASE OIL	Mustard Oil base mud	Local Canola Oil mud	Diesel Oil base mud	Corn Oil base mud
600 RPM	68	95	66	90
300RPM	45	63	44	60
Plastic viscosity(cp)	23	32	22	30
Yield point(lb/ft ²)	20	31	22	30
Emulsion stability (volt)	570	450	620	400

Table 4.3 Rheological analysis of Different Oil base Mud at 70/30 OWR

4.1Effect of oil water ratio over Plastic Viscosity

According to API specification ,plastic viscosity of oil base mud should be less than 35 cp [19,20]. The ability of mud posses solid control and hole cleaning depend on its plastic viscosity. The main cause of high solid concentration in mud is due to high plastic viscosity. The laboratory investigation results shows that mustard oil and diesel oil based mud posses good plastic viscosity value of 23cp, 22 cp at 80/20 and 70/30 OWR compared to the plastic viscosity value of diesel i.e. is 22cp and 20 cp as shown in fig 1.

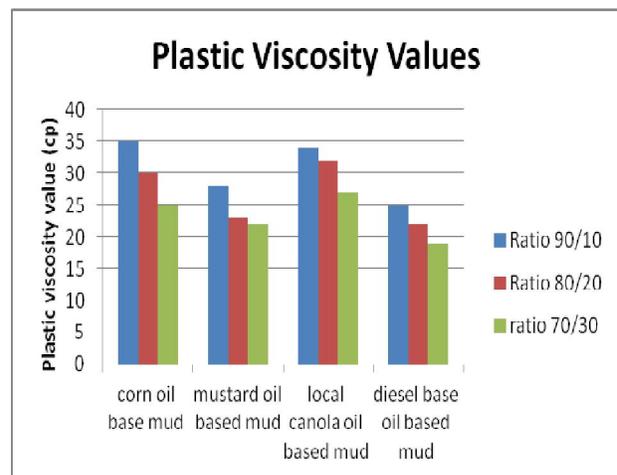


Fig no:1 The plastic viscosity values of different base oil mud at Different oil water ratios

It is clearly observed that there is very low variation of plastic viscosity values in between the mustard oil base

mud and diesel oil base mud measured at 80/20 and 70/30 OWR while high plastic viscosity values obtained at 90/10 OWR Which can cause solid settlement problems in the hole.

4.2 Effect of oil water ratio over Yield point

The API specification for the oil base mud posses the yield point value from 15-25 lb/ft² .As effective yield point of mud shows the effective and good hole cleaning of rocks cutting from wellbore to the surface. The laboratory investigation shows that high value of yield point were obtained at 90/10 OWR. The yield point values obtained at 80/20 and 70/30 OWR are very much closer to each other while the high value of yield point at 90/10 OWR can cause high frictional pressure losses during mud circulations .The yield point value of mustard oil base mud and diesel oil base mud depicted the acceptable values at 80/30 and 70/30 OWR compared with the standard API range as shown in fig no 2 ,while other base oil base mud shows flat values which cross the limit of API range.

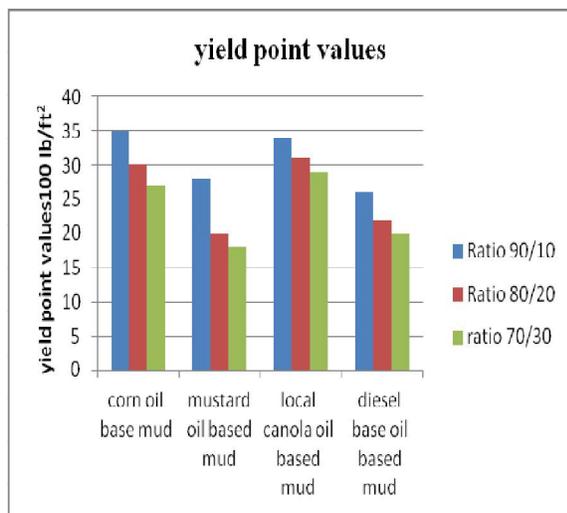
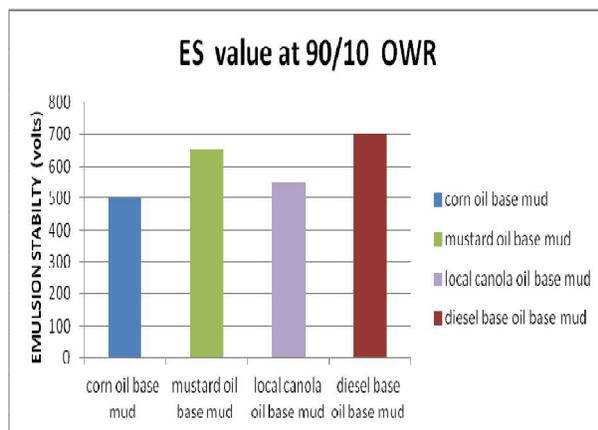


Fig no2: Yield point values at 80/20 OWR

4.3 Effect of Oil Water Ratio over Emulsion Stability

The laboratory investigation shows that high electrical stability values were obtained at 90/10 OWR for all prepared mud samples as shown in fig no3.



As the oil water ratio increase the electrical stability value decreased. The ES value of corn oil and local canola oil base mud at 80/20 and 70/30 OWR gave lowest value which will cause weak and unstable emulsion present in mud while ES value of mustard oil and diesel posses acceptable range of API Specification that is above 400volts at 80/20 and 70/30 The emulsion stability altered with increase on water content so there are decrease in ES value observed for all prepared oil base mud samples at 70/30 OWR which cause the mud instability

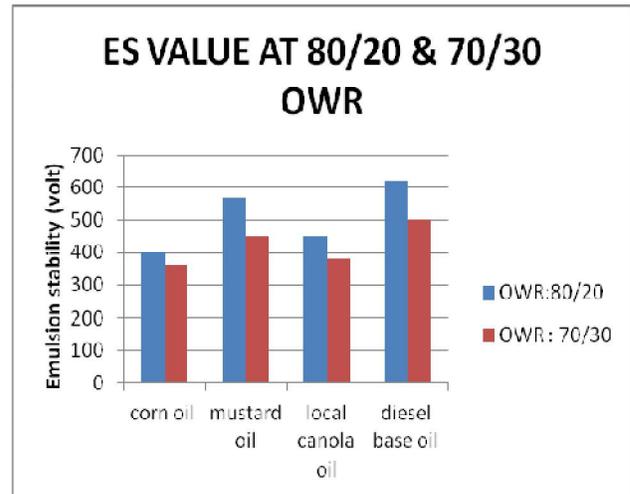


Fig no:4 emulsion stability value of mud at 80/20 & 70/30 OWR

5. Conclusion

Following are few conclusion obtained on the basis of laboratory investigation conducted during this research work:

1. The plastic viscosity of the mustard oil base mud exhibited good result of 23cp at 80/20 OWR as compare to value of diesel base mud which resulted 22cp where as corn oil and local canola oil 1 base mud depicted high plastic viscosity results which created hole instability problems.
2. The Emulsion stability value is influence with increase in oil water ratios so laboratory investigation results showed that low ES value of corn oil based mud and local canola oil based mud obtained at 80/20 and 70/30 OWR while acceptable emulsion stability value is obtained from mustard oil base mud at 80/20 OWR which shows good emulsion between water and oil phase.
3. From the above laboratory investigation it is clearly concluded that mustard oil base mud depicted the satisfactory rheological characteristics so it can be considered as good oil base mud .

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