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EVALUATION OF THE FLUID LOSS PROPERTIES OF PLEUROTUS AND ITS COMMERCIAL AVAILABILITY

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ABSTRACT

This technical paper evaluates the drilling fluids formulated with the proposed biomaterial fluid loss additive, Pleurotus and the existing Poly-pac lo-vis . The laboratory measurements were carried out as per the API specifications. The drilling properties such as fluid loss and cake thickness were measured at room temperature, 120°F, 150 °F and 180 °F. The field polymer muds that are currently in use namely; Poly-pac lo-vis was used as control to the new proposed product. The filtrates of both the proposed biomaterial product and the existing Poly-pac lo-vis were then measured using the filter press. The cake thickness was also examined and measured. The results of proposed fluid loss additive when compared with the existing one shows that the filtrates obtained from low solids mud were 8.9ml, 9.9ml, 10.4ml, 11ml compared with 7ml, 8.2ml, 8.8ml, 9.5ml results measured from the Poly-pac lo-vis. That of the weighted muds are 8ml, 9ml, 9.8ml, 10.8ml and 5ml, 6ml, 6.9ml, 7.5ml for both the proposed additive and the existing one respectively. Both the proposed and the existing muds gave good results in both filtrate and filter cake measurements. Although the existing Poly-pac lo-vis is slightly better than the proposed Pleurotus in terms of filtrate but both gave good filtered cake thickness. The proposed material is not commercially available to be used in preparing drilling fluids but is environmentally friendly.

Key words:-Biomaterial, Fluid loss control, Laboratory Measurements, Filter cake, Poly-pac lo-vis, Pleurotus.

1.INTRODUCTION

A drilling fluid is a mixture consisting of solids, liquids and gases distributed throughout the liquid or gaseous phase. A major component in the success of drilling operation is the performance of the drilling fluid. The search for hydrocarbon reserves has become significantly more expensive that offshore operations have moved into the deeper waters, and more hostile environments. These environments require the drilling fluid to excel in many performance categories. This is especially important now that oil producing nations emphasize the development of a drilling fluid that is effective, economically viable and environmentally friendly. This indeed has become a challenge to petroleum industry. Fluid loss is the measure of the quantity of filtrate that enters into the formation. If not controlled especially in the reservoir zone, formation impairment will occur, leading to high cost in stimulating the well. Fluid loss involves diffusivity and their computations enable the mathematical description of the filtration behavior of drilling mud [1]. The built up filter cake determines the resistance against the fluid flowing through the filter cake which-thereafter determines the volume of fluid in a particular filtration time.

The American Petroleum Institute (API) Model

The API Model is a static fluid loss model from which it is deduced that for any static filtration, the total fluid loss is directly proportional to the square root of time[2]. The model expresses the relation as:

$$V = (S)t^{0.5} \qquad \text{..........}1$$

Where V is total fluid loss volume or filtration volume or filter loss, S is the sorptivity which is the absorption of fluid and t is the time of filtration.

Henri Darcy Model

The Henri Darcy Model relates filtration rate to time in an exponential manner[3]. The model is expressed as

$$Q(R) = Q_o \exp^{-Dt} \qquad \text{.........}2$$

Where R is the filtration rate, Q_o is the initial volume of fluid, Q is the final volume of filtrate, D is the diffusivity of fluid, and t is time.

Dynamic Filtration

Dynamic filtration differs from static filtration in that drilling fluid velocity tends to erode the wall cake even as it is being deposited on permeable formations.

Testing equipment

The testing equipment is the filter press.

Test type

LP-LT Test and HP-HT Test.

	LP-LT Test	HP-HT Test
Differential pressure	100 psi	500 psi
Temperature	ambient	250 - 300^{o}F
Duration	30mins	30mins

The test is carried out according to the API procedures. The filtrate volume measured in milliliters collected after 30mins for HP-HT is doubled to correct it to the filter area of API filtration test. The filter cake should also checked for thickness and consistency after the filtrate loss has been tested and is expressed as 1/32 of an inch.

Correlation

Correlation between API standard fluid loss at 100psi and ambient temperature and high temperature – high pressure test 500 psi and 250 - 300^{o}F depends on several factors. Cake compressibility and thermal stability of additives contained in a fluid, are primary factors. Generally speaking, a well treated lignosulfonate, lignite, bentonite system may have a ratio between HT – HP and standard API filtrate test in the range of 2:1 to 4:1. On the other hand, a system comprised a high concentration of drilled solids may have a ratio of 10:1 or higher. Obviously, a drilling fluid could exhibit a low API filtrate value at 100psi and ambient temperature and extremely high filtrate (thick wall cake) on the HT-HP test. For this reason, more emphasis is placed on HT-HP data on deeper wells encountering high bottom-hole temperature.

Permeability of Filter Cake

The permeability of the filter cake is one of the most important factors in controlling filtration. The size, shape and concentration of the solids which constitutes the filter cake determine the permeability. If the filter cake is composed primarily of coarse particle, the pores will be larger, therefore, the filtration rate greater. For this reason bentonite with its small irregular shape platelets as well as many polymers compact under pressure to lower permeability, hence the term, cake compressibility.

Pressure

If the filter cake did not compress under pressure, the fluid loss would vary with the square root of the pressure. This does not normally apply to drilling fluids because the porosity and permeability of the filter cake is usually affected by pressure.A useful field check for determining cake compressibility to measure HT-HP filtrate in the normal manner, then test again with 100psi differential pressure. The lower the compressibility ratio,

$$\left(\frac{\text{cc at 500psi}}{\text{cc at 100psi}}\right)$$

the more compressible the filter cake becomes. If the compressibility ratio is 1.5 or greater, it could indicate that colloidal fraction is inadequate and that remedial measure are necessary.

Temperature

An increase in temperature will usually result in an increase in filtration rate because of adverse temperature effects on filtration control agents and decreased fluid phase viscosity. Higher temperature may also increase the solubility of contaminants and, therefore, decrease the effective of filtrate loss control chemicals. In addition, the colloidal fraction tends to flocculate and increase filtration at elevated temperature.

The theoretical change in filtrate due to reduction of the viscosity of the filtrate as temperature is increased can be expressed by the following equation:

$$f_1 = f \times \frac{\sqrt{u}}{\sqrt{u_1}} \quad \text{..........3}$$

where
f = filtrate at a known temperature
f_1 = filtrate at an elevated temperature
u = viscosity of water base mud at known temperature
u_1 = viscosity of water base mud at elevated temperature

Temperature changes of water base mud in the 80 to 140 range will result in change of filtrate of approximately 10% for each 17 change. Filtrate increases as temperature increases.

Time
The calculation of filtrate loss at variable time intervals relative to know filtrate loss and time intervals relative to unknown filtrate loss and time interval can be predicted by the following equation.

$$f_1 = f \times \sqrt{\frac{T_1}{T}} \quad \text{...........4}$$

Where
f = known filtrate at a time interval of T
f_1 = Unknown filtrate at a time interval of T_1

Characterization and Commercial Availability of Pleurotus
The mineral composition of major minerals and trace minerals of Pleurotus ostreatus and Pleurotus pulmonarius, both of which are examples of Pleurotus *tuber-regium* of degraded Peanut shell were studied[4]. The results of this study indicate that fungal treatment of Peanut shell by fermentation have potential to be used as feed supplements for ruminants especially during dry season when feedstuffs are lacking and the only available feedstuffs are crop residues.Table1 shows the result of chemical composition of Pleurotus ostreatus and Pleurotus pulmonarius. It is shown in the table that Pleurotus contain high concentration of fiber which is the main source of the fluid loss control . Pleurotus is the type of non – poisonous and edible tuberous and bulb shaped mushrooms. Their texture is hard or stony or puffy in the case of bulbous types with a visible sporocarp that lacks undersurface pores or gills but rather produce spores in a cloudy deposit on its surface. Pleurotus tuber regium is an example of soil burial mushroom. They are harvested from the bark of decaying wood or buried wood [5]. They are buried in soils under shade or cool place. After 5 – 10 days, the Pleurotus start producing fruiting bodies in flushes which are harvested and eaten by local people. Collection of Pleurotus from the wild by the people is usually in the rainy season. The unused ones are preserved by some traditional methods like sun drying and smoking. It is found in many parts of tropical Africa. It is widely used especially in the eastern part of the country to make melon like soup[6]. There is need for commercial protection of Pleurotus in Nigeria in view of its potential contribution to agricultural production and as a source of cheap protein. Nigeria is richly endowed with good quality mushrooms like Pleurotus which should be mass produced for local consumption as well as for international market. Since Pleurotus are seasonal and always in short of supply, commercial production is therefore necessary to ensure their constant availability. Commercial production of Pleurotus can also be done using agro waste materials as alternative substrates for the cultivation of Pleurotus using saw dust, oil palm fiber, dry cassava peels, a mixture of saw dust and oil palm fiber and a mixture of cassava peels and oil palm fiber were used to cultivate mushrooms[7].

Table 1: Chemical composition (g/100g) of Pleurotus ostreatus and Pleurotus pulmonarius degraded peanut shell.

Parameters	**Pleurotus ostreatus**	**Pleurotus pulmonarius**
Dry matter	80.8	80.4
Crude protein	9.29	16.1
Ether extract	5.47	6.12
Ash	8.35	9.01
Crude fiber	16.2	18.7
Nitrogen free extract	60.0	50.1
Neutral detergent fiber	62.9	63.64
Acid detergent lignin	24.1	15.3
Acid detergent fiber	49.6	44.0
Cellulose	25.5	28.7
Hemicellose	13.4	19.7

METHODOLOGY

The filtration measurement was conducted from the Pleurotus as per API standard.

Mud Formulations/Experimental Procedure

Two sets of measurements were carried out, the proposed mud obtained from Biomaterial: Pleurotus and the existing Polypac lo-vis muds. Tests were conducted. Formulations of the muds are shown in tables 2 to 3. All tests were carried out at room temperature and temperatures of 120^0F, 150^0F, and 200^0F. The tables show the laboratory measurements of the Pleurotus muds, and the existing Polypac muds. Equal concentrations were applied for Pleurotus muds and the existing Polypac lo-vis muds for easy comparison.

Table 2: Composition of weighted mud with Calcium Carbonate (Low solids mud).

Composition	**Concentrations**
Pleurotus	5g
Fresh Water	350ml
Potassium Chloride	10g
Caustic Soda	0.25g
XCD Polymer	1g
Calcium Carbonate	103.7g
Existing	
Fresh Water	350ml
Potassium Chloride	10g
Caustic Soda	0.25g
Polypac lo-vis	5g
Calcium Carbonate	103.7g

Table 3: Composition of weighted mud with Barite.

Composition	**Concentrations**
Pleurotus	6g
Fresh Water	350ml
Potassium Chloride	10g
Caustic Soda	0.25g
XCD Polymer	1g
Barite	75.4g

Existing	
Fresh Water	350ml
Potassium Chloride	10g
Caustic Soda	0.25g
Polypac lo-vis	6g
XCD Polymer	1g
Calcium Carbonate	75.4g

The seeds of Pleurotus were grinded separately using Hamilton grinder to powder form, dried in the sun for 24hrs and finally re-grinded. The coarse powdered materials were sieved until the fine powder of each specimen was obtained. Measured data were then obtained from the Fiter Press and the filter cake also examined.

DISCUSSION AND ANALYSIS OF THE RESULT

From tables 4 and 5, the amount of filtrates obtained from room temperature to 180^oF from 8.9ml to 11ml and 7ml to 9.5ml for muds with Pleurotus and the existing mud respectively. Both results obtained from biomaterial additive and that of the Polypac lo-vis gave good results. Although, the Polypac lo-vis additive result is slightly better than the proposed additive. From the practical point of view, their values will improve after 2 to 3 bottoms up during drilling. It is important to mention here that the smaller the filtrate obtain from the filter press, the better is the result, since the aim is to minimize the amount of filtrate that will enter the formation, thereby preventing formation impairment. The filter cake obtained from both systems are thin and impermeable. The proposed product is not very effective at high temperatures and also not commercially available to meet up the demand.

Table 4: Filter Press readings with Calcium carbonate (Low solids mud) at different temperatures.

Constituents	Room Temp.	120 ^{O}F	150 ^{O}F	180 ^{O}F
Proposed Additive Fresh Water 350ml Potassium Chloride 10g Caustic soda 0.25g Pleurotus, 5g Calcium carbonate 124g XCD Ploymer 1g	Fluid Loss Reading 8.9ml Cake Thickness 1/32 of an inch	Fluid Loss Reading 9.9ml Cake Thickness 1/32 of an inch	Fluid Loss Reading 10.4ml Cake Thickness 1/32 of an inch	Fluid Loss Reading 11ml Cake Thickness 1/32 of an inch
Existing Polymer Additive				
Fresh Water-350ml Caustic soda-0.25g Polypac-5g XCD Polymer-1g Potassium Chloride-10g	7ml Cake Thickness 1/32 of an inch	8.2ml Cake Thickness 1/32 of an inch	8.8ml Cake Thickness 1/32 of an inch	9.5ml Cake Thickness 1/32 of an inch

Table 5: Filter Press readings with barite as the weighting material at different temperatures.

Constituents	Room temperature	120 ^{O}F	150 ^{O}F	180^{O}F
Proposed Additive	Fluid Readings	Fluid Readings	Fluid Readings	Fluid Readings
Fresh Water- 350ml Caustic soda-0.25g Pleurotus-6g Potassium chloride-20g XCD Polymer-1g Barite-75.4g	8ml Cake Thickness 1/32 of an inch	9ml Cake Thickness 1/32 of an inch	9.8ml Cake Thickness 1/32 of an inch	10.8ml Cake Thickness 1/32 of an inch
Existing Polymer Additive	5ml Cake Thickness 1/32 of an inch	6ml Cake Thickness 1/32 of an inch	6.9ml Cake Thickness 1/32 of an inch	7.5ml Cake Thickness 1/32 of an inch
Fresh Water-350ml Caustic soda-0.25g Polypac-6g Potassium Chloride-20g XCD Ploymer-1g 74.5g				

2.CONCLUSIONS

1. The fluid loss property of the Polypac lo-vis when evaluated using API filter press is better than the existing Pleurotus additive of equal concentrations, although both gave good results.
2. Also, Pleurotus additives are not commercially available for preparing drilling fluids.
3. The proposed additive is not good enough to drill high temperature wells.

Contribution to Knowledge

The major contribution of this study was to formulate drilling fluids from locally sourced biomaterials for drilling. Based on the result of the work, it is confirmed that the local products are not economically and commercially comparable to currently used Polypac lo-vis additive. Hence, the major contribution is to dissuade investors from using these products as they are, without further evaluation using the results of this work as a base.

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