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Alternative Use of Achi, UKPO, and OFOR as Substitute to Standard Viscosifier

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ABSTRACT

In Nigeria, drilling companies import a bulk of drilling fluid materials that they use to carry out their respective operations. This has been a major concern to oil and gas industries since these drilling fluid materials cannot be recycled, are highly expensive in terms of foreign exchange, are not environmentally friendly, not very effective, and non-biodegradable. This work presents an experimental investigation into the reliability of the use of local materials as a substitute to conventional viscosifiers. Local materials used in the analysis are Mucuna solannie (Ukpo), Brachystegia eurycoma (Achi), and Detarium microcarpium (Ofo). The results obtained from the experimental analysis show that they compared closely to the standard viscosifer formulated with Pac-R. The results showed that the density, specific gravity, pH, yield stress, Gel strength, Plastic Viscosity, and yield point of mud formulated from local materials compared favorably with that of the imported viscosifer. It was observed that an increase in concentration produced a better result. Hence, they could replace the Pac-R considering cost, cutting carrying ability, etc.

Keywords: Drilling fluid, Local viscosifiers, Plastic viscosity, Biodegradable.

1 Introduction

In the oil and gas industry, drilling mud or fluid is needed to enhance drilling operations. Drilling fluids/muds are simply a heterogeneous mixture of chemicals, water, oil, clay, and/or certain local materials that aid drilling operation. The fluid controls subsurface pressure removes drilled cuttings, enhances well-bore stability, cleans the hole, controls fluid loss, etc. It also helps for maximum penetration of the bit into the geological formation. The absence of the mud may result in major drilling problems such as stuck pipe, lost circulation, formation damage, pressure losses, kicks, or blowout [1]. The mud properties must as well be altered with additives during the drilling process to escape these drilling problems. The drilling Engineers monitor and formulate mud suitable for a given geological formation. Thus, the properties of drilling mud are dependent on the prevailing formation parameters.

Viscosity as we know is the resistance to fluid flow. The higher the viscosity of a fluid, the lesser its tendency to flow and vise-visa. Less viscous fluids flow faster than more viscous fluids. Viscosity is the major property of a drilling fluid or mud. Viscosifiers are usually used to modify fluid flow tendency.

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Viscosifiers are additives used to increase drilling fluid resistance to flow. It helps to moderate the viscosity of drilling fluid. The viscosifying agents tend to control the thickness of the drilling fluid to suit the prevailing well-bore condition. Mud viscosity is increased to enhance cuttings suspension, mud cake formation, and reduce water loss to the formation while drilling.

Some foreign-made Viscosifiers(additives) have been commonly used for the viscosifying purpose. Regular Poly Anionic Cellulose (PAC-R), Carbonyl Methyl Cellulose (CMC), and Hydroxyl Ethyl Cellulose(HEC) are common examples of imported standard viscosifiers. Since imported, the conventional materials are expensive concerning foreign exchange. The standard viscosifiers are not environment friendly as it causes major pollution challenges, especially to aquatic lives. Hence the need for a mud that is biodegradable, less toxic, and less costly from organic sources so it could serve as fertilizer after drilling activities.

The Nigerian Local Content Initiative was established to find a local substitute for imported foreign materials. In this practical research, plant seeds such as Brachystegia eurycoma (Achi), Mucuna solannie (Ukpo), and Detarium microcarpium (Ofor) were evaluated. The seeds are well-known thickeners and could be effective Viscosifier. The materials are cheaply available across Nigeria.

So far, researchers have intensified efforts to discover a local substitute to imported foreign Viscosifiers. A lot of materials have been subjected to experimental evaluations/investigations. use good enough, their findings are promising and could be improved.

[2] on his work "Enhancing the Performance of Ukpakala Clay for Use as Drilling Mud" proved that clay viscosity in their natural state does not meet American Petroleum Institute(API) standard specifications. Therefore, not suitable for drilling mud formulation unless improved by beneficiation with some percentage concentration of sodium carbonate.

The drilling fluids formulated with local biopolymer-Irvingia Gabonensis(also known as Deterium microcarpium or Ofor) have higher effective viscosity at 600 rpm reading, yield point, and higher transport ratio which indicate a better cutting carrying potential than the conventional mud [3].

Figure 1: Samples of Ukpo, Achi, and Ufor for test analysis

2 Research Methodology

Materials used for the research experiment included Distilled Water, Sodium Chloride(NaCl), Bentonite (local clay), Barite, Regular Poly Anionic Cellulose(PAC-R), Mucuna Solannie(Ukpo), Brachystegia eurycoma(Achi), and Detarium microcarpium(Ofor).

The experimental apparatus used in the study consists of a 200 Mesh Tyler Sieve, Ostward Viscometer, Weighing balance, Thermometer, Pipette, and Stopwatch.

3 Theory and Calculation

The seeds of Ukpo, Achi, and Ofor were treated, processed, and stored according to the research of [5]. In the study, samples of Ukpo, Achi, and Ofor processed by soaking methods and stored in a fireplace or plastic container have higher viscosity.

The Raw seeds of Ukpo, Achi, and Ofor were sorted, soaked for 6hrs, dehulled, briefly dried under Sun, grind into flour, dried, and then stored in a labeled plastic container for a practical experiment.

Measurements of freshwater (350ml), Bentonite(22.5g), Barite(5g), and NaCl(5g) as used in the experiment were adapted from the work of [4]. The measured quantities comply with API specifications for standard.

350ml freshwater, 22.5g Bentonite, 5g Barite, and 5g NaCl are added to a given quantity of Pac-R, Ukpo, Ofor, and Achi as shown in Table 1 below.
Mud sample properties especially viscosity are tested, evaluated, and a conclusion drawn.

Table 1: *samples of composition.*

Mud Mixtures	Samples
5g Pac-R + *M	A1
6g Pac-R + *M	A2
7g Pac-R + *M	A3
8g Pac-R + *M	A4
5g Ukpo + *M	B1
10g Ukpo + *M	B2
15g Ukpo + *M	B3
20g Ukpo + *M	B4

Mud Mixtures	Samples
5g Achi + *M	C1
10g Achi + *M	C2
15g Achi + *M	C3
20g Achi + *M	C4
5g Ofor + *M	D1
10g Ofor + *M	D2
15g Ofor + *M	D3
20g Ofor + *M	D4

3.1 Mathematical Expressions and Symbols

API - American Petroleum Institute
Pm - Mud Density
RPM - Revolution Per Minute
AV - Apparent Viscosity
PV - Plastic Viscosity
Yp - Yield Point
A = Mud Sample Mixture of Pac-R
B = Mud Sample Mixture of Ukpo
C = Mud Sample Mixture of Achi
D = Mud Sample Mixture of Ofor

$$M = 350\text{ml Water} + \text{Bentonite}22.5\text{g} + 5\text{g Barite} + 5\text{g NaCl} \quad (1)$$

4 Results and Discussion

Table 2: Readings and evaluation of some rheological properties

Samples	Weight (g)	Pm(ppg)	Φ600 (cp)	Φ300 (cp)	AV (cp)	PV (cp)	Yp (cp)
A1	5	7.60	270	205	135	65	140
A2	6	7.80	286	218	143	68	150
A3	7	8.70	292	223	146	69	154
A4	8	9.30	310	237	155	73	164
B1	5	7.40	65	43	32.5	22	21
B2	10	7.45	215	170	107.5	45	125
B3	15	7.55	290	218	145	72	146
B4	20	8.80	330	270	165	60	210
C1	5	7.20	26	16	13	10	6
C2	10	7.40	68	60	34	18	42
C3	15	7.60	174	147	87	27	120
C4	20	7.65	248	202	124	46	156
D1	5	7.40	25	16	12.5	9	7
D2	10	7.60	53	42	26.5	11	31
D3	15	7.60	93	69	46.5	24	45
D4	20	7.70	176	137	88	39	98

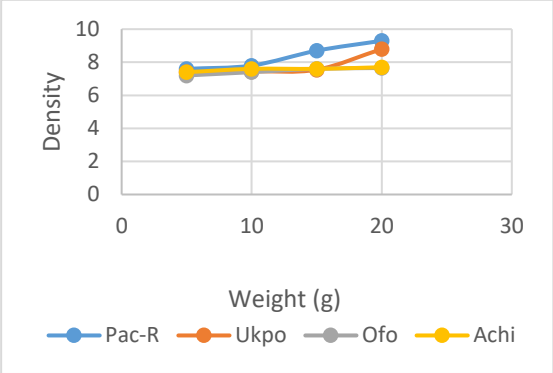

Figure 2: Effect of mud concentration(g) on density

In Figure 4.4.1; the increase in weight of drilling mud increases mud density and hydrostatic pressure required to subdue formation pressure. Pac-R, Ukpo, Achi, and Ofor showed a similar effect of increased mud concentration on density. An increase in mud density increases carrying capacity.

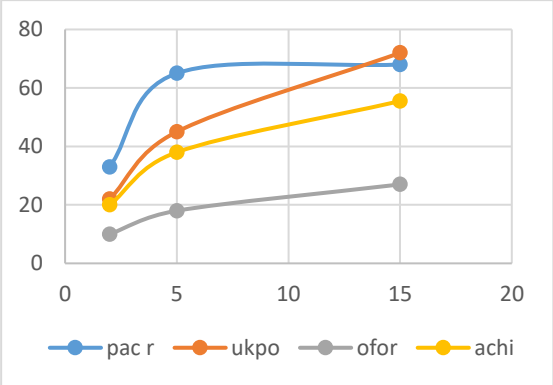

Figure 3: Effect of mud concentration(g) on the plastic viscosity

In figure 4.4.2; Ukpo showed a higher value of plastic viscosity due to increased weight. Hence, an increase in the concentration of the mud increases its resistance to flow.

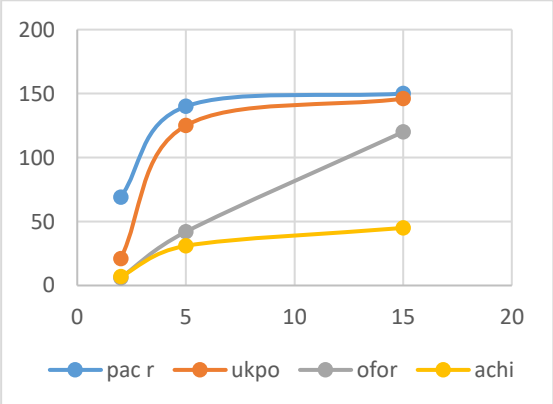

Figure 4: Effect of Mud concentration(g) on Yield Strength

From Fig. 4.4.5: The yield strength of the local materials compares closely to that of Pac-R. An increase in the weight of the local additives increases its effectiveness in resisting flow due to increased viscosity.

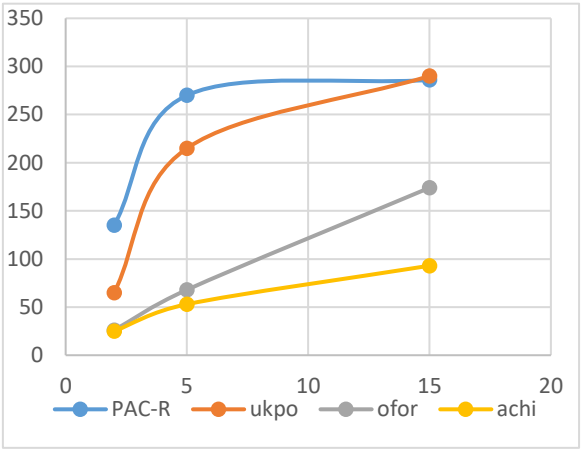

Figure 5: Effect of Mud concentration(g) on Viscosity at Φ600 rpm

From Fig4.4.6: At 600RPM although Pac-R still is a better viscosifier, the local materials (Ukpo, Ofo, and achi) are not far behind. An increase in the quantity of the Local based materials increases its viscosity and could be used as a substitute for Pac-R.

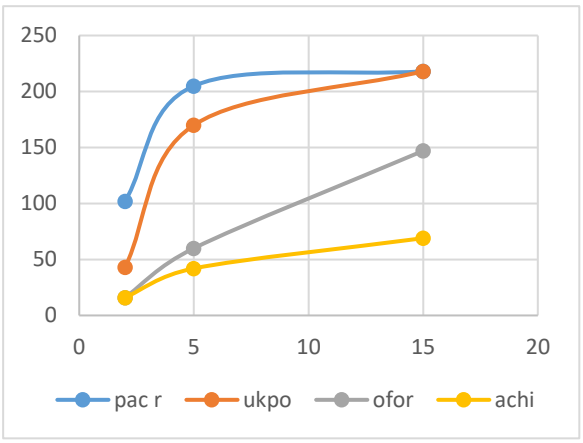

Figure 6: Effect of Mud concentration(g) on Viscosity at Φ300 rpm

From Fig 4.4.7: At 300RPM the Pac-R is a better viscosifier. When the revolutions being made during the drilling process are low Pac-R is a still better additive to achieve a better ROP (rate of penetration). Meanwhile, Ukpo, Ofo, and Achi followed closely.

5 Conclusions

Results from the study of the Local Additives (Mucuna solannie, Brachystegia eurycoma, and Deterium microcarpium) showed they have the potential to substitute standard viscosifier(Pac-R). The following conclusions were drawn;

(i) Mud Density of the Local Additives is good enough to provide hydrostatic pressure necessary to balance formation pressure.

(ii) The viscosity of the Local materials is high enough for efficient hole cleaning, cutting transport, and removal.

(iii) The Local Additives are biodegradable, non-toxic, less expensive, environmentally friendly, and can protect the environment from the detrimental effect of conventional mud additives.

(iv) At 300rpm and 600rpm, Pac-R is still a better viscosifier to achieve a good Rate of Penetration during a drilling operation. But Ukpo, Achi, and Ofor followed closely.

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