DRILLING FLUID FORMULATION USING CELLULOSE GENERATED FROM GROUNDNUT HUSK

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ABSTRACT

The work presents an experimental approach on the preparation of drilling mud using, local materials. Properties of mud formulated with variable concentrations of cellulose processed from groundnut husk have been studied. The results obtained were compared with that of a standard, mud formulated from polyanionic cellulose (PAC). The results shows that the pH, mud density, specific gravity of the mud formulated from groundnut husk cellulose were higher than that of the standard mud. The results show that cellulose from groundnut husk can significantly reduce fluid loss control agent. Hence, the polymer can be used as fluid loss control agent in the mud system. The water loss analysis showed that the drilling fluid formulated from groundnut husk cellulose of 2.0g has a high fluid loss of 7.6mls with a maximum percentage deviation of 13.2% at 30 minutes while the groundnut husk cellulose 4.0g has a lower fluid loss of 6.5 mls with a maximum percentage deviation of -0.02% at 30 minutes when compared with that of polyanionic cellulose. This suggests that cellulose processed from groundnut husk is a better fluid loss control agent than polyanionic cellulose (PAC) in the preparation of drilling mud.

Keywords : Drilling mud; Groundnut husk; Cellulose; Polyanionic Cellulose; PAC

1 INTRODUCTION

Drilling the wellbore is the first and the most expensive step in the oil and gas industry. expenditures for drilling represents 25% of the total oil field exploitation cost and are concentrated mostly in exploration and development of well drilling [1]. drilling fluids, which represent about one fifth (15-18%) of the total cost of petroleum well drilling, must generally comply with three important requirements – they should be easy to use, not too expensive and environmentally friendly. the complex drilling fluid plays several functions simultaneously. they are intended to clean the well, hold the cuttings in suspension, prevent caving, ensure the tightness of the well wall and form an impermeable cake near the wellbore area. moreover, they also have to cool and lubricate the tool, transfer the hydraulic power and carry information about the drilled formation by raising the cuttings from the bottom to the surface.

Drilling fluid has gone through major technological evolution, since the first operations performed in the United States, using a simple mixture of water and clays, to complex mixtures of various organic and inorganic products used in recent times. These products improve fluid rheological properties and filtration capability, allowing the bit to penetrate heterogeneous geological formations under the best conditions. However, the design and production of drilling fluids in Nigerian oil and gas sector over the years has been faced with the challenges of either importing the materials to produce and or in some cases imported, already designed and produced drilling mud. In this case, industry in this sector adjust the properties of the drilling fluid with the aid of the right types of additives which are also imported to suit the formation requirements of the area to be drilled [2].

Cellulose constitutes the most abundant, renewable polymer resource available today worldwide. It has been estimated that by photosynthesis, 1011-1012 tons are synthesized annually in a rather pure form, e.g. in the seed hairs of the cotton plant, but mostly are combined with lignin and other polysaccharides (so-called hemicelluloses) in the cell wall of wood plants. Cellulose is a versatile starting material for chemical conversions, aiming at the production of artificial, cellulose derivatives used in many areas of industry and domestic life [3].

The primary occurrence of cellulose is the existing lignocellulosic material in forests, with wood as the most important source. Other cellulosic materials include agricultural residue, water plant, grasses and other plant substances. Besides cellulose, they contain hemicelluloses, lignin and a comparably small amount of extractives. Commercial cellulose production concentrates on harvested sources such as wood or on naturally high pure sources such as cotton [4].

Various authors have carried out studies taking consideration of different materials and methods. Egun and Achandu [5] carried out studies on the comparative performance of cassava starch to polyanionic cellulose (PAC) as a fluid loss control agent in water based mud and the result obtained indicated close similarity between the cassava starch and PAC. Ademuluyi et al. [6] studied five different cassava starches and tested their viscosity and fluid loss control properties in water based mud and compared with an imported sample. It was discovered that some of the newly developed local starch products (with high amylose content and high water absorption capacity) have similar or better filtration control properties than the filtration control properties of a widely used imported starch. Slawomir et al. [7] carried out a research on the application of starch derivatives as the regulators in potassium drilling mud filtration. They studied the derivatives of starch, such as graft copolymer of acrylamide into starch, carbamoylethylated starch, carbamoylethyl-dihydroxypropylated starch, and dihydroxy-propylated starch and the influence of modified starch and their blends with amylose as protective agents in the filtration of drilling fluids. They found out that salt-starch drilling mud (potassium starch drilling fluid) for low filtration obtained should contain 2-4% of starch component per 1m3 of drilling fluid. Alexander and Albert [8] carried out a research on improving the thermal stability of starch in formate fluids for drilling high temperature shales. The thermal stability of starch was evaluated in sodium/potassium formate and potassium chloride fluids. The research showed that despite the relatively low concentration of starch (4yr/350cm) and low density of mud, the sodium and potassium formate salts increased the thermal stability of starch up to 150c for 16 hours is better than that of potassium chloride fluid and also increased the stability of starch. Amanullah and Yu [9], researched on environmentally friendly fluid loss additives to protect the marine environment from the detrimental effect of mud additives. The paper described the fluid loss characteristics of several starches. The result indicated that some of the starches have static and dynamic fluid loss characteristics similar to or better than those of a widely used modified starch used by the mud industry. The product developed by gelatinization using a reactive extrusion technique have negligible impurities, need no solvent during gelatinization, produce no waste water as a by-product and thus are suitable for environment sensitive areas. Amanullah and Long [10], carried out a research on superior can-based starches for oil filed application in terms of suitability as drilling fluid additives. Experimental results showed that some of the newly developed starch products had similar or better filtration control properties, than that of a widely modified starch.

In the study carried out by Egun and Achandu [5], on the comparative performance of cassava starch with PAC it is observed that rapid biodegradation and thermal degradation of the local starch was not put into consideration. Starch-based drilling fluid additives are generally considered to be useful at temperatures up to 225^0F [11]. At this point, rapid hydrolysis and degradation takes place as well as rapid biodegradation of starch. Also in the research carried out by Ademuluyi et al. [6], on the fluid loss control properties of five different cassava starches in water based mud, no definite information was given regarding the concentration to be maintained or increased to reduce fluid loss in a mud system. Increasing the concentration of starch in the mud system does not give a significant change in fluid loss property.

The major aim of this work is to investigate the performance of local materials, specifically cellulose extracted from groundnut husk as substitutes in the preparation of drilling mud which would be suitable as compared to conventional drilling mud additives. Cellulose processed from Nigerian groundnut husk is used as a fluid loss reducing agent substitute for polyanonic cellulose in the preparation of drilling mud while also altering concentrations of the groundnut husk cellulose in the drilling mud and a comparative analysis is made with a standard drilling mud. Based on its ability to reduce API filtration rate with minimum increase of viscosity in water based drilling mud, processed cellulose from groundnut husk gotten from a farmland in Michika Local Government Area of Adamawa

State Nigeria can be used to give better fluid loss reducing properties in low concentrations, at a very cheap price and environmentally friendly manner.

2 MATERIALS

2.1 Equipments

The equipments used for this study includes: Oven (type 48 BE Apex Tray Drier), weighing balance, measuring cylinder, beakers, Hamilton beach mixer and cup, pH indicator strip, thermometer, knife, sieving mesh, bucket, bowl and stop watch, Fann viscometer, API filter press, mud balance and a 150 micron sieve.

2.2 Reagents/Chemicals

For Reagents and chemicals used for this work are listed as follows: water (H_2O), caustic soda (NaOH), soda ash (Na_2CO_3), polyanionic cellulose (PAC), potassium chloride (KCL), barite, xanthan gum, dilute acetic acid.

3 METHODS

3.1 Cellulose Extraction

Groundnut was gotten from Michika Local Government Area of Adamawa State Nigeria. The seeds were removed and the husk was used for the extraction. It was observed that the groundnut husk could be sensitive to extractive conditions. Strong alkali conditions and/or heating of the husk above 80^oC could result in the disintegration of the husk to sizes not suitable for high value fibrous applications. The husk was dipped into 0.5N sodium hydroxide solution with a solution to husk ratio of 10:1 at room temperature over night. The solution was then heated to 80^oC for 30 minutes. The extracted components were then drained and fibers formed were thoroughly washed first in warm water and later in cold water, neutralized in dilute acetic acid solution to remove any remaining alkali, oven dried and then blended into fine form [12].

3.2 Barite Preparation

76.8grams of barite was dissolved in 350mls of water and properly mixed using electric mixer for 5 minutes. The resultant solution was left over night for proper yielding.

3.3 Mud Formulation Procedure

360 ml of barite solution was measured out into the electrical mixer and agitated with the correct measurement of each material additive added at 5 minutes interval according to the order in which they appear on Table 1. After about 1 hour of agitation, the resultant mud was brought down for weighing with mud balance [5].

3.3.1 Polymer Mud Preparation Procedure

The preparation was made with the same procedure for conventional mud but in this case, polyanionic cellulose was replaced with groundnut husk cellulose.

3.3.2 Preparation of Experimental Samples

Sample A: (standard mud: 2.0g PAC and 2.8g xanthan gum)

Sample B: (mud with 2.0g groundnut husk cellulose and 2.8g Xanthum gum)

Sample C: (mud with 4.0g groundnut husk cellulose and 2.8g xanthan gum).

3.4. Determination of Mud Density (Mud Weight)

3.4.1 Calibration

1. Remove the lid from the cup, and completely fill the cup with water.
2. Replace the lid and wipe dry.
3. Replace the balance arm on the base with knife-edge resting on the fulcrum.
4. The level vial should be centered when the rider is set on 8.33 if not, add to or remove short from the well in the end of the bream.

3.4.2 Procedure

1. Remove the lid from the mud cup and fill the cup to overflowing with the mud to be tested. If air bubbles have been trapped in the mud, tap the cup briskly on the side until air bubbles break out.
2. Replace the lid on the cup and rotate it until it is firmly seated. Do not vent hole with your finger.
3. Make certain that some mud squeeze out the vent hole in the lid. Wash and wipe excess mud from the exterior of the mud balance covering the vent hole, then dry the balance. Vent hole must be covered during step 4.
4. Place the balance in its base with the knife-edges on the fulcrum rest.
5. Move the rider until the beam is balanced. The spirit level bubble should be on the center line.
6. Read the mud weight at the edge of the rider nearest the fulcrum (towards the knife-edge).
7. Clean and replace the instrument.

3.5 Determination of Mud Viscosity Using Fann Viscometer

Fill the measuring cup with a fresh sample of drilling fluid and immerse the rotor exactly to the scribed line. switch on the viscometer at a speed of 600rpm, wait until the dial has reached a steady reading and record the 600rpm dial reading.

Repeat this procedure at 300rpm, 200rpm, 100rpm, 6rpm, and 3rpm.

3.6 Determination of Fluid Loss

The determination of fluid loss in the mud using filter press is as follows:

1. Detach the mud cell from the filter press

frame.
2. Remove bottom of filter cell, place right size filter paper in the bottom of the cell.
3. Introduce mud to be tested into cup assembly, putting filter paper and screen on-top of mud, tighten screw clamp.
4. With the air pressure valve closed, clamp the mud cup assembly to the frame while holding the filtrate outlet end finger tight.
5. Place a graduated cylinder underneath to collect filtrate.
6. Open air pressure valve and start timing at the same time.
7. Report the amount of filtrate collected for specified intervals up to 30 minutes.

3.6.1 Wall Building

It should be measured in thirty (30) second of an inch in whole number. A Vernier caliper could be used to measure the thickness, however, while measuring care should be taken not to press vernier jaw on mud cake to penetrate through.

4 RESULTS

Table 1 shows the mud properties for sample A,B and C. The mud pH , mud density and the specific gravity are shown for the three samples.

TABLE 1
MUD PROPERTIES OF SAMPLE A, B AND C RESULTS

Sample	pH	Mud density (ppg)	Specific Gravity
A	7	7	0.83
B	7.5	9.5	1.14
C	7.5	9.5	1.14

The pH, mud density and specific gravity of the mud prepared from groundnut husk cellulose is higher than that of the standard mud.

4.1 Effect of the Concentration of Cellulose on the Rheology of Drilling Mud

Increasing the amount of cellulose in the drilling mud makes the mud thicker Viscosity is resistance to flow, therefore it is expected that the thicker mud will have higher resistance to flow (higher viscosity). The results in Table 3 and 4 show that the viscosity of drilling mud sample C (thicker mud) are higher than those of sample B.

TABLE 2
RHEOLOGY OF STANDARD MUD SAMPLE A

RPM	Dial Reading
600	246
300	206
200	189
100	155
6	74.5
3	54.5
PV (cp)	42
YP	164

Gel (10 secs) = 74; Gel (10 mins) = 77

where,
RPM = Rotations per minute
PV = plastic viscosity of the mud sample
YP = Yield point of the mud sample
Dial reading = The reading taking at 600rpm to 3rpm
Gel strength = It is a property of the driving fluid that demonstrates the ability of the drilling fluid to suspend drill solid and weighting materials when circulation is ceased.

TABLE 3
RHEOLOGY OF MUD SAMPLE B

RPM	Dial Reading
600	185
300	153
200	136
100	130
6	39
3	35
PV(cp)	33
YP	120

Gel (10 secs) = 50; Gel (10 mins) = 59

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TABLE 4
RHEOLOGY OF MUD SAMPLE C

RPM	Dial Reading
600	195
300	162
200	144
100	112
6	39
3	32
PV(cp)	33
YP	129

Gel (10 secs) = 39; Gel (10 mins) = 42

Table 2, 3 and 4 show the rheology of standard mud and the prepared mud, which reading was taken at 600rpm, 300rpm, 200rpm, 100rpm, 6rpm and 3rpm dial reading and the PV(cp), YP were also gotten, their gel strength was also gotten after 10 seconds and 10 minutes.

Table 5 depicts the volume of fluid loss with respect to time for samples A, B and C. From the table, it is clear that Sample C is of very close range with the standard Mud Sample A. The maximum percentage deviation of Sample B is 18.2% at 5 minutes and a minimum of 13.2% at 30 minutes; while that for Sample C are 7.4% at 5 minutes and -0.02% at 30 minutes respectively. This shows that Sample C can be used as a substitute of Sample A in time of crisis to maximize profit.

TABLE 5
VOLUME OF FLUID LOSS (ML) VS TIME (MINS) FOR MUD SAMPLES

Time (min)	Vol of fluid loss (ml) A	Vol. of fluid loss(ml) B	Vol. of fluid loss(ml) C
5	2.7	3.3	2.9
10	4.5	5.2	4.6
15	5.3	6.7	5.3
20	5.9	7.2	5.6
25	6.4	7.4	5.9
30	6.6	7.6	6.5

4.3 GRAPHICAL PRESENTATION AND DISCUSSION ON THE RESULTS

4.3.1 Variation of the Volume of Fluid Loss of Sample A with Time

Fig. 1 shows that the volume of water collected between 5-10 minutes is rapid but between 10-30 minutes the volume collected becomes less with increased in time. This was as a result of the formation of mud cake with time.

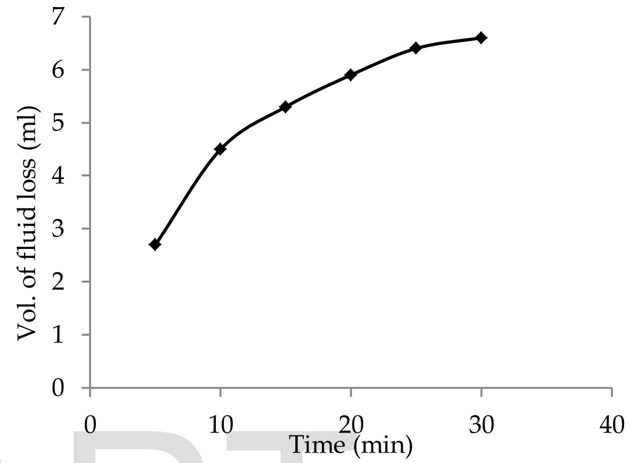

Fig. 1 Volume of fluid loss of sample A (ml) against Time (min)

4.3.2 Variation of the Volume of Fluid Loss of Sample B with Time

From Fig. 2, the fluid loss is also rapid at the initial stages. As time goes on the fluid loss also reduced with time which is suspected to be as a result of formation of filter cake in the sample. This filter cake reduces the fluid loss as it is deposited.

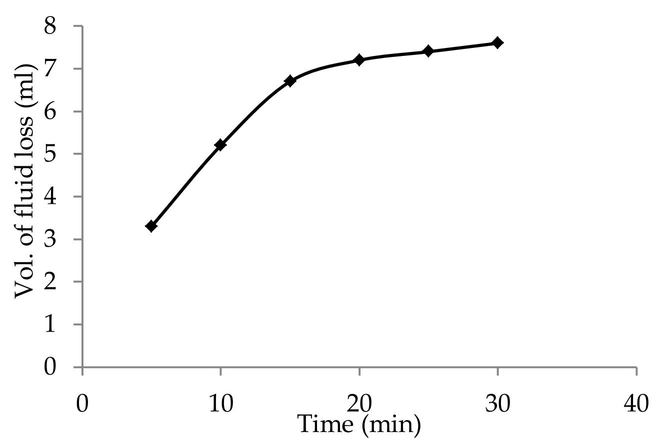

Fig. 2 Volume of fluid loss of sample B (ml) against Time (min)

4.3.3 Variation of the Volume of Fluid Loss of sample C with Time

From Fig. 3, it can be seen that there is initial high rate of fluid loss. This also decreases rapidly with time. The decrease is suspected to be as a result of mud cake even forming faster to minimize fluid loss within a shorter time as it is deposited.

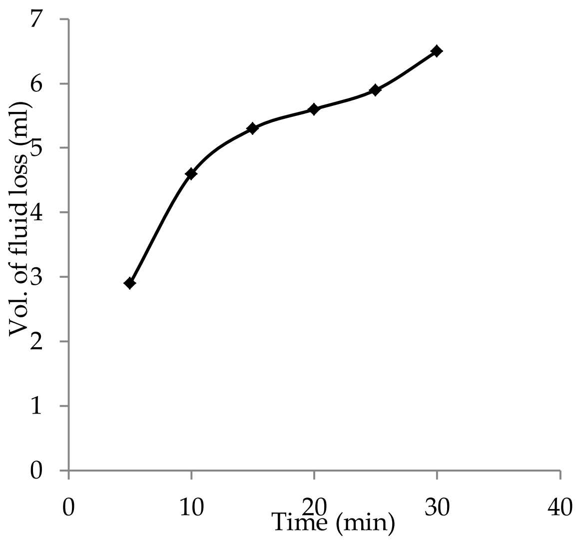

Fig 3 Volume of fluid loss of sample C (ml) against Time (min)

4.3.4 Comparison of the Volume of Fluid Loss of Sample A and B with Time

Fig. 4 shows the comparison of fluid loss between sample A and B with time where sample B has a higher fluid loss than sample A.

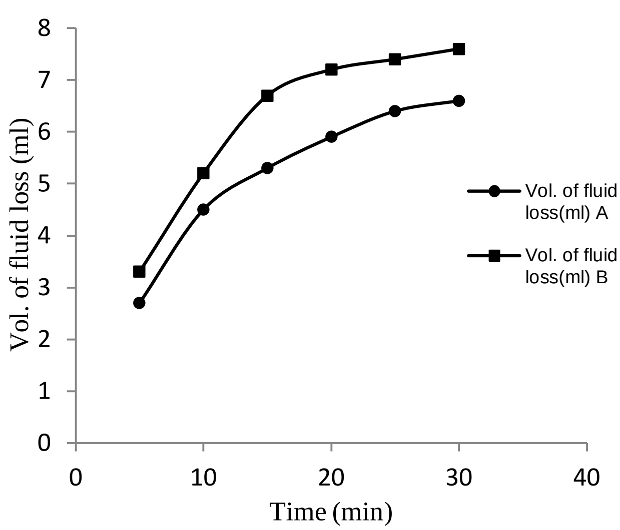

Fig. 4. Volume of fluid loss of sample A and B (ml) against Time (min)

From the figure above, it is noticed that as time increases, the rate of fluid loss in sample B is higher than that in sample A. This is suspected to be as a result of filter cake formation in sample B being faster than in that in sample A.

4.3.5 Comparison of the Volume of Fluid Loss of Sample A and C with Time

From Fig. 5, the volume of fluid loss in sample A and C are the same initially but after 15 minutes there is a slight increase in fluid loss in sample A which is also as a result of formation of filter cake.

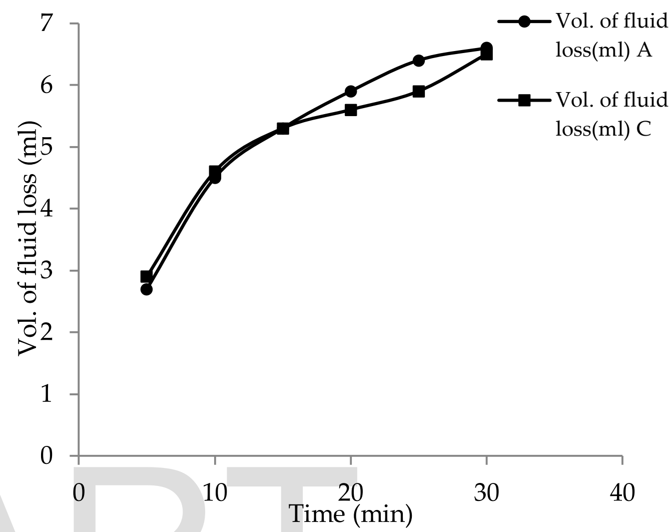

Fig 5 Volume of fluid loss of sample A and C (ml) against Time (min)

4.3.6 Comparison of the Volume of Fluid Loss of Sample A, B and C with Time

From Fig. 6 it could be noted that sample B has a higher fluid loss, while the fluid loss in sample A and C are the same between 5-15 minutes. After 15 minutes fluid loss in sample C becomes lower than that in sample A, this is as a result of the formation of filter cake faster in sample C which results to a lower fluid loss, this shows that cellulose from groundnut husk can be used as a substitute in the preparation of drilling mud and when the concentration is being increased it will meet the properties of the standard mud.

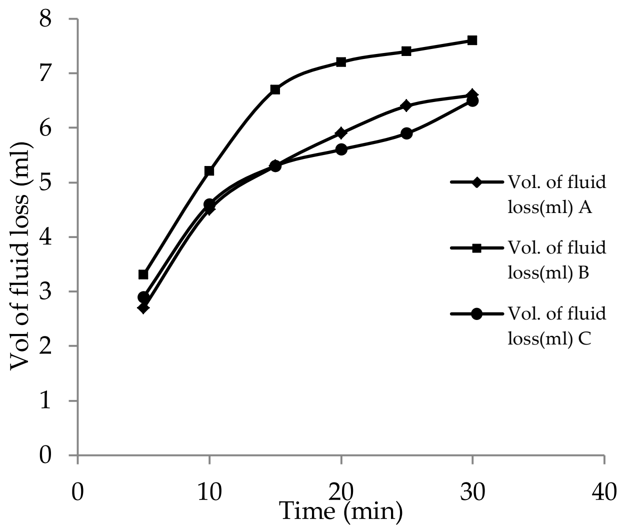

Fig 6 Volume of fluid loss of sample A, B and C (ml) against Time (min)

5 CONCLUSION

Drilling mud (fluid) has been prepared using cellulose from processed groundnut husk that was sourced locally.

The result shows the following:

1) The pH value of the prepared mud is comparable to that of the standard mud.
2) Mud density of the prepared mud is higher than that of standard mud by 28%.
3) Specific gravity of the prepared mud was considerately higher than that of the standard mud.
4) The rheological properties of the prepared mud were lower than that of the standard mud by 50%.
5) Cellulose from processed groundnut husk can control fluid loss in a drilling mud effective and also at higher concentrations.
6) The close value of fluid loss obtained when the exact concentration of substituted polyanionic cellulose (PAC) was used and the lower value of fluid loss at higher concentrations of groundnut husk cellulose shows that groundnut husk can be used to replace polyanionic cellulose in the preparation of drilling mud.
7) The accessibility and low cost of the groundnut husk which is a waste material can account for a reduced well cost and increase in the concentration of the groundnut husk will give a good fluid loss.
8) The drilling fluids prepared from groundnut husk are environmentally friendly.
9) The cost effectiveness of this mud will reduce importation of mud or its additives which will boost the economy.
10) With the improvement in the economy, jobs will be created

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