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Evaluation of Corn Cob Cellulose and its Suitability for Drilling Mud Formulation

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ABSTRACT
Properties of mud formulated with variable concentrations of cellulose processed from corn cob have been studied. The results obtained were compared with that of a standard mud formulated from Polyanionic Cellulose (PAC). These results have shown that the pH, mud density, specific gravity of the mud formulated from corn cob cellulose are higher than that of the standard mud, but rheology of the prepared mud was lower than that of the standard mud. The results show that cellulose processed from corn cob can significantly reduce fluid loss in a water based drilling mud, suggesting cellulose as a good fluid loss control agent. It is confirmed that polymer can be used as fluid loss control agent in the mud system. The water loss analysis showed that the drilling fluid formulated from local material has a lower fluid loss of between 5.2-5.8 mls as compared to 6.6 mls for PAC. This also confirms that cellulose processed from corn cobs are preferred fluid loss control agents thanPolyanionic Cellulose (PAC).

Keywords-Drilling mud, Cellulose, viscosity, fluid loss.

I. INTRODUCTION

Cellulose is the most abundant, renewable polymer resource available worldwide. Haven 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 derivative used in many areas of industry and domestic life [1]. The major purpose of this study is to investigate the performance of local materials (cellulose from corn cob) as a substitute for the preparation of drilling mud. As demand for oil and gas increases, so does the need for extremely economic techniques to recover these resources. The process of drilling must however be safe, cost effective and environmental friendly. One of the major challenges of the indigenous petroleum companies is the importation of mud additives or the drilling mud itself, this has not allowed them to compete favorably with foreign counterparts [2].

1.1 Occurrence and natural sources

The main source of cellulose is that of polysaccharides in different types of plants, often combined with other. The primary occurrence of cellulose is lignocellulosic materials found in woods which is the most important and common 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 extracts. Commercial cellulose production concentrates on harvested sources such as wood or on naturally pure source such as cotton.

1.2 Structure and analysis

Cellulose is a polydisperse linear homopolymers consisting of regio-and enantioselectively β-1,4-glycosidic linked D-glucopyranose units (so-called) anhydroglucose unit (AGU). It has been shown by HNMR spectroscopy that the β-D-glucopyranose adopts the 4C chain information, the lowest free energy conformation of the molecule. As a consequence, the hydroxyl groups are positioned in the ring plane while the hydrogen atoms are in the vertical position (axial). The polymer contains free hydroxyl groups at the C-2,C-3, and C-6 atoms. Based on the 0H groups and the oxygen atoms of both the pyranose ring and the glycosidic bond, ordered hydrogen bond systems form various types of supramolecular semi-crystalline structures. Egun and Achadu carried Egun and Achadu 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 [3]. Five different cassava starches were studied and tested for their viscosity and fluid loss control properties in water based mud and then compared with an imported sample (Barazan D). 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 [3]. The use of local starches, namely sago and tapioca, as fluid loss control agents in water based mud was investigated. It was observed that sago and tapioca starches could achieve expected viscosity produced by PAC but sago could give a thinner mud cake than PAC mud. Both samples were found to give comparable values of fluid loss [4].

II. ATTEMPTS MADE FOR MUD ANALYSIS

Research on the application of starch derivatives as regulators in potassium drilling mud filtration had been conducted. The study of the derivatives of starch, such as graft copolymer of acrylamide into starch, carbamoylethylated starch, carbamoylethyl-dihydroxypropylated starch, and dihydroxypropylated starch were also analysed. The influence of modified starch and their blends with tylose as protective agents in the filtration of drilling fluids. And was comfirmed that salt-starch drilling mud (potassium starch drilling fluid) for low filtration obtaining should contain 2-4% of starch component per 1m3 of drilling fluid [5]. Valizadeh carried out a research on improving the thermal stability of starch in formate fluids for drilling high temperature shale. 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 salts increased the thermal stability of starch up to 150c for 16 hours which was considered better than that of potassium chloride fluid and which also increased the stability of starch [6].

Evaluation of drilling-fluid filter-loss additives under dynamic conditions as described by Krueger tested the dynamic fluid loss rates on cores from clay-gel water-base drilling fluids containing different commercial fluid loss control agents (IMC, polyacrylate or starch), organic viscosity reducers (quebracho and complex metal lignosulfate) and oil at several different level of concentration. The result showed that in the dynamic system, the most effective individual additives to the clay-gel drilling fluid, based on cost-equalized concentrations, were found to be starch and the viscosity reducers [7].

A research on superior corn-based starches for oil field application in terms of suitability as drilling fluid additives was conducted. Experimental results showed that some of the newly developed starch products had similar filtration control properties than that of a widely modified starch[8]. The study of [2] on the comparative performance of cassava starch with PAC, it was 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 2250F [9]. At this point, rapid hydrolysis and degradation takes place as well as rapid biodegradation of starch. Also, the work ofAdemiluyi [3] on the fluid loss control properties of five different cassava starches in water based mud, it was noticed that 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.

Based on its ability to reduce API filtration rate with minimum increase in viscosity in water based drilling muds, processed cellulose from maize cob, gotten from a farmland in Nonwa-edume town, Tai Local Government Area of Rivers State is used in this work to give better fluid loss reducing properties in low concentrations, at a very cheap price and in an environmental friendly manner.

III. MATERIALS AND METHODS

Equipments used for this study includes: Oven (type 48 BE Apex Tray Drier), weigh 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, 150 microns sieve and spatula.

3.1 Materials, Reagents/Chemicals

Corn cobs were freshly harvested from a farm land in Nonwa-edume town in Tai Local Government Area of Rivers State. The reagents and chemicals used for this work are listed as follows: water (H2O), caustic soda (NaOH), soda ash (Na2CO3), polyanionic cellulose (PAC), potassium chloride (KCL), barite, xanthan gum, dilute acetic acid.

3.2 Cellulose Extraction Method

The method of extraction was based on experiences in obtaining fibers from various agricultural byproducts. Corn was harvested from a farm in Nonwa-uedume town in Tai Local Government Area in Rivers State. The kernels were removed and its cobs used for the extraction. It was observed that the corn cob could be sensitive to extractive conditions. Strong alkali conditions and/or heating of the cob above $80^{o}C$ could result in the disintegration of the cob to sizes not suitable for high value fibrous applications.

The cob was dipped into 0.5N sodium hydroxide solution with a solution to cob ratio of 10:1 at room temperature overnight.

The solution was then heated to 80oC for about 30 minutes. The extracts were 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.

3.3 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.

3.4 Mud formulation procedure

350 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 1.1. After about 1 hour agitation, the resultant mud was brought down for weighing with mud balance as demonstrated by Egun and Achandu.

3.5 Polymer Mud Preparation Procedure

The preparation was made with the same procedure for conventional mud but for this case, polyanionic cellulose was replaced with corn cob cellulose.

3.6 Preparation of experimental samples

Sample A is a standard mud sample prepared with 2.0g PAC and 2.8g xanthan gum.
Sample B mud was prepared with 2.0g corn cob cellulose and 2.8g xanthan gum.
Sample C mud was prepared with 3.0g corn cob cellulose and 2.8g xanthan gum.

3.7 Mud density (mud weight) determination

The procedure used to determine the mud density using the aroid mud balance is outlined below.

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 ituntil it is firmly seated. Do not vent hole with your finger. Make certain that some mud squeeze out the vent hole in the lid.
3. 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.

3.8 Determination of mud viscosity using fann viscometer

The measuring cup was filled with a fresh sample of drilling fluid and the rotor was immersed exactly to the scribed line. The viscometer was switch on at a speed of 600rpm and allowed to run until the dial reached a recorded steady reading. The procedure was repeated at 300rpm, 200rpm, 100rpm, 6rpm, and 3rpm.

3.9 Determination of filtration and wall building properties

The procedure adopted to determine the filtration and cake-building abilities of the mud samples are given below.

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.
8. Tabulate the results in an appropriate table.
9. Wall Building {measurement procedure for mud cake thickness (32nd of an inch or cm)

It should be reported in thirty second of aninch in whole number. Verniercaliper could be used to measure the thickness.However, while measuring care should be taken not to press the vernier jaw else the mud cakeshall penetrate through.

IV. RESULTS

Table 1-5 shows the results of the various mud properties investigated.

Table-1: Mud properties

Sample	pH	Mud density(ppg)	SG
A	7.0	7.0	0.83
B	8.0	9.6	1.15
C	7.1	9.4	1.13

Table-2: Rheology of Standard Mud

Rpm	Dial reading
600rpm	246
300rpm	206
200rpm	189
100rpm	155
6rpm	74.5
3rpm	54.2
PV (cp)	42
YP	164

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

Table-3: Rheology of Mud Sample B

Rpm	Dial reading
600rpm	150
300rpm	101
200rpm	86
100rpm	55
6rpm	40
3rpm	30
PV (cp)	49
YP	52

Gel (10 secs) = 25
Gel (10 mins) = 44

Table-4: Rheology of Mud sample C

Rpm	Dial reading
600rpm	163
300rpm	133
200rpm	113
100rpm	90
6rpm	38.5
3rpm	31,5
PV (cp)	30
YP	103

Gel (10 secs) = 40
Gel (10 mins) = 45

Table-5: Volume of Fluid loss (ml) vs Time (mins) for Mud Samples

Time(min)	5	10	15	20	25	30
Vol of fluid loss(ml) A	2.4	4.3	5.1	5.8	6.3	6.6
Vol of fluid loss(ml) B	1.2	3.5	4.3	5.2	5.6	5.8
Vol of fluid loss(ml) C	1.0	2.6	3.2	4.5	5.0	5.2

The pH, mud density and specific gravity of the mud prepared from corn cob cellulose was found to be higher than that of the standard mud. However, the rheology of the standard mud is higher than those of the prepared mud.

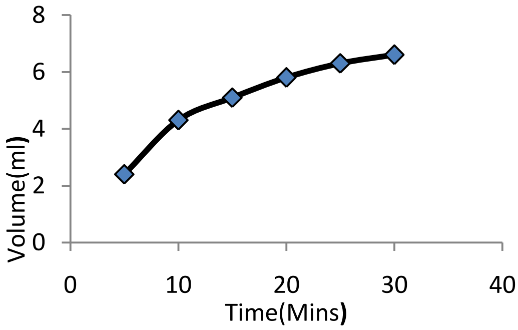

Fig-1: Volume of fluid loss in sample A (ml) with Time (min).

From the figure above, the volume of water collected between 5-10 minutes was rapid but between 10-30 minutes the volume collected became less with increase in time which was as a result of the formation of mud cake with time.

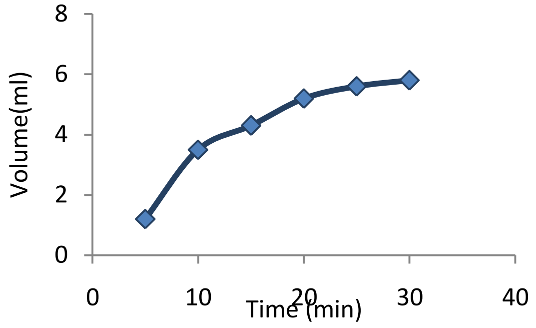

Fig-2: Volume of fluid loss in sample B (ml) with Time (min).

From the figure above there also seems to be a higher initial rate of fluid loss in the polymer mud. This later decreased with time. The decrease was suspected to be as a result of the formation of filter cake on the filter paper which minimizes the fluid loss as it is deposited.

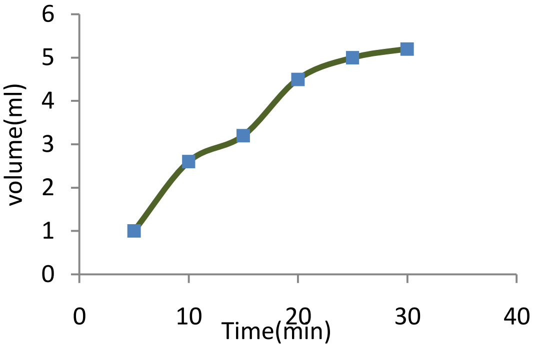

Fig-3: Volume of fluid loss in sample C (ml) with Time (min)

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

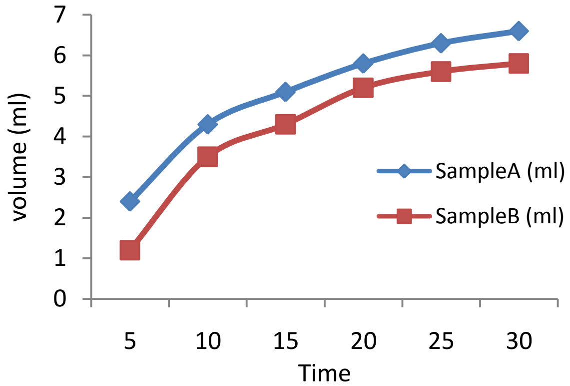

Fig-4: Volume of fluid loss in A+B (ml) with Time (min).

From the figure above, within 30 minutes, the volume of fluid in sample B was found to be less than that of sample A. This decrease showed that the formation of mud cake in sample B was more rapid than in sample A.

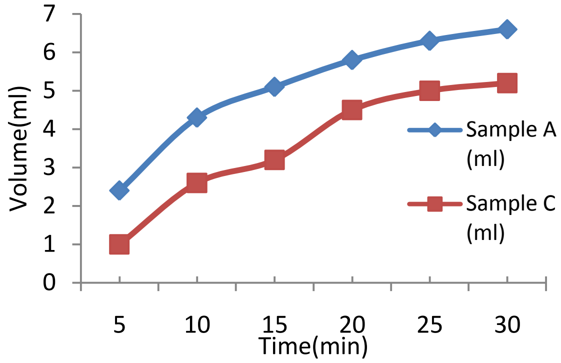

Fig -5: Volume of samples A+C (ml) with Time (min).

From the figure above, within 30 minutes, the volume of fluid loss in sample C was small as compared to that of sample A. This showed that mud cake deposition is much faster than in sample A.

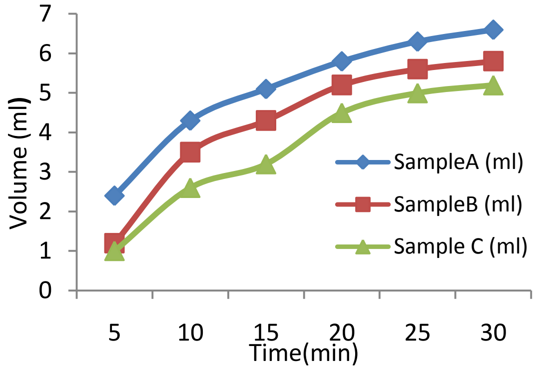

Fig-6: Volume of fluid loss in samples A,B and C (ml) with Time (min).

From the figure above, the volume of fluid loss in sample C was much more less as compared to that of sample A and B. the decrease was suspected to be as a result of formation of mud cake which seemed to be deposited faster when compared to samples A and B.

V. CONCLUSION

Prior to the experiments conducted, it can be concluded that

(1) The pH value of the prepared mud was comparable to that of the standard mud.

(2)The prepared mud density was higher than that of standard mud by 27%.

(3)Specific gravity of the prepared mud was considerably high than that of the standard mud.

(4)The rheological properties of the prepared mud were lower than that of the standard by 50%

(5)Cellulose from corn cob can control fluid loss in a drilling mud significantly and even better when the concentration is increased in the water based mud.

(6)The lower volume of fluid-loss obtained from corn cob cellulose as compared to polyanionic cellulose reveals that cellulose processed from corn cob can be used as a substitute to polyanionic cellulose (PAC).

(7)The availability and cheapness of corn cobs which is considered a waste material would account for a reduced overall drilling cost. Increased concentration of the corn cob will give a lower fluid loss value.

(8) Muds formulated with cellulose from corn cobs are environmentally friendly.

(9)The cost effectiveness of this mud will enable indigenous companies to compete favorably with their foreign counterparts, improve the economy and reduce importation of drilling fluid or its fluid loss additives in water based muds.

(10) The improvement of the economy will create job opportunities

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