INVESTIGATION OF LOCAL POLYMER (CASSAVA STARCHES) AS A SUBSTITUTE FOR IMPORTED SAMPLE IN VISCOSITY AND FLUID LOSS CONTROL OF WATER BASED DRILLING MUD

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ABSTRACT

Comparative study of local polymer (cassava) with an imported type in controlling viscosity and fluid loss in water-based mud was investigated in this study. Five different cassava starches were tested as viscosifiers and fluid loss control additives in water based mud and compared with Barazan D, an imported sample. Experimental results indicated that at same concentration, the imported sample had higher rheological properties compared with the local samples. However, 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 imported sample. Although the viscosity of the drilling fluid produced from the local starches were lower than that of the imported type, with proper quality control efforts of the local samples, they could be used as a substitute for imported grade for exploration and exploitation of oil and gas in Nigeria. It is also hoped that this work will open new market for non-food use of starches from cassava and thus expected to provide economic benefit to Nigerian farmers and a way forward to actualize vision 20-2020 agenda.

Keywords: local starch, Barazan D, fluid loss, viscosity, swelling power, water based mud.

INTRODUCTION

The success of drilling operations depends on the proper selection and monitoring of the drilling fluid system. Considering the techno-economic and environmental factors, drilling a well successfully depends very much on the drilling fluids system. This simply means that good drilling fluid enhances the operation while poorly designed fluid system generates numerous drilling problems. The composition of drilling fluid depends on the requirements of the particular drilling operations. Starch is the second most abundant biomass found in nature, next to cellulose (Herman Katopo *et al*., 2002). It consists of two major components namely amylose and amylopectin, chemically, it contains amylose, a liner polymer with a molecular weight in the range of 100,000 - 500,000 and amylopectin, a highly branched polymer with a molecular weight n the range of 1-2 million (Wing, 1988).

Starch is usually used in the technology of drilling fluids in modified forms due to its solubility in water. Starch materials are predominantly used as effective protective colloids decreasing the filtration of practically all kinds of water dispersing drilling fluids with the impact on the kind of used salt and additionally increasing the viscosity of drilling fluids. This starch action is caused by its swelling and increasing of its volume due to free water absorption. At the same time we can observe the decrease of filtration and the increase of rheological properties of drilling fluids. Swelled starch becomes a component of filtrating deposit to form polymer-clayey mixture. This mixture decreases the permeability of this deposit and reduces negative action of filtrate on sectors of borehole without drill pipe. There is a possibility of controlling the permeability of filtration deposit by proper utilization of starch constituents and their mixture with bentonite and other polymers (Chatterji, *et al*., 1981, Joel, *et al*., 2010).

The amylose component of starch controls the gelling behaviour since gelling is the result of re-association of the linear chain molecules. Amylopectin is usually larger in size. The large size and the branched nature of amylopectin reduce the mobility of the polymer and their orientation in an aqueous environment. The abundance in hydroxyl groups in the starch molecules impart hydrophilic properties to the polymer and thus its potential to disperse in water.

Different types of polymers and chemicals are used by the petroleum industry to design some drilling muds to meet some functional requirements such as appropriate mud rheology, density, fluid loss control property etc. (Amanullah *et al*., 1997). Amanullah and Long (2004) developed several corn-based starches using local resources to study their suitability to use as drilling fluid additive. Experimental results indicate that some of the newly developed starch products have similar or better filtration control properties than the filtration control properties of a widely used imported starch. The novel products have higher purity and thus expected to be better candidates for exploration and exploitation of oil and gas in environment sensitive areas. Okumo and Isehunwa (2007) studied the prediction of the viscosity of a water-base mud treated with cassava starch and potash at varying temperatures using factorial design. The work of Ikegwu *et al*., 2009 shows that variations were observed in the functional properties of the starch samples of about 13 cassava cultivars studied; water absorption capacity ranged from 59.75- 68.02%; oil absorption capacity 60.70 - 80.01%; swelling power 5.49 - 6.92% and solubility index 4.25 - 5.96%. Significant differences ($P<0.05$) were also observed in the functional properties of the starch samples. Onitilo (2007) also reported the same on the test carried out on 40 cassava varieties. Therefore need to study influence of these functional properties on the viscosity and fluid loss of drilling fluid produced from different cassava starches is inevitable.

This study is aimed at undertaking comparative study using local polymer (different cassava starches) with an imported type to determine viscosity and fluid loss control capabilities with water based drilling mud.

MATERIALS AND METHODS

Materials

In this research work, local starches from five different cassava species and an imported type listed in Table-1 were used to formulate the water based drilling fluid. The local cassava was obtained from IITA (International institute for tropical agriculture), Onne in Nigeria. Cassava starches were prepared as whole cassava flour. A control test was first carried out using imported sample (Barazan D). This is a polysaccharide used as viscosifying and fluid loss control agent. Water was used as the basic material for the mud formulation. Other materials used are shown in Tables 2 and 3 below:

Table-1. Functional properties of local starch.

S. No.	Type of cassava	Mud types	Amylose (%)	Starch (%)	Swelling power (%)	WAC (%)	Dry matter (%)
1	TMS 30572	Mud A	27.69	74.21	9.04	122.45	95.13
2	TME 419*	Mud B	18.97	70.87	-	-	-
3	TMS 95/0289	Mud C	23.93	85.24	11.58	86.98	91.41
4	TMS 91/02324	Mud D	21.45	78.54	11.43	96.22	94.33
5	TMS 96/1642*	Mud E	22.77	67.36	-	-	-

Source: Onitilo *et al*, (2007), Eke *et al.*, (2010)*

Table-2. local and imported starches.

S. No.	Starch type	Sample
1	Barazan D	Control
2	TMS 30572	A
3	TME 419	B
4	TMS 95/0289	C
5	TMS 91/02324	D
6	TMS 96/1642	E

Preparation of starch

The method described by IITA for the production of whole cassava flour was used for the production of various cassava starches. The cassava roots were harvested from the farm (IITA, Onne) and washed to remove dirt from the skin. Ten kg of freshly harvested cassava roots/genotype were peeled manually using a stainless steel knife and washed thoroughly with potable water to remove dirt and adhering sand particles. The peeled roots were grated and sieved. The mixture was filtered. The filtrate was allowed to settle for about 6 hours. The supernatant was decanted and sediment washed three times with potable water to obtain a white, odourless and tasteless starch. The resultant wet starch plus fibre was thinly spread over an aluminium tray in the open air for drying under ambient conditions (28-30^{o}C, 50-65% RH) for 5 hours, to minimize damage of native starch granule. It was further dried in an air oven at about 60^{o}C for about 6 hours. The dried cake was milled using a blender to fine particles.

Determination of viscosity

Prior to the rheology test, the drilling mud formulation was made with required quantity of the additives as shown in Table-3.

Viscosity test was carried out at six different speeds (600, 300, 200, 100, 6 and 3rpm) and at three different temperatures namely, 80°F, 120°F and 150°F using Fann Model 35 Viscometer. Starting with the control, the viscosity was measured with the different prepared mud samples (A, B, C, D, E) produced from the various local cassava starches. After 16 hours, the static aging tests were done on the muds.

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Experimentation

Table-3. Additives and functions in the mud formulation.

S. No.	Additives	Functions	Quantity
1.	Water	Base Fluid	1 BBL
1.	Soda Ash	To add alkalinity to the system	0.25Ibs/bbl
2.	Caustic soda	To add alkalinity to the system	0.25Ibs/bbl
3.	PAC L	Viscosity enhancing and fluid loss control agent.	1.25Ibs/bbl
4.	PAC R	Viscosity enhancing and fluid loss control agent	1.75Ibs/bbl
5.	Potassium chloride	Inhibitor	13Ibs/bbl
6.	Barite	Weighting agent	428Ibs/bbl
7.	Starch (Cassava)	Viscosifying and fluid loss control agent.	2Ibs/bbl
8.	Barazan D	Viscosifying and fluid loss control agent.	2Ibs/bbl

Determination of API fluid loss

Prior to the fluid loss test, the drilling mud formulation was made with required quantities of the additives as shown in Table-3. The control mud sample from the imported polymer (Barazan D) was placed in API fluid loss cell and pressurized to 100 psig. The volume of the filtrate produced by the fluid was measured. Thereafter, the mud samples A, B, C, D and E produced from different local cassava starches respectively were tested.

RESULTS AND DISCUSSIONS

Test results are indicated in Figures 1 to 5 and discussions highlighted as reflected as applicable in the discussion section.

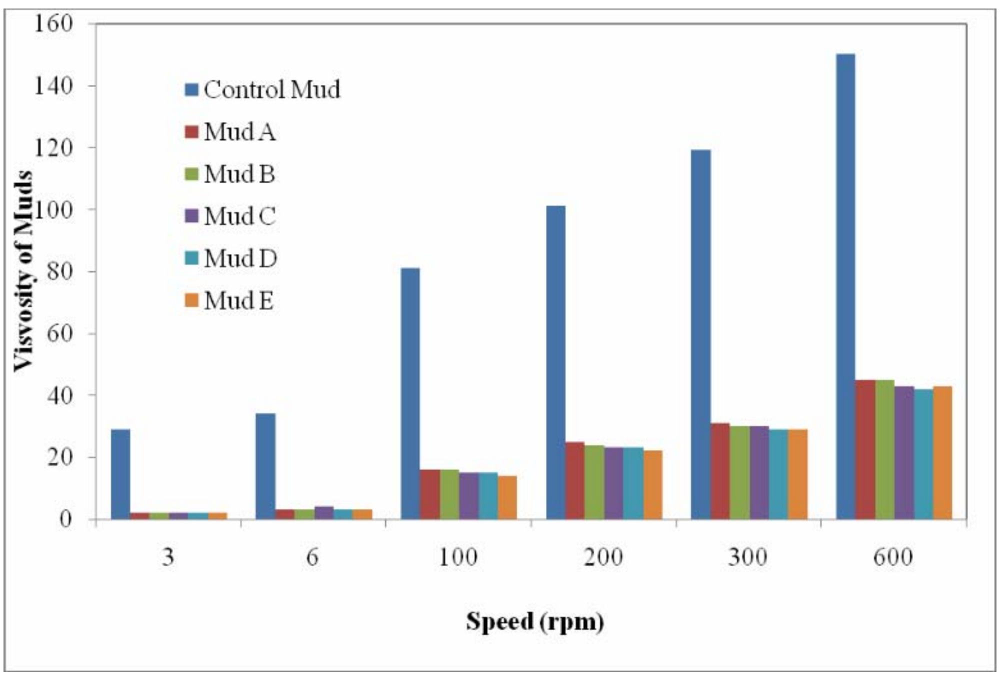

Figure-1. Viscosity of drilling fluids in (Cp) at different speed before aging at 80^{o}F.

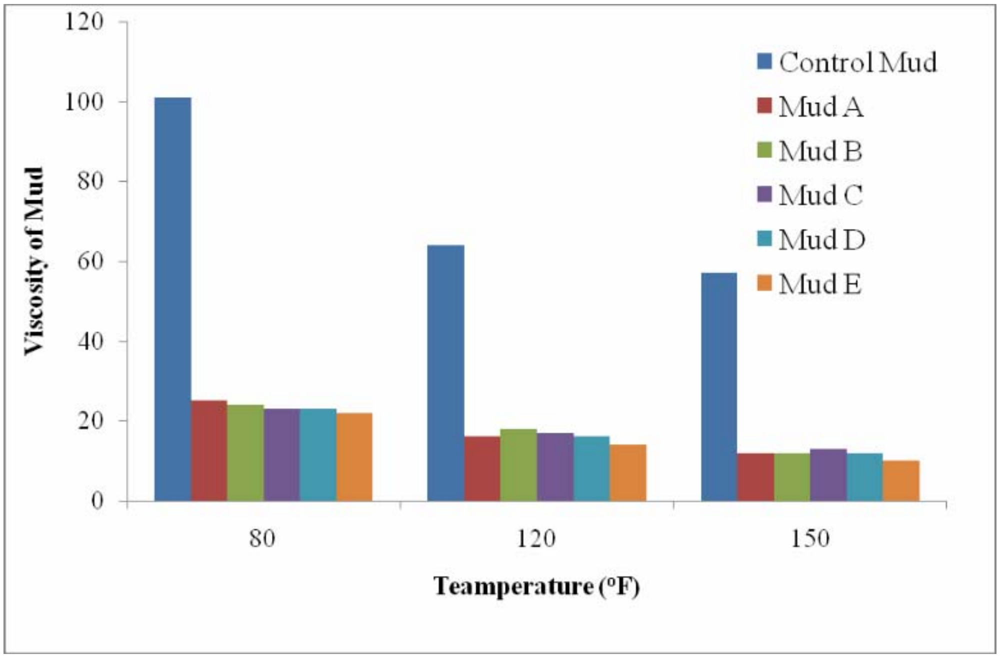

Figure-2. Viscosity of drilling fluids in (Cp) at different temperatures before aging (at 200rpm).

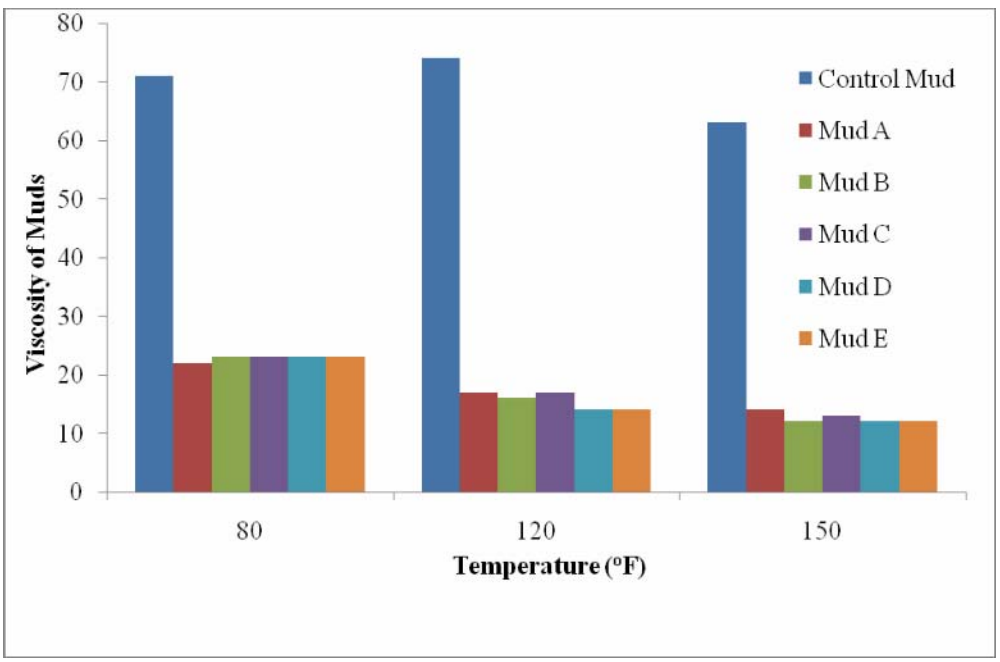

Figure-3. Viscosity of drilling fluids at different temperatures after aging (at 200rpm).

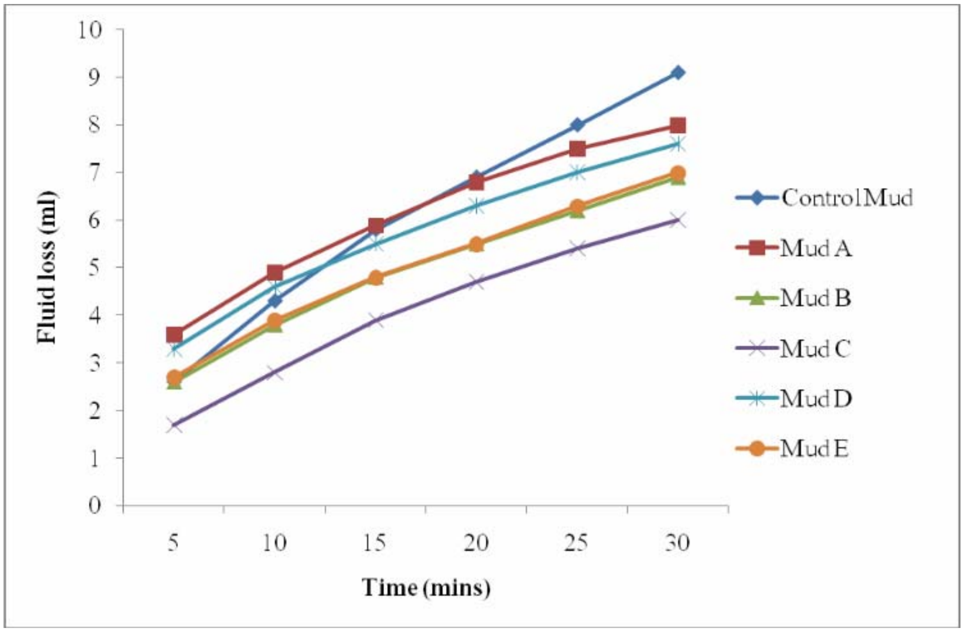

Figure-4. Fluid loss with time before aging at 80°F.

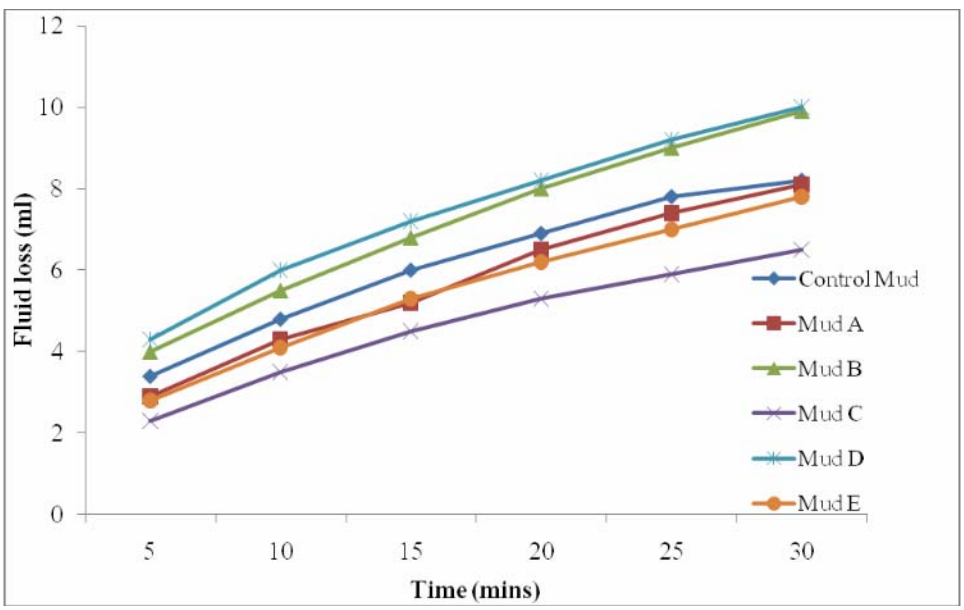

Figure-5. Fluid loss with time after aging at 80°F.

The viscosity of the drilling fluids tested at different speed before aging at 80°F is presented in Figure-1. Generally, the viscosity increased with speed for both the drilling fluid formulated using the imported polymer and local cassava. The viscosity of the the drilling fluid produced using the imported polymer was significantly higher than that produced from local samples. This could be attributed to the variation of the constituents between the imported sample and local ones. Amanullah and Long Yu (2004) reported that the short branching chains in the amylopectin are the main crystalline component in granular starch. Variation in the amount of amylose and amylopectin in a starch changes the behaviour of the starch. The amylose component of starch controls the gelling behaviour since gelling is the result of re-association of the linear chain molecules. Amylopectin is usually larger in size. The large size and the branched nature of amylopectin reduce the mobility of the polymer and their orientation in an aqueous environment. Amylose content of cassava increases the water absorption capacity and affects hydration (Eke *et al.*, 2010). The viscosities of the drilling fluids produced from local starches (Mud A to

E) vary slightly due to differences in amylose content of cassava starches used. Drilling fluid (Mud A) produced using TMS 30572 exhibited slightly higher viscosity than other mud samples, this also may be due to its high amylose content compared with other drilling fluids produced from other cassava cultivars as shown in Table-1.

The abundance in hydroxyl groups in the starch molecules impart hydrophilic properties to the polymer and thus its potential to disperse in water(Amanullah *et al*., 1997).

The effects of temperature on the viscosity of the formulated muds at different temperature and tested at 200rpm before and after aging are presented in Figures 2 and 3. Test results from the rehological values indicated that the higher the temperature, the lower the rheological values respectively. This is in line with previous work that higher temperature results in thinning effect (Joel, *et al*., 2010).

The fluid loss control potentials before and after aging was determined for the control sample and other samples prepared using the local starch and results indicated in Figures 4 and 5, respectively. The fluid loss of the control sample and other samples prepared using the local starch increased with increase in time. Test results indicated that there was significant difference in the fluid loss Figures before and after aging especially for the imported sample. This shows that aging enhance the hydration process for the samples that have higher amylose content and higher water absorption capacity. Therefore, this could be the reason why mud C and the control sample had lower fluid loss than other local samples. Eke *et al*., (2010) reported similarly that amylose content of *cassava* increases the water absorption capacity. Previous study by Chatterji, *et al*., 1981, indicated a decrease of filtration with increase in rheological properties of drilling fluids.

CONCLUSIONS

- Local starch could be used as a substitute for imported sample to control viscosity and fluid loss in water based drilling muds;
- Samples with highest amylose content and high water absorption capacity produced drilling fluid with higher viscosity and lower fluid loss;
- Further research on this on better quality control efforts to obtain reproducible results with local samples will open up a new market for non-food use of starches from cassava; and
- This no doubt will provide economic benefit to Nigerian farmers and a way forward to actualize vision 20-2020 agenda.

REFERENCES

Amanuallh M. D., Marsden J. R. and H. F. Shaw. 1997. An experimental study of the swelling behaviour of mudrocks in the presence of drilling mud system. Canadian Journal of Petroleum Tech. 36(3): 45-50.

Amanullah and Long YU. 2004. Superior Corn based starches for oilfield application. http://www.cropscience.org.au/icsc2004/poster

Chatterji J. and Borchardt J. 1981. Applications of water-soluble polymers in the oil field. JPT.

Eke J., Achinewhu S.C, Sanni L. 2010. Chemical, Pasting and Sensory Properties of Tapioca Grits from Cassava Mosaic Disease-Resistant Cassava Varieties. Journal of food processing and preservation. 34(4): 632-648.

Herman K, Song, Jay-Lin Jane. 2002. Effect and Mechanisms of ultrahigh hydrostatic pressure on the structure and properties of drilling fluids. Carbohydrate polymers. Vol. 47, pp. 233-244.

IITA. 2004. Pre-emptive management of the virulent cassava mosaic disease through an integrated cassava development approach for enhanced rural sector economy in the south-south and south-east zones of Nigeria, Nigeria: Multiple Investor Development Project Document, IITA.

Ikegwu O.J, Nwobasi V.N., Odoh Mo. and Oledinma N.U. 2009. Evaluation of the Pasting and Some Functional Properties of Starch Isolated from some Improved Cassava Varieties in Nigeria Ejeafche. 8(8): 647-665.

Joel O.F and Nwokoye C.U. 2010. Performance Evaluation of local Bentonite with imported grade for utilization in oil field Operations in Nigeria, Refereed proceedings, 34th Annual SPE International Technical Conference and Exhibition, in Tinapa, Calabar, Cross River State. 31st July- 7th August.

Joel O.F. and Ujile A.A. 2010. Evaluating the Performance of Cement Slurry properties at low temperature. NSE Technical Transaction. 45(4): 68-74.

Okumo I and Isehunwa S.O. 2007. Prediction of the Viscosity of a Water-Base Mud Treated With Cassava Starch and Potash at Varying Temperatures Using Factorial Design Nigeria Annual International Conference and Exhibition, 6-8 August 2007, Abuja, Nigeria http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-111886-MS&soc=SPE.

Onitilo M.O., Sanni L., Daniel I., Maziya-dixon B. and Dixon A. 2007. Physicochemical and functional properties of native starches from cassava varieties in Southwest Nigeria. Journal Food, Agriculture and Environ. 5(3-4): 108-114.

Wing R.E. 1988. Chemically modified cornstarch serves as an entrapment agent. Proceedings of corn utilization conference II, National Corn growers association. November 17-18. pp. 1-4.