International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

Evaluation of the Potential of Cassava Flour as Viscosifier in Water Based Mud

Oluogun Mojeed[1], Aladeitan Yetunde[2], Adebayo Segun[3], Bisola Atanda[4]

[1]African University of Science and Technology, University of Abuja (Corresponding Author)

[2]African University of Science and Technology, University of Abuja, Nigeria

[3]University of Abuja, Nigeria

[4]Schlumberger

Abstract: ***Success of any rotary drilling mud is to remove cuttings during drilling process. Viscosity is by far, the most needed property of the drilling fluid to aid it perform its needed task. The viscosity property of the mud helps in well cleaning and also aid in the suspension of drilling cuttings when circulation of the fluid is put on hold. It is important to monitor and continuously adjust the viscosity of the drilling fluid. Cassava flour in controlling viscosity and fluid loss in Water Based Mud (WBM) was investigated in this study. Various mud samples were formulated consisting of different masses of cassava flour (5 g, 15 g, 30 g and 45 g) and an additional one being the control bentonite clay (0 g of cassava flour). Rheological tests were carried out to determine the plastic viscosity, mud density, and gel strength. This investigation showed that increasing the amount of cassava flour in a water based mud increased the viscosity of the mud swelling with exception of 5g cassava flour for the 10secs and 10mins gel strength and mud density.***

Keywords: Cassava flour, viscosity, gel strength, bentonite clay, drilling, and water base mud

1. Introduction

Drilling fluids are the fundamental demand in majority of drilling operations. Most wells are drilled with clear water for faster penetration rates, until a depth is reached where hole conditions dictate a need for a fluid with special properties (Dankwa et al., 2018). Enhancers such as clay as filtrate reducers, viscosifying agents and dispersants for rheology control have to be added to the drilling fluids. The main requirement of any drilling fluid is to removing cuttings from the wellbore to the surface. For the effectiveness of the fluid to be able to remove cuttings, the fluid has to have some viscosity (Neff et al., 2005). Therefore, it is important to monitor and continuously adjust the viscosity of the drilling fluid during drilling process to achieve the purpose the mud is designed for (Okumo and Isehunwa, 2007). Aside removing cuttings from the well, the mud should be capable of forming a thin seal preventing fluid from entering in to the formation otherwise, it will cause stuck pipe and loss of circulation, an influx or a kick that may graduate to a blowout, formation damage just to mention but few (Igbani et al., 2015).Water based mud has a wide application because it is easy to formulate, environmentally friendly (Dankwa et al., 2018) and while nearly 5-10 % use oil-based muds (Sifferman et al., 2003). The frequent use of water based mud has led to the development of three distinct types; inhibitive; non-inhibitive and polymer water based mud (Reza, 2015). For the purpose of this study, much emphasis will be place on polymer water based fluid. These fluids contain polymers to viscosify, control filtration, deflocculates and provide high-temperature stabilization. Polymer fluids generally contain only minor amounts of bentonite to build viscosity. Polymer fluids also reduce cuttings dispersion and stabilize the well bore through capsulation (Amorin, 2014) Drilling fluid is linked directly or indirectly to most drilling problems, there is no particular drilling fluid that could serve as a solution to all drilling problems yet still, it is a tool that is used to solve most drilling problems. Commonly used drilling fluids should contain a minimum number of additives, this helps to preserve and check the properties of the drilling fluid. It is beneficial to have a mud system that is easy for an adjustment to meet the development demands as drilling problems arise (Annis and Smith, 1974).

Today, various polymers, which can be in the form of natural (e.g. starch), synthetic, and/or modified (e.g. Carboxymethyl Cellulose or CMC) polymers, are used in order to control the fluid loss and viscosity oil and gas industry (Nasiri et al., 2012; Winson 2012; Samavati et al., 2016) Starch used in drilling operations are basically derived from corn, potato and other cereals. Corn starch was discovered to be an effective material for fluid loss control in 1937 and is the first polymer to be used for bentonite drilling fluid (Ademiluyi et al., 2011). Starch is mostly used as effective colloids, because of its ability to decrease fluid loss and increase the viscosity of drilling fluids. These are caused by its swelling capacity which increases its volume due to free space water absorption (Rupinski et al., 2009). Starch contains amylose and amylopectin polysaccharides, the amylose in starch swells up and helps in controlling fluid loss. Cassava starch is a polysaccharide polymer and the amylose present in cassava enables its starch to exhibit similar functions as some of the imported viscosity and fluid loss polymers used in formulating drilling fluids (Harry et al., 2016). Cassava is a root crop cultivated in various parts of the world. Global production of cassava was estimated to be 278 million tons in 2017, with Nigeria being the world's largest producer with annual production of 20 % of the world's output (Chuasuwan, 2018). Ghana produces approximately 18 million tons of cassava annually (Anon, 2017a). Among the several varieties of cassava cultivated, exhibits high starch content (40% dry matter content) which aids in the production of high quality flour for industrial products such as alcoholic beverages, flour for bakery, glue for lumber, as well as industrial alcohol and pharmaceutical products (Anon, 2015).

The use of locally produced materials as a substitute for imported drilling fluid additives have gained much attention over the years due to the high cost of the imported mud additives. Research conducted by Olatunde et al. (2012) and Undohand Okon (2012) revealed that local materials such as gum Arabic, soda ash and sweet potato have the potential to serve as a substitute for imported drilling fluid additives in formulating water based mud. Ademiluyi et al. (2011) investigated the use of local cassava starch as substitute for imported sample in viscosity and fluid loss control in water based mud. Their results indicated that the local cassava had similar or better filtration control properties that imported sample, however, the viscosity of the drilling fluid produced from local starch were lower than that of the imported type. Igbani et al. (2015) also conducted a research using cassava starch flour and found out that it can improve the density of the drilling fluid. Similarly, Harry et al. (2016) did a comparative analyzes on local cassava starch flour with imported starch for drilling fluid formulation, the local cassava starch had structural properties considerably close to the imported starch. They concluded that imported starch could be substituted with local cassava starch as drilling fluid additive. In the Nigeria oil industry, materials used as viscosifier and fluid loss agents are mostly imported therefore expensive and not readily available. However, Nigeria has the necessary materials to produce locally based drilling fluids, hence this has led to research into several local materials such as yam, cocoyam and corn cob cellulose that could be used as substitute for commercial additives in mud formulation (Ossai,2015; Nyande, 2017; Ashikwei and Marfo, 2016).Yet, little or no research have been conducted in an attempt to investigate the potential use of locally produced cassava in formulating drilling mud to serve as a viscosifier and a possible fluid loss control.
Therefore, it is imperative that comprehensive research be conducted into the local cassava, to study their characteristics and formulate mud that can perform the same function as those with imported additives. This will reduce the cost of some expensive viscosifiers and fluid loss agents that are being imported and will create employment as well. This study therefore evaluates the performance of local cassava as viscosity enhancer and a fluid loss agent in water base drilling mud

2. Methodology

2.1 Preparation of Water Based Drilling Mud

22g of Betonite was weighed with a digital mass balance and 350ml of distilled water was measured using a measuring cylinder. First of all, half of the distilled water and the bentonite clay were poured into the stainless steel container and the mixture was stirred for about 5 minutes using the OFFITE mixer. After about a few minutes the remaining distilled water was added to ensure that no lumps appeared in the mixture. Five samples of water based mud were prepared and a mud balance was used to determine the mud weight of each of the sample and the readings were taken. Following standard practice, a pressurized mud balance was used to determine the mud weight of each sample. The mud balance was calibrated using distilled water. The balanced cup was cleaned, dried and filled to the brim with the mud sample to be measured. The lid was placed on the cup as some mud flowed out of the hole on the lid to ensure that there was no trapped air in the cup. The cup and lid were wiped to dry off any mud on the surface in order to obtain accurate measurement as the knife edge was placed on the fulcrum and the rider adjusted until the cup content and the rider was at equilibrium. The density of the mud sample was read on the calibrated arm of the mud balance.

2.2 Water Based Mud Samples Preparation (Bentonite and Cassava Starch Mud)

The experimental procedures used in this study followed the API 13B-1 standard for drilling fluid preparation and testing as follows.

1) A total of 112.5 g of bentonite clay was weighed with a mass balance and 1750ml of fresh water was measured with a measuring cylinder.
2) 22.5g of bentonite clay and 350ml of distilled fresh water was used in each of the set-up according to API requirement for preparing drilling fluid.
3) Firstly, half of the water was poured into a container and the bentonite clay was added. The mixture was then stirred with a mud mixer for 5 minutes.
4) The remaining water was added and stirred for about 5 minutes till all the lumps became invisible. In all, five samples of mud were required for this investigation which included one control sample with no cassava flour.
5) The remaining four samples of mud were prepared by adding 5g, 15g, 30g and 45g of cassava flour to the prepared water base mud and were stirred vigorously with the aid of the mud mixer.
6) The offfites viscometer was used to determine the viscosity properties of each mud sample, provided in table 1.

Rheology and Fluid Loss Test of the Formulated Mud Samples

The viscosity properties of drilling fluid are made up of two main variables: Plastic Viscosity (PV) and gel strength. These parameters were recorded with Offite Viscometer Model 3500 at dial readings of 600, 300, 200, 100, 60, 6, 3rpm as indicated in API 13B-1 for measuring drilling mud properties. The experiments were carried out at room temperature (25 ºC). After the rheology test, the control bentonite clay and the bentonite with respective weight of cassava flour was poured into the API filter press mud cell and pressurized to 100psi to determine the fluid loss.

3. Results

Parameters varied include mass of 5g, 15g, 30g and 45g to Mud Rheology, Shear Stress(Pa) at different shear rates 6rpm, 30rpm, 100rpm, 200rpm, 300rpm and 600rpm. As well as the mass of 5g, 15g, 30g and 45g to Mud weight (ppg).

Table 1: Effect of Cassava Flour on Mud Rheology

Mass of Cassava Peels(g)	Shear Stress (Pa) at different Shear rate (rpm)						
	6rpm	30rpm	60rpm	100rpm	200rpm	300rpm	600rpm
0	1	1.5	1.5	2	2.5	3	4
5	1	1	1.5	1.5	2	2.5	3.5
15	1	1.5	1.5	2	2.5	3	5
30	1	1.5	2	3	3.5	4.5	6.5
45	1.5	2	2.5	3	4.5	5.5	9.5

Table 2: Effect of Cassava Flour on Gel Strengths

Mass of cassava flour samples (g)	Gel strength in 10 secs (1b/100ft^2)	Gel strength in 10mins (1b/100ft^2)
0	1	1
5	1	1
15	1	1.5
30	1.1	2
45	1.5	3

Table 3: Effect of Cassava Flour on mud weight

Mass of Cassava peels (g)	Mud Weight (ppg)
0	8.8
5	8.8
15	8.9
30	9
45	9.1

4. Discussion

Effects of Cassava Flour on the Plastic Viscosity

Plastic viscosity is defined as the resistance of a fluid to flow. Plastic viscosity of water based mud increases with the increase in the solid content. From the data obtained from the result in table 1, the cassava flour concentration ranging quantity resulted in the varying mud rheology results obtained from each mud sample, thereby indicating the potential of the cassava flour on the plastic viscosity of the mud samples. Considering the rheological evaluation of the water based mud illustrated in the results above, all the plastic viscosity values are within acceptable range desired for optimum drilling. Also, considering the Gels strength evaluation of the water based mud in the illustrated results from table 4.1b, the results obtained indicated that the cassava flour has potentials effects on the drilling mud gel strength.

Lastly from the mud density evaluations that are illustrated in table 4.1c, is appreciable as this will be very effective during drilling in protecting the well formation from being contaminated.

This result affirms that mud formulated with cassava flour can effectively carry cutting to the surface with some extra modifications.

5. Conclusion

Results from this study have shown the potential use of Nigeria locally sourced Cassava Flour as a viscosifier in a water based mud, hence the following conclusions can be drawn.

1) The plastic viscosity of the water based mud when the cassava samples was added especially for sample 30gand 45g is acceptable for the mud in carrying out the drilling fluid cutting functions
2) Mud samples with the cassava flour exhibited greater suspension ability (gel strength) of the cutting than that of the control sample (no cassava flour).
3) The Mud density obtained is acceptable for the water based drilling mud in carry out cutting functions and formation permeable seal importance.

References

[1] Ademiluyi, T., Joel, O. F. and Amuda, A. K. (2011), "Investigation into Local Polymer (Cassava Starch) as a Substitute for Imported Sample in Viscosity and Fluid Loss control of Water based Drilling Muds", APRN Journal of Engineering and Applied Science, Vol. 6, No. 12,pp. 43-48.

[2] Amorin, R. (2014), "DrillingFluids", Unpublished BSc Lecture Note, University of Mines and Technology, Tarkwa, pp120.

[3] Annis, M. R. and Smith, M. V. (1974), "Drilling FluidTechnology", Exxon Company, USA, 366pp.

[4] Anon (2015), "Expanding the Frontiers of Improved Cassava Varieties in Ghana", https://agra.org/news/expanding-the-frontiers-of-improved-cassava-varieties-in-ghana/. Accessed: November 27, 2018.

[5] Anon (2017a), "Cassava Production in Ghana", www.adomonline.com/ghana-news,"ghana-can-produce-30-million-metric-tons-Cassava. Accessed; March 7, 2018.

[6] Anon (2017b), "API RP 13B-1", Recommended Practice for Field Testing Water based Drilling Fluids, 5th edition, USA, 121pp.

[7] Ashikwei, D. A.and Marfo,S.A.(2016),"Evaluation of the Suitability of CornCob Celluloseasa Viscosity Modifier in Water Based Drilling Fluid", 4th UMaT Biennial International Mining and Mineral Conference, pp. MP 66 - 70.

[8] Chuasuwan,C. (2018), "Cassava Industry", Thailand Industry Outlook 2018-2020, Krungsri Research, pp. 1-8.

[9] Dankwa, O.K., OpokuAppau,P.andBroni-Bediako, E.(2018), "Evaluating the effects of Monovalent and Divalent Saltson the Rheological Properties ofWater Based Mud",The Open Petroleum Engineering Journal, Vol.11,No. 1, pp. 98-106.

[10] Harry, T. F.,Joel, O. F., Ademiluyi, F. T. and Oduola, K. (2016),"Performance Evaluation of Local Cassava Starches with Imported Starch forDrilling Fluid", American Journal of Engineering Research (AJER), Vol. 5, pp. 111 – 120.

[11] Igbani, S., Peletiri, S. P. and Egba, S. U. (2015), "A Study on the Individual Impact of Cassava Starch and Hydroxyl Propyl-Modified Starch on Mud Density", International Journal of Eng. Trends and Technol (IJETT), Vol. 29, No.4, pp. 1 - 5.

[12] Latunde, A. O., Usman, M. A., Olafadehan O. A., Adeosun,T. A. and Ufot, O. E. (2012), "Improvement of Rheological Properties of Drilling Fluid Using Locally Based Materials", Journal of Petroleum and Coal, Vol. 54, No. 1, pp. 65 – 75.

[13] Nasiri, A. R., Valizadeh, M. and Norouzi, H. and Hemmati, M. (2012),"Investigating the Effect of Polythin and Polydrill on the Properties of Drilling Fluids", Journal of Petroleum Sci. and Technology, Vol. 2, No. 1, pp. 37-42
[14] Neff,J. M., (2005),"Composition, Environmental Fates and Biological Effectsof Water Based Drilling Muds and Cuttings Discharged to the Marine Environment: A Synthesis and Annotated Bibliography", Petroleum Environmental Research Forum and American Petroleum Institute, Vol. 5, No. 2, pp. 73 – 95.
[15] Nyande, K. (2017), "A Comparative Analysis of Local Cocoyam (Colocasia Esculanta)and Yam (Dioscorea) as Secondary Viscosifiers and Fluid Loss agentinwater based muds", Unpublished BSc Project Report, University of Mines and Technology, Tarkwa, 31pp.
[16] Okumo, I. and Isehunwa, S. O. (2007), "Prediction of the Viscosity of Water Base Mud Treated with Cassava Starch and Potash at Varying TemperatureUsingFactorialDesign", 31st Nigeria AnnualInternational Conference and Exhibition, Abuja, Nigeria, pp. 1 - 9.
[17] Ossai, J. O. (2015), "The Use of Cocoyam (ColocasiaEsculanta) as a Secondary Viscosifier and a Fluid Loss Agent in Water BasedMud", Unpublished BSc Project Report, University of Mines and Technology, Tarkwa, 36pp.
[18] Rupinski, S., Brzozowski, Z. K. and Uliasz, M. (2009),"Study on the Application of Starch Derivatives as the Regulators of Potassium Drilling Fluids Filtration", Chemistry & Chemical Technol., Vol. 3, No. 3, pp. 197-202.
[19] Samavati, T., Adullah, N., Nowtarki, K. T., Husain, S. A., Biak, D. R. A. and Mohammed, M. K. (2014), "The Application and Rheological Behaviour of IgebuGarri (Cassava Derivative) as a Fluid Loss Inhibitor in Water Based Mud in Formation", International Journal of Scientific Research in chemical Engineering (IJSRCE),Vol. 3, No. 1, pp. 56 - 65.
[20] Samavati, T. and Adullah, N. (2016),"The Experimental Assessment and Study of UbiKayu Starch as Fluid Loss Control Agent in Water Based Drilling Fluids", International Journal of Scientific Research in chemical Eng. (IJSRCE), Vol. 3, No. 4, pp. 1 – 6.
[21] Sifferman,R. T., Muijs, H.M., Fanta,G. F., Felker, F. C. and Erhan, S. M. (2003), "Starch- Lubricant Compositions for Improved Lubricity and Fluid Loss in Water-Based Drilling Muds", International Symposium on Oilfield Chemistry, 5-7 February, Houston, Texas, pp. 1-5.
[22] Udoh, F. D. and Okon, A. N. (2012), "Formulation of Water-Based Drilling Fluids UsingLocal Materials",Global Science Publications, Vol. 14, No. 2, pp. 167 - 174.