The Prospect of using Modified Local Starches from Cocoyam and Wheat Starches as Fluid Loss Material in a Water - Based drilling

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ABSTRACT

As an oil producing nation, Nigeria embarks on substantial drilling activities. The additives used for these activities are all imported as a result there is need to reduce the over dependency on foreign additives this has necessitated the sourcing locally for suitable substitute. During drilling, adequate filtration control is essential to prevent drilling problems such as excessive torque and drag; differential pressure sticking; borehole instability; and formation damage. This study was aimed at a comparative analysis of the use of wheat starch and cocoyam chemically modified with ammonium phosphate and sodium acetate as suitable fluid loss additives in a water-based mud. The filtration properties of a water- base fluid formulated with variable quantities of the chemically modified starch were determined using the recommended standard API practice at different conditions of temperatures with Carboxymethylated Cellulose CMC used as control. Using Eviews 7, the statistical analysis showed drilling fluid formulated with starches treated with sodium acetate had a fluid loss value in the range of 4.0 - 8.9 mls, while those from starches modified with ammonium phosphate had a fluid loss of 4.3 - 8.3 mls; although, these values were lower than 9.1 - 11.1 mls for CMC formulated mud, the results show that mud sample treated with modified wheat starch and cocoyam starch can significantly reduce fluid loss in a water based drilling mud, thereby confirmed that polymer can be used as fluid loss control agent in the mud system

Key words: Ammonium phosphate, Cocoyam starch, Filtration control, Sodium acetate, Wheat starch

1. INTRODUCTION

In rotary drilling, the use of drilling fluid is very important as it helps in providing a means of controlling the formation pressure, removing and releasing the drilled cuttings at the surface, suspending drilled cuttings among others. Drilling fluid can be classified as water based, oil based and pneumatic based fluids. It is key for the drilling engineers to select and maintain this fluid Small amount of substance called additives are added to the drilling fluids to give specific properties to the mud.

When a superior hydrostatic force applies to mud formation, a phenomena known as fluid loss occurs. This Fluid loss process may present multiple drilling problems such as structure destruction and stuck pipe, as a result, fluid loss control agent (also known as filtrate reducing additives), will be needed to be added to the drilling fluid in order to enhance it properties.

At present Carboxymethylated Cellulose CMC, a cellulose based fluid loss agent is one of the commonly used fluid loss control agents in the oil and gas industry, this product is usually imported which makes it quite expensive. As a result, this has necessitated the need for less expensive polymers, which can be sourced local as an alternative to CMC

Starch a polysaccharide carbohydrate consisting of a large number of glucose units joined together by glycosidic bonds is typically applied in drilling fluids because of its solubility in water. It comprises of linear shaped amylose and branch shaped amylopectin as it macromolecules. Amylose section is responsible for the gelling function, while amylopectin reduces polymers movements and profusion in hydroxyl assemblies within the starch molecules and expressing hydrophilic property of the polymers and therefore makes it possible to dissolve in water. They are principally applied to diminish the filtration of virtually all types of water based drilling fluids, owing to their swelling ability. This swelling assortment diminishes muds permeability, decreases the mud filterability and hence causing fluid loss on borehole areas.

Starch in its native state is highly crystalline (due to a strong intramolecular H-bonding between the hydroxyl groups of its glucose units) which result in the insolubility of starch in water at room temperature. However, starch is soluble in solvents that are capable of disrupting the intramolecular H-bonding in favour of an intermolecular H-bonding. The properties of starches can be improved by various modifications process through: physical, chemical, enzymic and biological modifications. The purposes of this modification is to enhance the starch properties such as improving the water holding capacity, heat resistant behavior, reinforce its binding, minimized syneresis of starch and improved thickening (Adzahan. (2002). Modification using the method of cross linking increases the amylopectin content of native starch. Chemical modification of starch involves the treatment of native starch with specific chemicals reagent. This definition includes acetylated, oxidized, lintnerized, pyrodextrinized, hydroxypropylated and cross-linked starches Kauri *et.al* (2004).

In 1988, Nyland et al studied the effect of additive and influence of contaminant on fluid loss control in water based mud and concluded that out of the additives tested. Dextrid/cc-16 provided the best overall fluid loss control in the presence of the following contaminant: salt, calcium sulphate, etc. increasing mud weight increases fluid loss when the mud system is aged at a temperature higher than the ambient temperature, While Chin (1995) in his study, revealed that incorporating particles into the mud system has a significant role in preventing fluid loss. Warren et al (1997) worked on the effect of rate, fluid loss and rheology of the drilling fluid on the amount of filtrate lost to the formation. They submitted that increase in dynamic circulation rate resulted in an increase in the filtrate rate. Alteration of the filter cake with subsequent filtration rate increases with annular flow. Over the past decades, starch used for preparing drilling mud has been chemically modified starch had been used over the years to prepare drilling fluids. Different types of chemicals are used for preparing drilling mud to meet functional requirements, numerous modified starches have been produced for oil field applications, and this is carried out by gelatinization in the presence of a solvent (wet method).

In 2003, Michal and Ken successfully researched into the use of high temperature, high pressure polymers in a high temperature water based drilling fluid on a blow operation. Amanullah and Long ((2004) developed a number of corn-based starches. Their results showed a good filtration control property by some of the corn-based formulation, comparable to the commercial starch. A study by Okumo and Isehunwa (2007) presented a basic rheological investigation of potash and cassava starch water based drilling muds (WBM) in different temperatures.

2. Experimental Procedure

2.1 Materials

The reagents used in this study were all analytical grade The experimental apparatus used are API standard filter press, the Hamilton beach mixer, mud balance, thermometer , spatula and filter paper, measuring cylinder, bentonite, sea water, wheat starch, cocoyam starch, carboxymethyl cellulose (CMC) caustic soda, duovis Pac Ul polyanionic cellulose and Pac R polyanionic cellulose

2.2 Methods

The different mud sample was formulated as presented in the Table 1 and Mud filtration property tests were measured according to American Petroleum Institute (API) specifications. API filtrate volume of mud was determined using an API Filter press under 100 psi differential pressure for 30 minutes , with the Table 2 showing the amount of additives added to each sample

The modified starches were labeled as follows Samples AI (wheat starch modified with ammonium phosphate) Samples A2 (wheat starch modified sodium acetate); Samples B1 (coco yam starch modified ammonium phosphate) and Samples B2 (cocoyam starch modified sodium acetate)

2. 3 Extraction of Wheat and Cocoyam starches

Wheat and cocoyam tubers were bought from a local market in Ekiti state. Wheat starch (5 kg) was produced through wet milling these process include grinding, screening and centrifugation to separate purified starch from fiber, oil and protein. Wheat grains was softened by diluting in an acid solution this is to fermentation and help in separation of the starch from protein. The Wheat grains splits to remove oil containing germs by rough milling, then the finer milling for separation of fiber from endosperm. The centrifugation was used to separate less dense protein from starch. Finally, the starch was washed; sun dried and kept in a labeled air tight container

Fresh cocoyam tubers (1 kg) were brushed in water to remove adhering dirt, were washed carefully in tap water. The cocoyam were cut in smaller pieces, macerated with added tap water in a blender and filtered through two layer of gauze. The filtrate was washed extensively with cold tap water, in order to separate starch granules and cocoyam cell debris. The residual containing the starch grains were further washed by several cycles of centrifugation and air dried at 26 ^{o} C for about 14 hours before been kept in a labeled air tight container

2.4 MODIFICATION OF THE STARCHES (WHEAT AND COCOYAM)

a Chemical Modification Using Ammonium Phosphate

Thirty grams of native starch was measured into a plastic container, followed by the addition of 4.5ml aqueous solution of sodium hydroxide (alkaline catalyst), the solution was mixed thoroughly, before 1.5g of ammonium phosphate (cross-linking agent) was added to the starch solution. The solution was thoroughly mixed before been dried in an oven and store in a plastic air tight container at room temperature.

b Chemical modification using Sodium Acetate

Thirty grams of native starch was measured into a plastic container, followed by the addition of 6.0 ml aqueous solution of sodium hydroxide (alkaline catalyst), the solution was mixed thoroughly for 20 minutes, before 4.0 g of ammonium phosphate (cross-linking agent) was added to the starch solution and stirred 15 minutes. The solution was thoroughly mixed before been dried in an oven and store in a plastic air tight container at room temperature.

2.5 PREPARATION OF EXPERIMENTAL SAMPLES

The different mud sample was formulated as presented in the Table 1 and mud filtration property tests were measured according to American Petroleum Institute (API) specifications. API filtrate volume of mud was determined using a Filter press, with the Table 2 showing the amount of additives added to each sample

The modified starches were labeled as follows: Samples A1 (wheat starch modified with ammonium phosphate) Samples A2 (wheat starch modified sodium acetate) ; Samples B1(coco yam starch modified ammonium phosphate) and Samples B2 (cocoyam starch modified Sodium acetate).

Table 1: Mud Samples. Quantity and Mixing time

Materials	**Quantity**	**Mixing time**
Sea Water	349.69	
Caustic Soda	0.25	2mins
Polymer	Varies	5mins
Pac UL	2.00	5mins
Pac R	1.00	10mins
Duovis	0.50	10mins

Table 2: Mass of Modified starches and CMC

Samples AI (g)	Samples A2 (g)	Samples B1 (g)	Samples B2 (g)	Samples C (g)
A11 -1.00	A21 - 1.00	B11 - 1.00	B21 - 1.00	C1 - 1.00
A12 – 1.50	A22 – 1.50	B12 – 1.50	B22 – 1.50	C2 – 1.50
A13 – 2.00	A23 – 2.00	B13 – 2.00	B23 – 2.00	C3 – 2.00
A14 – 2.50	A24 – 2.50	B14 – 2.50	B24 – 2.50	C4 – 2.50

RESULTS AND DISCUSSION

The mean value for fluid loss after 30 minutes of filtration for two samples with those of the control is presented in the Table 3. Sample A24, B14 and C4 produced a filtrate volume of 6.1 ml, 4.3 ml and 9.3 ml, respectively. This implies that sample B14 formulated with 2.5 g coco yam starch modified ammonium phosphate produced the least filtrate volume (4.3 ml) after 30 minutes of filtration, thus demonstrating a better filtration control characteristics than others. The Table 3 also shows that all the modified starches had filtrate losses which were not beyond the required maximum API standard test value of 15.0ml.

In addition, the results from the statistical correlations for all the different mud samples treated with varying concentration of the additives were presented in the Tables 4.0 – 7.0. The results obtained invariably shows that the fluid loss from these newly formulated starches was as good as those of the control sample.

Table3: Mean value for Fluid Loss of Some Mud Samples

Mass	Wheat Acetate	Cocoyam Phosphate	CMC
1. 0 g	4.0 ml	6.1 ml	9.1ml
1.5 g	8.9 ml	8.3 ml	11.1 ml
2.0 g	6.9 ml	6.0 ml	9.0 ml
2.5 g	6.1 ml	4.3 ml	9.3 ml

CONCLUSION

From the statistical correlation, the starches modified with sodium acetate proved to behave better than CMC and ammonium phosphate treated mud as it mean fluid loss was least. The series of results obtained from the series of graphs, showed that almost all the starches followed the normal trend established by earlier drilling practices that filtrate volume is directly proportional to the square root of time after an initial spurt loss.

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Statistical Correlations

Table4: 1.0 g Modified starches and CMC

	A11	**A21**	**B11**	**B21**	**C1**
Mean	9.742857	4.000000	9.971429	6.057143	9.114286
Median	11.00000	4.400000	11.80000	6.800000	9.800000
Maximum	14.00000	6.800000	15.00000	9.600000	14.20000
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000
Std. Dev.	4.732461	2.289105	5.215910	3.244923	4.938093
Skewness	-1.361453	-0.535969	-1.004972	-0.855140	-0.826869
Kurtosis	3.682587	2.390508	2.880124	2.748286	2.639244
Probability	0.316894	0.801120	0.553638	0.646740	0.658486
Sum	68.20000	28.00000	69.80000	42.40000	63.80000
No of observation	7	7	7	7	7

Table5: 1.5 g Modified starches and CMC

	A12	**A22**	**B12**	**B22**	**C2**
Mean	10.65714	8.857143	9.971429	8.342857	11.10000
Median	12.00000	10.00000	11.80000	9.600000	12.60000
Maximum	15.40000	13.00000	15.00000	13.00000	16.80000
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000
Std. Dev.	5.158442	4.361520	5.215910	4.488079	5.613971
Skewness	-1.370390	-1.271261	-1.004972	-0.901319	-1.118805
Kurtosis	3.738961	3.533892	2.880124	2.681063	3.261568
Probability	0.308783	0.373702	0.553638	0.613411	0.477042
Sum	74.60000	62.00000	69.80000	58.40000	77.70000
No of observation	7	7	7	7	7

Table: 2.0 g Modified starches and CMC.

	A13	A23	B13	B23	C3
Mean	9.357143	6.914286	11.88571	5.971429	9.000000
Median	10.00000	7.000000	12.20000	6.800000	10.00000
Maximum	15.00000	10.80000	19.60000	9.800000	13.80000
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000
Skewness	-0.725725	-0.880101	-0.712779	-0.661158	-1.165252
Kurtosis	2.585854	2.844570	2.755733	2.323909	3.426673
Probability	0.717315	0.634220	0.737075	0.724950	0.441046
Sum	65.50000	48.40000	83.20000	41.80000	63.00000
No of observation	7	7	7	7	7

Table 7.0 2.5 g Modify starches and CMC.

	A14	A24	B14	B24	C4
Mean	8.514286	6.114286	7.828571	4.285714	9.285714
Median	9.800000	7.200000	8.800000	4.600000	10.80000
Maximum	12.70000	9.800000	11.80000	7.200000	13.40000
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000
Std. Dev.	4.388025	3.507814	3.960519	2.481551	4.660268
Skewness	-1.092417	-0.737098	-1.125670	-0.577624	-1.215883
Kurtosis	3.025216	2.259755	3.248047	2.282583	3.280259
Probability	0.498462	0.672439	0.473249	0.763618	0.417347
Sum	59.60000	42.80000	54.80000	30.00000	65.00000
No of observation	7	7	7	7	7

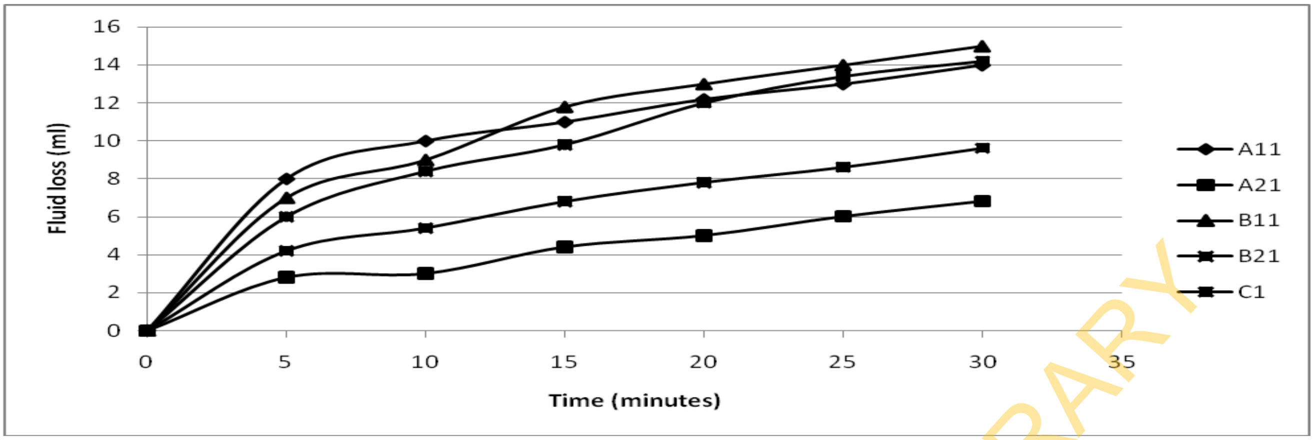

Figure 1 Fluid loss (ml) against Time (mins.) for 1.0 g of additive.

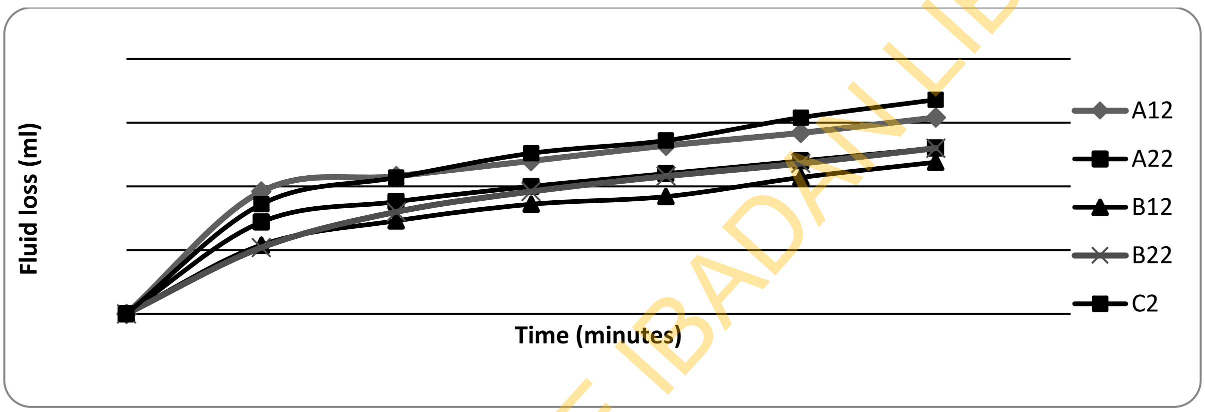

Figure 2 Fluid loss (ml) against Time (mins) 1.5 g of additive

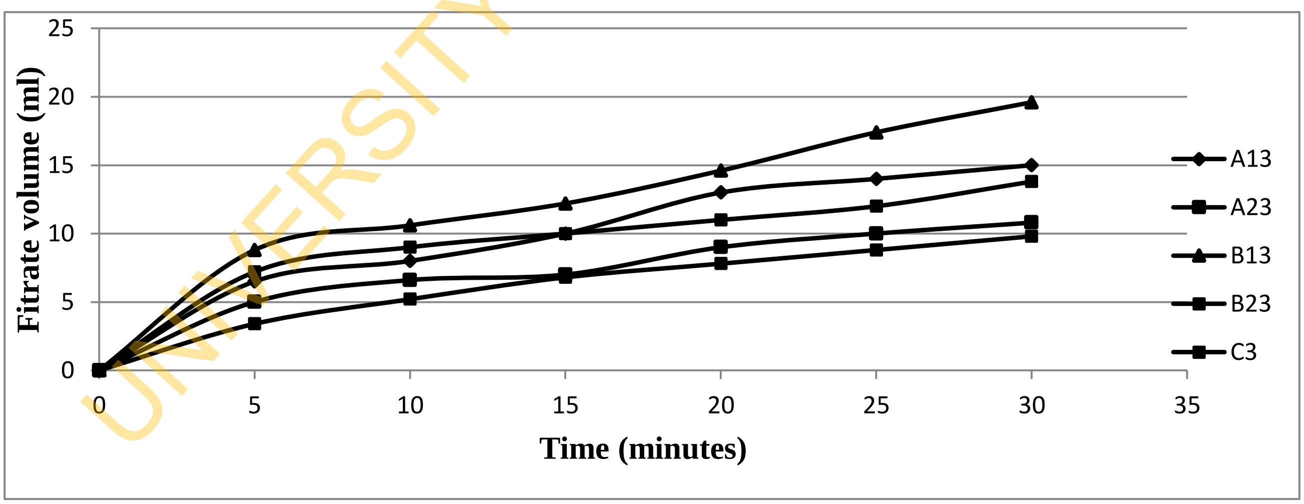

Figure 3 Fluid loss (ml) against Time (mins) 2.0 g of additive

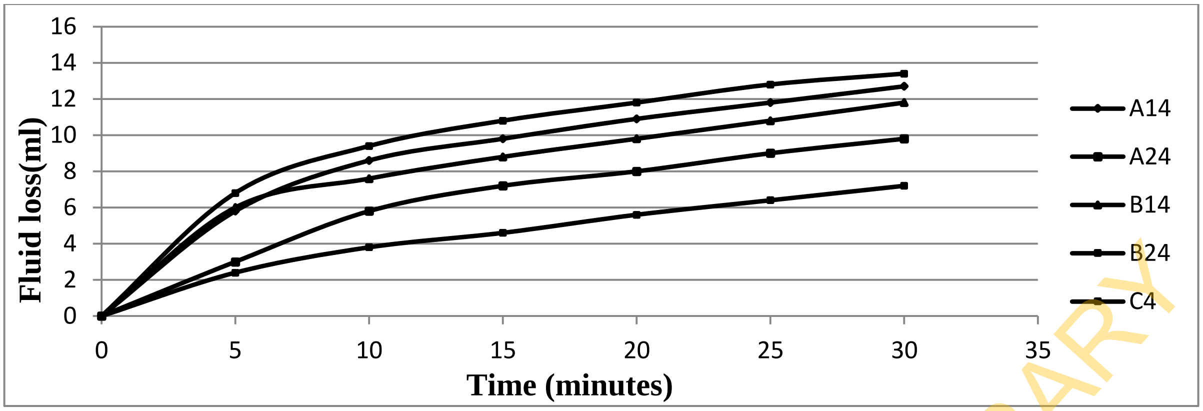

Figure 4.0: Fluid loss (ml) against Time (mins) 2.5 g of additive