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Tropical Manihot Cassava Species as Substitute for Viscosifier in Aqueous and Non-Aqueous Drilling Mud System

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Abstract— The huge variables for distinguishing the benefit of the mud system are viscosity (plastic and apparent), the gel strength, mud density, PH, thermal dependability and furthermore, the filtration. Untreated colloids, essentially starch and its optimized types, were utilized as part of mud additives for quite a while to crush the dangerous impact of anhydrite and saline on mud systems. The amylose component of starch controls the gelling behaviour since gelling is as a result of re-association of the linear chain molecules. Sample with highest amylose content and high water absorption capacity produce drilling fluid with higher Viscosity and lower fluid loss. In this study, Tropical Manihot Cassava Species was analyzed and its suitability as substitute for industrial viscosifier in aqueous and non-aqueous mud systems was experimentally examined. A total of five mud samples were formulated, four samples for different concentration of cassava starch ranging from 2ppb, 4ppb, 6ppb and 8ppb. The fifth mud sample was formulated as control for each type of mud system with standard viscosifier. API filter press assembly and What-man filter paper were used for the fluid loss test. The results from the mud density showed that, at temperature of 81oF the mud densities were within the API standard for both aqueous and non-aqueous mud systems. The optimum concentration of the starch was 6ppb. The flow properties from the analysis showed that, the starch extracted from this cassava specie can optimally improve the viscosity of both aqueous and non-aqueous drilling mud systems.

Index Terms— Tropical Manihot Cassava species, Aqueous and Non-aqueous mud systems, Viscosifier, Starch, Fluid loss

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1 INTRODUCTION

Drilling muds are ordinarily known for their gel or thixotropic attributes, in which they can encounter a reversible change from high to low viscosity status while being subjected to shear (Dolz et al., 2007). These transformations run the microstructure of the bit but will be progressively improved when the fluid is in static condition (Azar and Samuel, 2007). The pressure, depth and mechanical properties of the wellbore are the key parameters that figured out which kind of the mud is most relevant. In spite of their differences in categories, that main purposes and functions remain mutual (Barnes et al., 1998). The mud system function to preserve hole reliability, provide hydrostatic pressure, seal permeable formations, convey the rock cuttings, managing the pressure of the mud framework alongside greasing up and cooling the bit (Baba Hamed and Belhachi; 2009; Brazzel, 2009; Gonzalez et al., 2011; Okoro et al., 2015).

The huge variables for distinguishing the benefit of the mud system are viscosity (plastic and apparent), the gel strength, mud density, PH, thermal dependability and furthermore, the filtration (Caenn et al., 2011). Untreated colloids, essentially starch and its optimized types, were utilized as part of mud additives for quite a while to crush the dangerous impact of anhydrite and saline on mud systems (Civian, 2007; Windarto et al., 2011). In drilling mud mixture, diverse chemical (synthetic or inorganic) and polymer are utilized for different applications, these chemicals generally impact the rheological and fluid loss properties of the mud (Austin, 1983). Starch materials are principally used as effective proactive colloids reducing the filtration of practically all kinds of water dispersing drilling muds with the effect on the type of utilized salt and also optimize the viscosity of the mud system (Joel and Nwokoye, 2010). This starch activity is caused by its swelling and expanding of its volume because of free water ingestion or absorption (Ademiluyi and Amuda, 2011). There is a possibility of controlling the permeability of this formation by utilizing starch constituents and their blend with bentonite and different polymers (Joel and Nwokoye, 2010). Casava starch could be utilized to control viscosity and fluid loss in drilling mud (Amanuallh et al., 1997). In this study, Tropical Manihot Cassava Species was analyzed and its suitability as substitute for industrial viscosifier in aqueous and non-aqueous mud systems was experimentally examined.

2. LITERATURE REVIEW

The amylose component of starch controls the gelling behaviour since gelling is as a result of re-association of the linear chain molecules (Harry et al., 2016). Amylopectin is generally bigger in size, the extensive size and the branch of amylopectin decreases the mobility of the polymer and their introduction in an aqueous situation. The high quantity of hydroxyl groups in the starch particles impact the hydrophilic properties to the polymer and subsequently it's capability to dissolve in water (Okoro et al., 2015).

Sample with highest amylose content and high water absorption capacity produce drilling fluid with higher Viscosity and lower fluid loss (Amanuallh et al., 1997).
Considering design costs, environmental impacts and exploiting naturally available materials for use as additives becomes imperative.

2.1 Cassava (TMS 98/0505)

This is a recent hybrid specie of the Tropical Mani hot Spp. This specie is of tropical climate that has a high starch yield of about 67.1% (NRCRI, 2010). It is composed of 36.2% dry matter and root yield of 45.8% t/ha. This is one of the improved cassava cultivars grown by farmers, it is one of the most widely grown cultivars in Anambra State, Nigeria (Agwu and Anyaeche, 2007), with 78.8% of the respondents cultivating it (Table 1). The properties of some Casava species are presented in table 2. Specially many of the farmers cultivated TMS 98/0505 for the following reasons:

- High yield
- Perceived low level of HCN in products
- High products quality
- Pests/disease resistance
- Capacity to shade off weeds and early maturity.

But for industry and for the sake of this study, (TMS 98/0505) was selected due to its

- High amylose content of 27.69% (Onitilo, et al, 2007).
- Good pH
- Moisture content
- Bulk volume
- Fine – particle distribution
- Poly-dispersed dispersion.

Table 1: Percentage distribution of respondents by major cassava cultivars grown

Cassava cultivars	Percentage
TMS 30572/ **TMS 98/0505**	**78.8**
TMS 30552	**56.8**
TMS 4(2) 1425	**10.2**
'akuocha'	**11.9**
'udukanami'	**77.1**
'achirinaka'	**5.9**
Less common local cultivars	**3.6**

Source: **Journal of Food, Agriculture & Environment, Vol.5 (3&4), July-October 2007**

Table 2: Useful properties of Local starches (Onitilo et al, 2007, Eke et al., 2010).

S. No	Type of cassava	Amylose (%)	Starch (%)	Swelling power (%)	WAC (%)	Dry matter (%)
1	TMS 30572	27.69	74.21	9.04	122.45	95.13
2	TMS 419	18.97	70.87	-	-	-
3	TMS 95/0 289	23.93	85.24	11.58	86.98	91.41
4	TMS 91/0 2324	21.45	78.54	11.43	96.22	94.33
5	TMS 96/1 642	22.77	67.36	-	-	-

3. Methodology

The experimental procedure were of two parts; first is the extraction of starch from the TMS cassava specie and analyzing of the starch properties. The second part is the formulation of aqueous and non-aqueous mud systems with this starch and industrial viscosifiers, then comparing the rheological properties of the mud systems with API standard.

3.1 Extraction and Purification of Cassava Starch

The cassava starch was extracted from the Agricultural Development Program (ADP) Port Harcourt, Rivers State, using traditional method of harvesting.
The pulp mash grated by mechanical grater, was further blended with three (3) liters of water for easy filtration. The pulp was placed unto a muslin/ nylon screen, tired on a bucket and the mash was sifted through the muslin screen; while water was added persistently to help screening. The filtrate was permitted to settle under gravity for about 5 hours. The starch extract (filtrate) was blended with water again to remove impurities and contaminates. The blend was subjected to filtration operations the second time and after that concentrated utilizing sack made of material. The sack obtained were dried in an electric-thermo-regulated oven at a temperature of 30oC for 3hours to form cake and then sieved to reduce particle size to fine texture. The sieved powdered starch obtained were packaged and sealed for further analysis.

3.2 Water Based mud system Formulation

A total of five mud samples were formulated, four samples for different concentration of cassava starch ranging from 2ppb, 4ppb, 6ppb and 8ppb. The fifth mud sample was formulated as control for each type of mud system with standard viscosifier. Table 3 and table 4 present the quantities of additives used during the water and oil based mud formulation process. API filter press assembly and What-man filter paper were used for the fluid loss test.

Table 3: Additives used in formulating the Water Based Mud systems

ADDITIVES	**QUANTITY**	**MIXING TIME (Mins)**
Water (ml)	332	1
Bentonite (g)	4.0	30
Starch / PAC R (g)	2	5
PAC L (g)	0.6	3
Xanthan (g)	0.2	15
Barite (g)	15	15

Table 4: Additives used in formulating the Oil Based Mud systems

ADDITIVES	**QUANTITY**	**MIXING TIME (Mins)**
ECD-99 (ml)	198	10
Organophilic Clay (g)	4.0	5
Starch (g)	2	5
Soltex (g)	5	3
Calcium Chloride (g)	0.4	5
Barite (g)	15	15
Primary Emulsifier (ml)	6	3
Secondary Emulsifier (ml)	3	15

4 RESULT AND DISCUSSION

The results from the mud density showed that, at temperature of 81oF the water based mud formulated with PAC R has a mud weight of 13.90ppg; while the mud system formulated with starch has a mud weight of 13.60ppg at the same temperature. For the oil based mud system without starch the mud weight at temperature of 81oF is 10.55ppg; while the oil based mud with starch as viscosifier has a density of 10.50ppg at the same temperature. The optimum concentration of the starch was 6ppb.

The rheological properties of the mud gives an insight on the mud systems efficiency in carrying out its functions during drilling operation; thus, the rheological properties experiments were conducted using Fann V-G Viscometer. The rheological property results are presented in table 5 for the water based mud systems and table 6 for the oil based mud systems.

Table 5: The Rheological Properties of the Water Based Mud Systems

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Rheological Properties	Control Mud	WBM + starch
Mud weight (ppg)	13.9	13.6
600 rpm	41	39
300 rpm	30	30
10 sec, (Ib/100ft2)	11	11
10 min.(1b/100ft2)	14	13
PV (cP)	11	9
YP(1b/100ft2)	19	21
Filtrate@30min	7.2	9
Filtrate@1hr	10	13

Table 6: The Rheological Properties of the Oil Based Mud Systems

Rheological Properties	Control Mud	OBM + Starch
Mud weight	10.55	10.50
600 rpm	58	56
300 rpm	40	42
10 sec, (Ib/100ft2)	10	18
10 min.(1b/100ft2)	9	13
PV (cp)	18	14
YP(1b/100ft2)	22	28
Filtrate@30min.	3.2	3.4
Filtrate@1hr	5.1	6

The Plastic Viscosity (PV) of WBM + Starch and OBM + Starch met the API specification. From the result, it can be deduced that the yield point for WBM + starch and OBM + Starch were also within the API standard. The fluid loss test for WBM + starch and OBM + Starch were significantly within the standard. Thus, the starch extracted from this cassava specie can optimally improve the viscosity of both aqueous and non-aqueous drilling mud systems.

5 Conclusion

In this study, mud samples of aqueous and non-aqueous mud systems were formulated using extracted starch from Tropical Manihot Cassava species which have high amylase content. It can be deduced from the experimental results that these specific type of Starch can be used as a viscosifying agent for aqueous and non-aqueous drilling mud systems. The physio-chemical analysis showed that TMS 98/0505 specie used in this study can give a high yield of starch that can be used in the drilling fluid industry.

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