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SUITABILITY OF BENEFICIATED LOCAL STARCH UNDER ELEVATED TEMPERATURE AS A FLUID LOSS CONTROL ADDITIVE USED IN PETROLEUM INDUSTRY

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ABSTRACT
Several local drilling fluid loss control additives have been developed using agricultural products, but the extent of temperature effect on the local additives is not well known when evaluation and performance is made with those of the widely used foreign additives. This study investigated and compared the effect of temperature on drilling fluids prepared with foreign additive (Carboxyl Methyl Cellulose) and those prepared with local starch obtained from Cassava grown in Rivers State. The results indicated the extent of the effect of temperature on their rheological properties and filtration properties using Fann Viscometer and API Static Filtration Test respectively. All the samples exhibited similar trend in their rheological behaviors and filtration loss under normal temperature, but the local samples had major decrease in rheological properties and very high increase in fluid loss at elevated temperatures. However the beneficiated local starch had better results and compared favorably to the imported Carboxyl Methyl Cellulose at the same conditions of temperature.

***Key Words**: Local Starch, Elevated Temperature, Rheological Properties, Filtration Properties, Drilling Fluids*

INTRODUCTION
Drilling operations in Nigeria began in the mid-fifties and local additives and clays were used on drilling fluids. Later in the early sixties, the use of local additives and clays for drilling in the petroleum industry subsided in Nigeria as a result of the introduction of imported commercial additives and bentonite (Bindei, 1987). Drilling fluid is a mixture of natural and synthetic chemical compounds used to cool and lubricate the drill bit, clean the hole bottom, carry cuttings to the surface and control formation pressure. Filtration property is one of the most important analysis carried out on drilling fluids in the petroleum industry. Several types of materials are used to reduce filtration rate and improve mud cake characteristics. Most of these materials are starch and polymers which are organic colloids that are ionic and soluble in fresh and salt water. When drilling mud made from these materials are subjected to an elevated temperature, the rheology, thixotropy and filtration control of the mud are adversely affected, consequently leading to drilling mud filtrate lost into the permeable formation causing problems such as tight hole, sticking, shale sloughing, reduction in production-zone permeability and stuck pipe (Ifediora,1986). Filtration properties of drilling mud are a measure of the ability of the solid component of the mud to form a thin low-permeability filter cake. The lower the permeability, the thinner the filter cake and the lower the volume of filtrate from mud of comparable solid concentration.

Many components of drilling fluids are relatively stable at surface temperature but react readily with one another at elevated temperature causing increase in fluid loss , therefore good knowledge of down hole temperature and its effect is very essential in the formulation of any drilling fluid through proper selection of additives (Oriji et al. 1989). High down-hole temperature limit the use of organic additives and synthetic polymers to those not subjected to thermal degradation (Ranald and Bernhard, 1981). The effectiveness of CMC decreases sharply at temperatures above 149 ^{o}C while Dextrid Starch decreases at 130^{0}C which could also lead to the coagulation of the filter cakes (Nyland,1988). Fresh water-bentonite mud used geothermal wells can easily be damaged under high temperature environment, that is greater than 175 ^{o}C due to flocculation phenomenon of bentonite plates,this phenomenon affects the drilling process unfavorably and increases the drilling cost (Gursant et al.2005). Mohammed and Long (2004) concluded from their study of some local starch, namely DF-01, DF-02, DF-03 and DF-04 and its beneficiation, the beneficiated starch were able to withstand thermal degradation to a temperature of 150^{0}C by preventing the hydrolytic and oxidative degradation of the starch at this temperature. Also the spurt and API fluid loss values of the starch indicated that some of them have similar or better fluid loss control properties compared to the currently used modified starch.

MATERIALS AND METHODS

Three drilling fluids samples were prepared and labeled A, B and C. Sample A was prepared with foreign fluid loss additive; Carboxyl Methyl Cellulose (CMC). Sample B was prepared with local fluid loss additive, starch obtained from Cassava grown in Rivers State. The Cassava tuber was obtained, the brown back pilled off and the main white cassava grinded. The grinded Cassava was soaked in water and the solid shaft removed to obtain the filtrate. The filtrate was then allowed to settle for hours leaving a white pasty substance at the bottom, the water at the top was decanted and the pasty residue–starch obtained. This starch was dried and grinded to 213 mm size .All the mud samples were formulated individually with, 10grams of bentonite mixed in 350ml of distilled water in a Hamilton Beach mixer for five minutes to obtain a uniform mixture and to initiate the hydration of the bentonite. Then 0.5 grams of Xanthan gum polymer was added to each sample for sufficient viscosity to suspend the barite and prevent sagging. Two grams of foreign starch-CMC was added to sample A. Sample B was prepared by mixing the same quantities of additives like sample A, but the CMC was replaced with 2 grams of local starch. Finally, Sample C was prepared by mixing same additives as sample A, but the fluid loss additives were 1 gram each of local starch and foreign (CMC) to eliminate and reduce the cost of the extra 1gram of the foreign CMC. A viscometer was used to measure the dial reading of the various mud samples at 600rpm (θ_{600}) and 300 rpm (θ_{300}) subjected to various temperature as shown in the tables, from which the calculation of the plastic viscosities (PV) in centipoises (cp), apparent viscosities (AV) in centipoises (cp) and yield points (YP) in (Ib/100ft^{2}) were carried out.

Plastic viscosity, (PV) = θ_{600} - θ_{300} ..… …………………………………. …........... (1)

Yield point, (YP) = θ_{300} - PV ….... ……………………………………………… (2)

Apparent viscosity, (AV) = ½ θ_{600} …. …………………………………………….. (3)

The Filtrate losses in milliliters (ml) after 30 minutes were recorded using a standard API Filter Press Assembly at a test pressure of 100 psig. The Filtrate losses were collected with a graduated cylinder placed under the filtrate tube. After 30 minutes the collection of filtrates was

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stopped and the Filter Press Assembly was disengaged and the filter cake measured in 1/32 of an inch. During the filtrate loss measurement at various elevated temperatures, there was loss of heat energy causing a fall in temperature due to the un-lagged nature of the Filter Press Assembly, therefore the filtrate losses were further taken at every 7.50 minutes to minimize heat loss that could lead to error compared to the standard 30 minutes time of measurement. Then the API filtration losses for 30 minutes were obtained from the equation:

$$\mathbf{Q_2 = Q_1 \sqrt{(T_2/T_1)}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Where:

Q_1 = Fluid loss in 30 minutes
Q_2 = Fluid loss in 7.50 minutes
T_1 = 30 minutes
T_2 = 7.50 minutes

RESULTS

The analyses of the results from the experimental test carried out are based on comparative interpretations and graphical correlations on the behavior of the beneficiated mud sample (C) with the other samples (A and B) at elevated temperatures. The data obtained from the experiment and presented in the tables showed that, the samples A, B and C exhibited some degree of variance in their rheological properties and wall building characteristics. At elevated temperatures, there was an appreciable decrease in the plastic viscosities for all the samples, though the curves were not linear, figure-1. Also, the apparent viscosities and the yield points decreased with increase in temperature, figures 2 and 3. This was attributed to the increase in water loss through evaporation and the brake down of the intermolecular forces between the particles causing a decrease in the gel strength of the fluid samples. Figure-.4, showed that the fluid loss increased greatly at a higher temperature and appeared to be linear for all the samples. Conclusively, the experimental results of this study showed that temperature affected the effectiveness of the mud additives causing the wall building properties, thixotropic properties and the flow properties to break down. Also increase in temperature caused a significant evidence of dispersion due to an increase in evaporation of water from the samples which consequently caused an increase in filtrate loss. However, **t**he local starch from the Cassava have the potential to be used as fluid loss control agents if preserved and beneficiated to minimize the rate of degradation and then achieve cost reduction in overall drilling operations.

Table 1: Properties of the Mud Samples at Room Temperature

Samples	**θ_{600}**	**θ_{300}**	**PV(cp)**	**AV(cp)**	**YP (1b/100ft2)**	**Mud weight(1b/gal)**	**Fluid loss (ml/30mins)**	**pH**
A: (foreign)	49	35	14	24.50	21	10.00	28.50	8
B: (local)	40	28	12	20.00	16	10.00	29.00	8
C(beneficiated)	55	41	14	27.50	27	10.00	24.00	9

Table 2: Properties of the Mud Sample A at Elevated Temperatures

Properties	**Temperature(°C)**			
	30	**55**	**80**	**105**
θ_{600}	49	45	33	27
θ_{300}	35	33	24	19
$PV_{(cp)}$	14	12	9	8
$AV_{(cp)}$	24.50	22.50	16.50	13.50
YP $_{(1b/100ft^2)}$	21	21	15	11
Mud weight (ppg)	10.00	10.00	10.00	10.00
Fluid loss (ml/30mins)	28.50	36.00	40.50	46.10
Mud Cake ($\frac{1}{32}$”)	0.346	0.390	0.350	0.472
Ph	8.0	8.0	8.0	8.0

Table 3: Properties of the Mud Sample B at Elevated Temperatures

Properties	**Temperature(°C)**			
	30	**55**	**80**	**105**
θ_{600}	40	34	30	25
θ_{300}	28	24	21	18
$PV_{(cp)}$	12	10	9	7
$AV_{(cp)}$	20	17	15	12.50
$YP_{(1b/100ft^2)}$	16	12	12	10
Mud Weight (ppg)	10.00	10.00	10.00	10.00
Fluid Loss (ml/30mins)	29.00	30.00	33.80	36.00
Mud Cake ($\frac{1}{32}$”)	0.236	0.390	0.610	0.689
ph	8.0	8.0	8.0	8.01

Table 4: Properties of the Mud Sample C at Elevated Temperatures

Properties	**Temperature(°C)**			
	30	**55**	**80**	**105**
θ_{600}	55	45	41	37
θ_{300}	41	34	31	28
PV $_{(cp)}$	14	11	10	9
AV $_{(cp)}$	27.50	22.50	20.50	18.50
YP $_{(1b/100ft^2)}$	27	23	21	19
Mud weight (ppg)	10.00	10.00	10.00	10.00
fluid loss(ml/30mins	24.00	28.60	32.40	34.80
Mud Cake ($\frac{1}{32}$”)	0.236	0.649	0.748	0.708
ph	9.0	9.0	9.0	9.0

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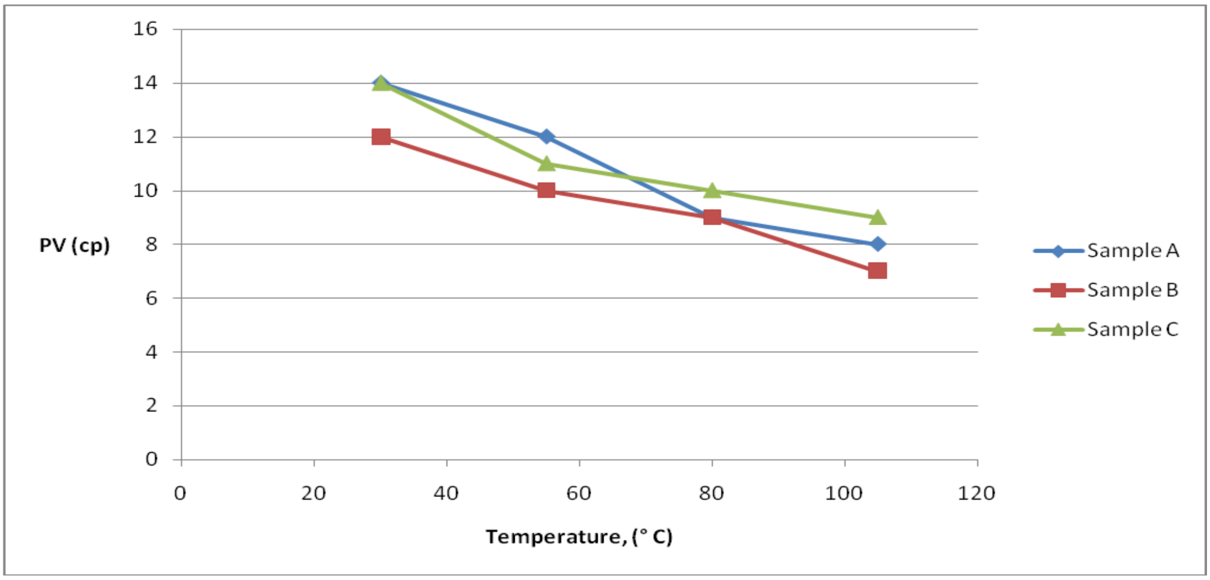

Fig.1: Plastic Viscosity against Temperature

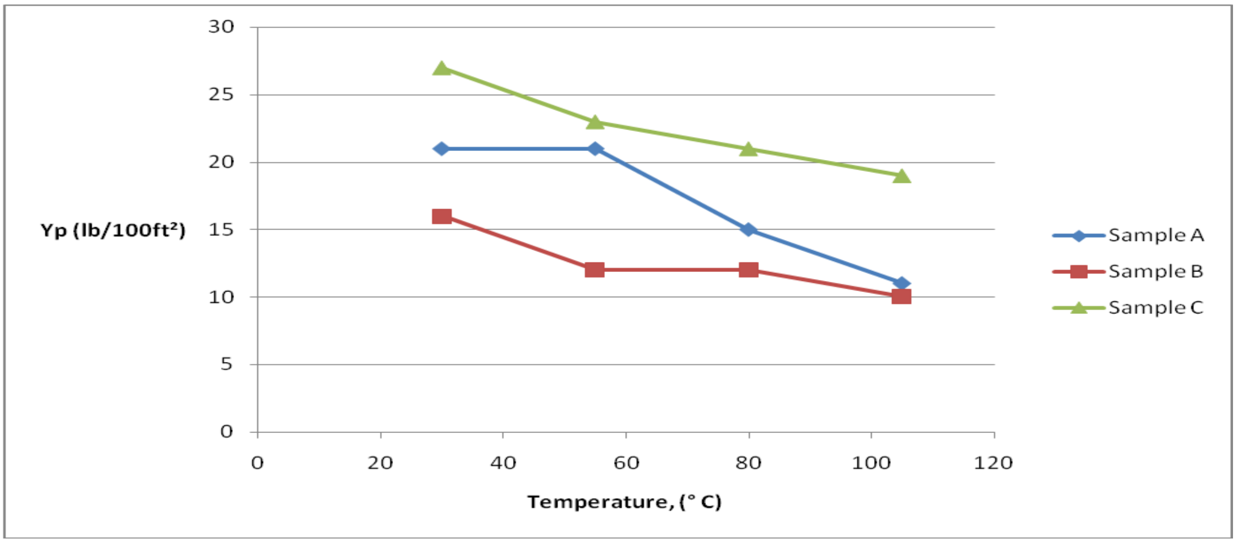

Fig .2: Yield Point against Temperature.

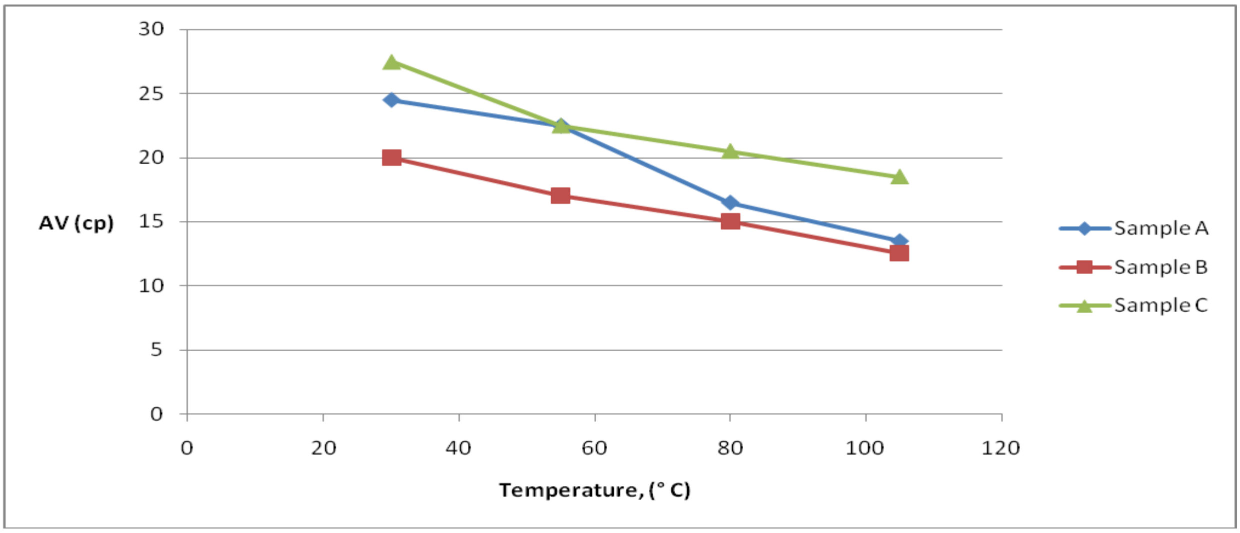

Fig .3: Apparent viscosity against Temperature.

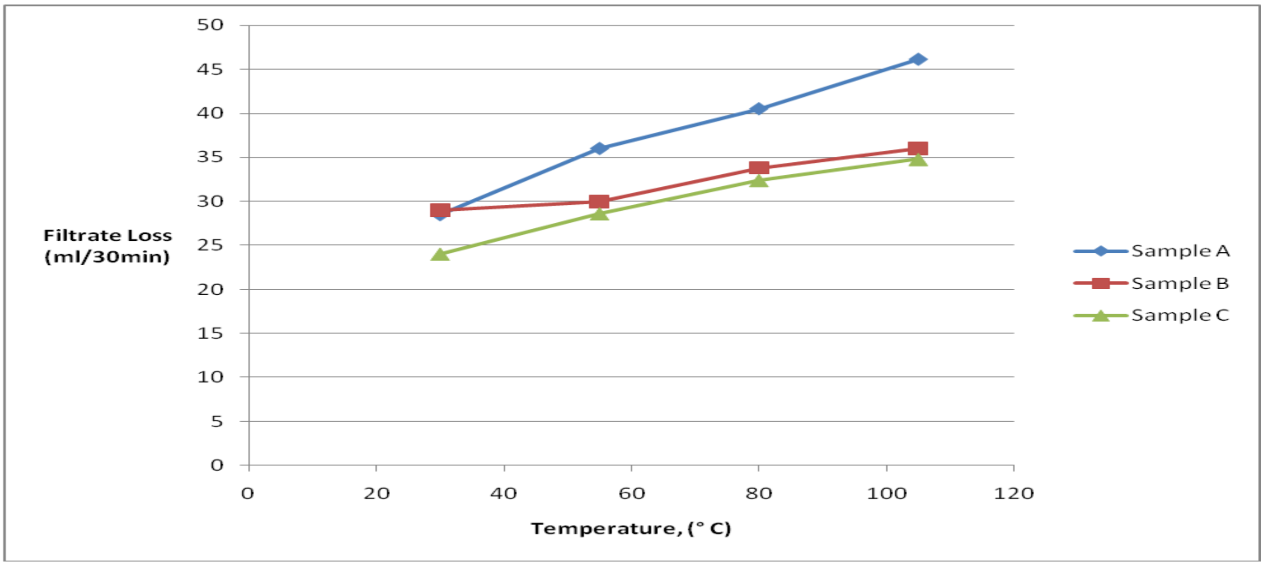

Fig .4: Filtrate Loss against Temperature

DISCUSSION

Drilling mud is very vital in drilling operations where it acts as the blood streams of drilling operations. Temperature actually has an effect on the performance of fluid loss additives on drilling mud, but the extent of temperature effects on the local fluid loss additives on drilling mud is not yet well known. This experimental investigation is as an attempt to better characterize the rheological properties of the local based drilling mud under a variety of conditions in mixing times, mixing speed and elevated temperature. Hence the research involved, identifying, collecting, analyzing and comparing the behavior of local and foreign additive at ambient and elevated temperature for their suitability. Chinlingarian (1981), rise in temperature of about 18 ^{o}F doubled the speed of chemical reaction and that many components of drilling fluids are relatively stable at surface

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temperature but reacts readily with one another at elevated temperature. This phenomenon was beneficial to the local starch because in cases where temperature was not excessive, it speeds the reaction of the chemicals added for rheological control, but at a elevated temperature the local based drilling fluids thickened as the molecular cohesion of the fluid decreased, thus resulting in the decrease of the effective viscosity. Also the fluid loss became excessive resulting to large filter cake and this in actual drilling situation can lead to differential stuck pipe and shale problems.

The local starch behaved considerably astonishing and unstable at elevated temperature and had detrimental effects on the filtration and rheological properties. Extensive care should be taken into consideration when using local starch to formulate drilling fluids. The effects of grain size, mixing speed and mixing time must be evaluated with proper additives.

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