The Prospect of Using Palm Wine As a Fluid Loss Control Agent In Water Based Drilling Mud

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Abstract: The need to advance and project the use of local materials as suitable drilling fluid additive in the oil and gas industry in Nigeria led to the research on the possible use of palm wine and potash as additives in a water base drilling mud. A comparative study of these local materials (palm wine and potash) with imported foreign materials (lignite and caustic soda) as control were used in investigating the properties of a water base drilling fluid. A laboratory investigation of the effects of temperature and aging time on the properties of water-base drilling fluid is made with Fann Model 800 High Temperature and a High Pressure (HTHP) Viscometer, according to the API recommended standard practice. The results obtained showed similarity in the drilling fluid's rheological and filtration properties; mud weight and pH values for both local and foreign additives. The result from the mud sample prepared from the palm wine and potash had apparent viscosity, plastic viscosity and yield point decreasing steadily with increase in temperature for all aging time just as shown with the control sample, while the aging effect diminishing as the aging time increases. The potash was seen to have increased the mud pH from 7.0 to 12.9 pH units. The results, shows that both palm wine and potash can be used as suitable in water base drilling mud additive.

Keywords: Aging, Fluid loss, Palm wine, Potash, Drilling fluid, Temperature.

1. INTRODUCTION

Drilling fluids (muds) are complex heterogeneous fluids, consisting of several additives that were employed in drilling of oil and natural gas wells since the early 1900 in Spindle tops, Texas. Drilling fluid is usually a mixture of water, clay, weighing material and a few chemicals. Sometimes oil may be used instead of water, or oil added to the water to give the mud certain desirable properties. Drilling fluid is used to raise the cuttings made by the bit and lift them to the surface for disposal. But equally important, it also provides a means of keeping underground pressures in check. The heavier or denser the mud, is the more pressure it exerts. Hence, weighting materials (barite) are added to the mud to make it exert as much pressure as needed to suppress formation pressures.

The original use of the drilling fluids was to remove cuttings continuously. Progress in drilling engineering demanded more sophistication from the drilling mud. In order to enhance the usage of drilling fluids, numerous additives were introduced and a simple fluid became a complicated mixture of liquids, solids and chemicals. As the drilling fluids evolved, their design changed to have common characteristic features that aid in safe, economic and satisfactory completion of a well. In addition, drilling fluids are also now required to perform other functions [1].

In order to ensure proper functionality of drilling fluid, appropriate drilling fluid is selected, and adequate understanding of the key factors governing the selection of the fluid is critical. Highly viscous fluid usually results to high frictional force which would result to high equivalent circulating density that could fracture the formation and lead to loss circulation. Hence solving this problem of high viscosity is the use of viscosity reducers. The scope of this project is limited to water based muds at Low Pressure Low Temperature.

Numerous studies have been conducted to effectively understand change in fluid properties under down-hole conditions Using a concentric-cylinder, rotational viscometer of the Fann type, the changes in rheological property with time and temperature up to 300^0F was investigated [2] and observed that bentonite clays tends to flocculate at high temperature resulting in high viscosities, high yield points, high gel strengths and a permanent thickening of the mud at low shear rates, and concluded that proper treatment of bentonite mud with NaOH and lignosulphate reduces the effect of dispersion and flocculation at high temperature.

Flocculation causes variation in drilling mud properties; it results in high yield point at low shear rate and high viscosities at high gel strengths The major cause of flocculation in drilling mud is high active solids, high electrolyte concentration and high temperature [3]. Thus proper treatment of mud with NaOH and ligmosulfonate reduces the effects of dispersion and flocculation at high temperature [4]. The rheological properties of drilling mud, under

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E-ISSN: 2409-787X/16

temperature of 130°C and pressure up to 1000 bar, was best fitted using the three parameter Herschel-Bulkley power law at low temperature and high pressure conditions also it was noted that model behavior of the continuous phase is weakly pressure dependent and an exponential temperature dependent. The pressure dependence increased with mud density. In all cases the fluid yield stress was essentially independent of pressure [5]. Similarly, an extensive research was conducted on the effects of temperature, pressure and aging on water based muds, they reported that high pressure increases the values of the rheological properties of the drilling fluids [6].

Aging of drilling mud also affects mud properties. Aging tests are conducted to determine how bottom-hole conditions affect mud properties. Aged drilling mud samples are obtained after samples have been put in a hot rolling oven in a sealed aging cell for 16 hours. Aged mud samples (before stirring) are tested for shear strength which determines gelling tendencies of fluid in the borehole. Setting of mud solid in an aged mud indicates formation of a layer (hard/soft) of sediment in the borehole after stirring aged mud sample their rheological properties are determined [7]. The effective viscosity, plastic viscosity, yield point and gel strengths (10 sec. and 10 min.) of aged mud sample increase with the increase in aging time and vice-versa and shear stress at a given shear rate increased with increase in aging time [4].

Drilling fluid's invasion of fractured zone has caused severe problems in the past. Industry recently started monitoring mud loses in order to identify the fractured zones. Mathematical modeling of these fractured formations is being done in order to describe the physical phenomenon and the mechanism under which the flow within the fractures will take place, so that causes of the problem and methods to minimize it could be determined [8].

The particle size of a material could limit fluid loss to formation and minimize solid plugging in reservoir pores, as a result, optimization of drilling fluid could be achieved by distribution of bridging particle sizes. However, a combination of pore size, fluid property, and filter cake quality considerations will be needed to achieve the most effective particle size distribution [9]. Palm wine is an alcoholic drink produced from the fermented sap of the oil palm tree Elaiesguineensisor the Raffia tree Raphiasp. Fresh palm-wine is sweet, clear, neutral, colorless juice containing 10-12% sucrose, minimal invest sugar (less than 0.5%), small amounts of proteins, gums and mineral. Spontaneous fermentation starts immediately the sap is collected and within an hour or two becomes reasonably high in alcohol (up to 4%) [10].

The equations 1.0 and 2.0 of reaction of fermentation of palm-wine and oxidation of ethanol are represented thus respectively;

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 \quad 1.0$$

Glucose Ethanol Carbon dioxide

$$C_2H_5OH + O_2 \rightarrow CH_3COOH + H_2O \quad 2.0$$

$$Ethanol + Oxygen --- Aceticacid + Water$$

2. EXPERIMENTAL DETAILS

2.1. Materials

The bentonite clay, lignite and caustic soda, used in this experiment were donated to the department of petroleum engineering by Mi-Swaco. Freshly tapped sap from a palm tree was collected from a tapper at a location in Ibadan. The sap was allowed to continue to ferment for 24 hours and a sweet, white, mildly intoxicating aromatic beverage called palm wine was obtained. The palm wine was stored in an air tight container to prevent further fermentation which would turn the palm wine into vinegar. The potash lumps was crushed to a fine powder using the mini hand crusher and sieved using a 200 micron sieve (to obtain a fine talc size powder) before packaging and then labeled, The de-ionized water was obtained from the department of Petroleum Engineering Laboratory University of Ibadan.

2.2. Experimental Apparatus

The following equipment were used during the course of the research: pH hydrion paper strip, Beakers, Weighing balance, Multi-mixers and cups, Mud cups graduated, pH meter model Jenway 3520, Baroid roller oven, spatulas and stirrers, Conical flat bottom flask, Fann Model 800, API Filter Press, Sieve and shaker, A mini hand crusher, Local evaporating basin and Mud balance.

2.3. Preparation of Prehydrated Mud

A Laboratory equivalent barrels of mud with known initial pH of 7.0 was prepared from 21.0g of Bentonite, mixed with 350ml of fresh de-ionized water The mixtures of bentonite and fresh de-ionized water were

Table 1: Formulation of Water Based Mud by Composition

Materials	Sample A	Sample B	Sample C	Sample D	Sample E
Water (ml)	350	350	350	350	350
Bentonite (g)	21	21	21	21	21
Lignite (g)	-	2	2	-	-
Caustic soda (g)	-	1	2	-	-
Palm wine (ml)	-	-	-	2	2
Potash (g)	-	-	-	1	2

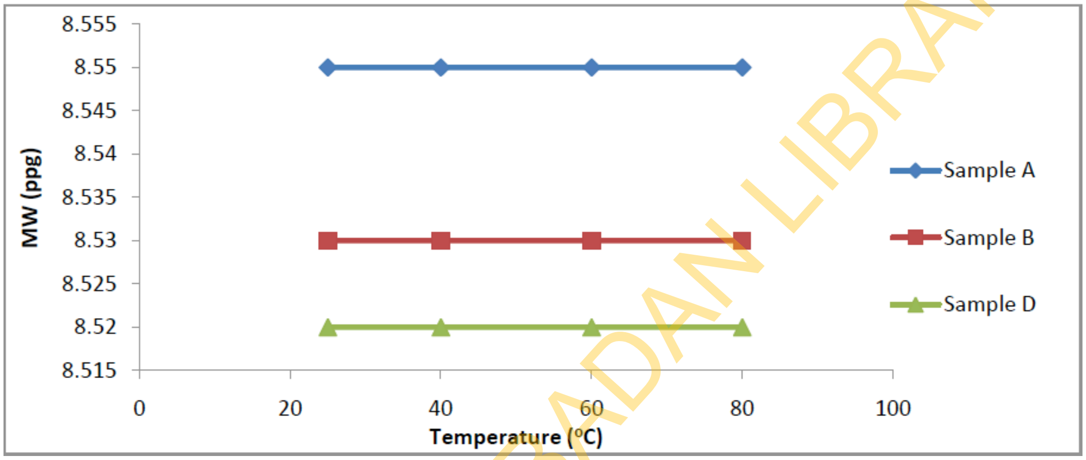

Figure 1: Effect of Temperature on sample mud weight for both local and foreign additives.

thoroughly mixed, and allowed to age over a period of 24 hours, The initial properties of these mud samples at different temperature were tested using a viscometer, mud balance, pH, and an API filter press.

2.4. Determination of the Effect of Palm wine on the properties of a WBM

2.4.1. Procedure

The American Petroleum Institute (API) recommended practice procedure were used when performing all the experiments [11]. 2g of the lignite was added to a laboratory equivalent of 1 barrel of the prehydrated mud sample (21.0g + 350ml of de-ionized water). The additive was thoroughly mixed to obtain a homogenous mixture and the properties were measured every 24 hours over a period of 96 hours. Similarly, 2.0g equivalent of palm wine solution was added to the already prepared mud of the same equivalent of barrel.

2.5. Determination of the Effect of Potash on the properties of WBM

2.5.1. Procedure

1g and 2g of the potash and the caustic soda respectively was added into the pre hydrated mud. The additives were thoroughly mixed into the mud to obtain a homogenous mixture and ready to be analyzed and tested.

3. RESULTS AND DISCUSSION

The density for the mud samples did not change with temperature and aging (Figure **1**). But reduction in density was observed when lignite and palm wine were added respectively (Figure **2**).

The pH of mud did not change with temperature (Figure **3**), although the pH of the mud reduced when lignite and palm wine were added (Figure **4**) this can be attributed to the acidic nature of both additives .pH increased when caustic soda and potash were added separately in increased concentration of 1.0g to 2.0 g and the results were also comparable. During Aging the pH value was noticed to be decreasing as shown in the Figure **5**.

3.1. Filtrate Loss

The Figure **6** showed that filtration loss increased with increased temperature, and increased with aging. But filtration loss reduces when the viscosity reducers

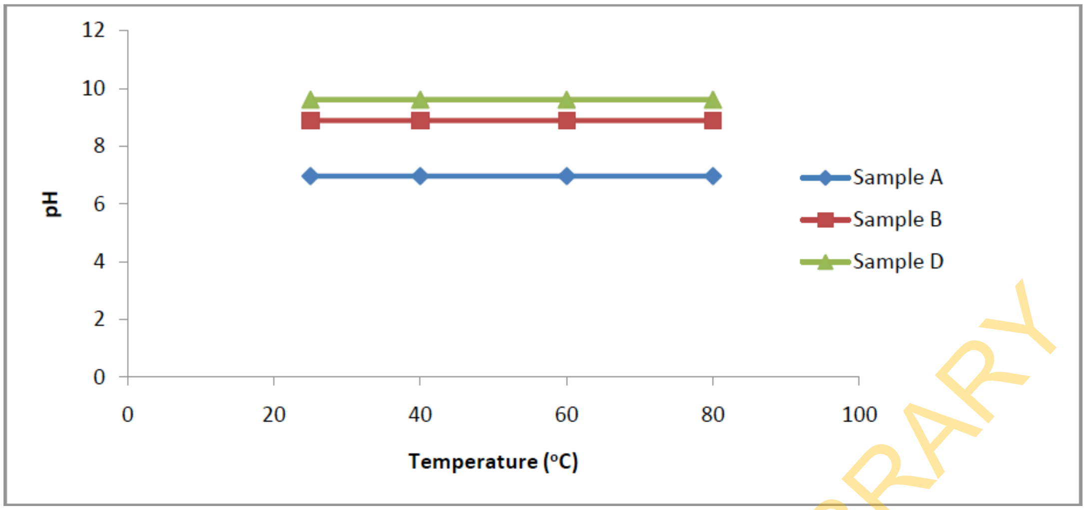

Figure 3: Effect of temperature on mud pH containing 1g of both local and foreign additives.

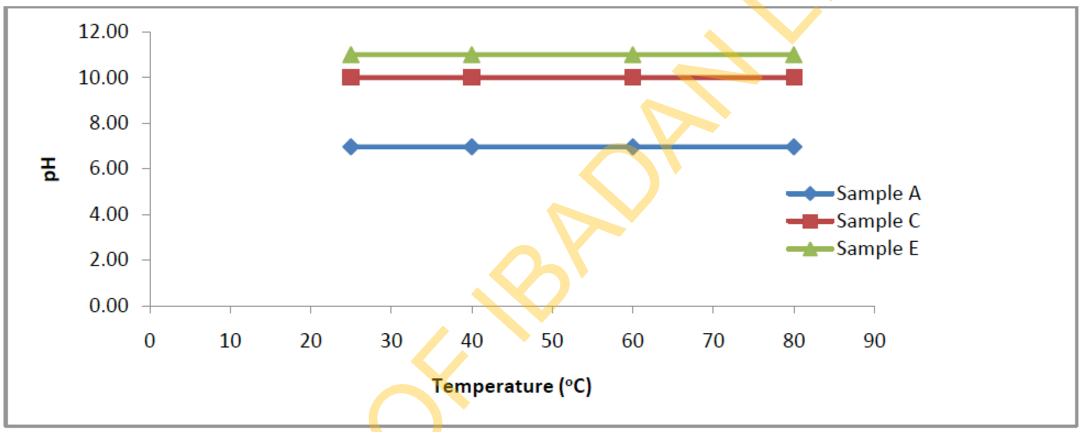

Figure 4: Effect of temperature on mud pH containing 2g of both local and foreign additives.

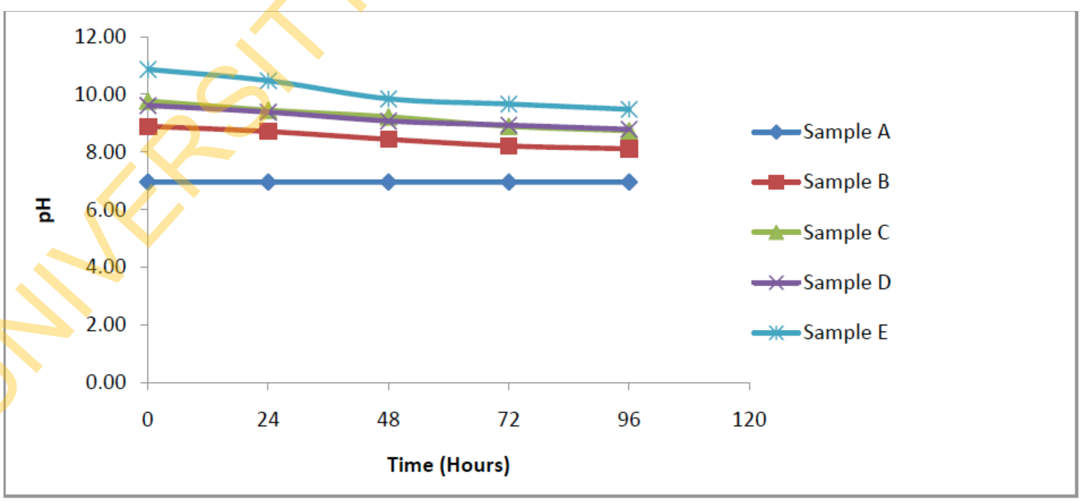

Figure 5: Effect of Aging on mud pH using both local and foreign additives.

were added (both local and foreign). Although, filtration loss measured was less when foreign material was used, the results were comparable.

3.2. Effect of Aging

The effect of aging on mud rheology was also studied and results presented in Figure **8** through 10, it

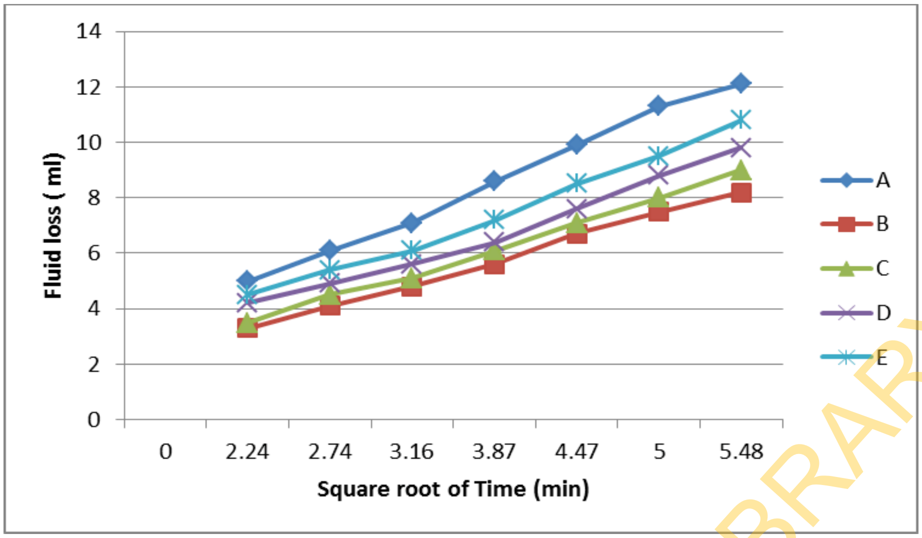

Figure 6: Fluid loss against Square root of Time (min).

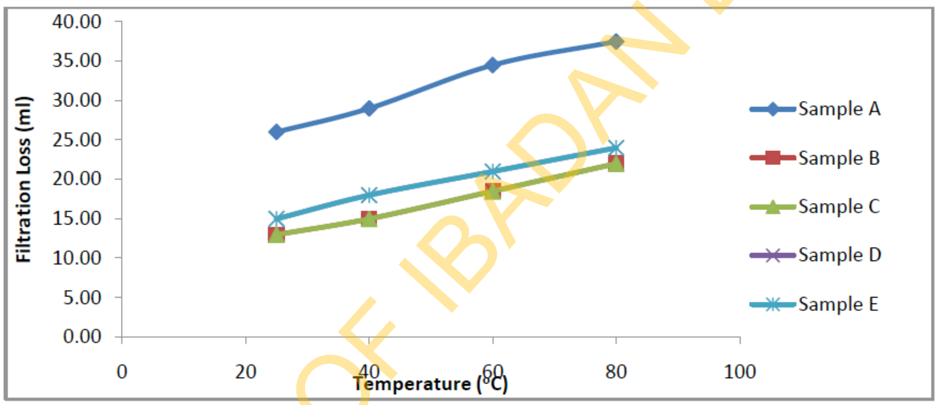

Figure 7: Effect of temperature on mud Filtrate loss for all mud samples.

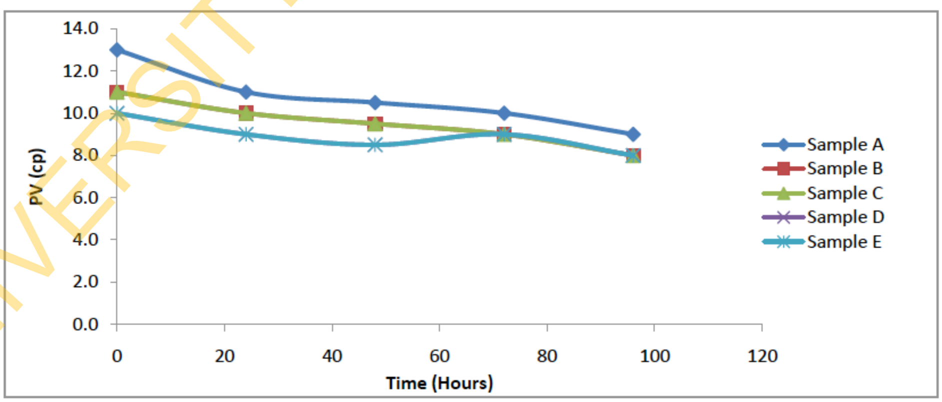

Figure 8: Effect aging on mud plastic viscosity for all mud samples.

was observed that plastic viscosity, apparent viscosity and yield point at a given temperature decreased with increase in aging time and the aging effect diminished as the aging time increased especially for the yield point. But the gel strength increases with increasing aging. It was also observed that gel strength at a given temperature increased with aging. The viscosity of the mud before adding additives was higher than when additive (both local and foreign) were added, and the resulting viscosities when the additives were added can be comparable.

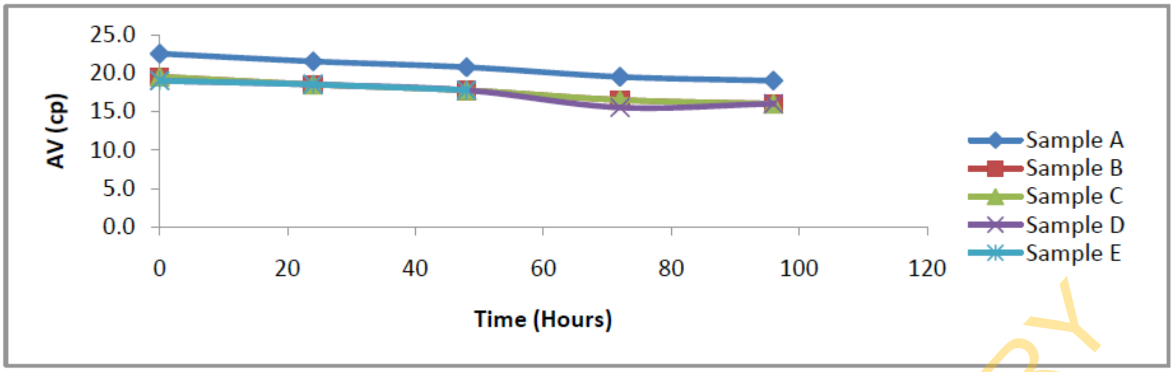

Figure 9: Effect aging on mud apparent viscosity for all mud samples.

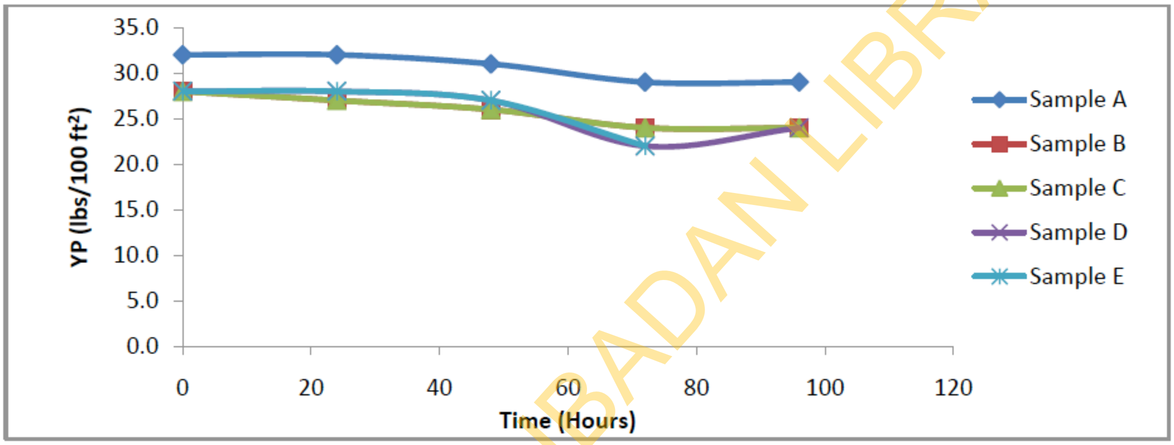

Figure 10: Effect aging on yield point for all samples.

3.3. Effect of Temperature

The effect of temperature on drilling mud can be attributed to the complicated interplay of several causes, some of which are more dominant than others. Some factors such as reduction in the degree of hydration of the cation, changes in the electrical double layer thickness and increased thermal energy of the clay micelles all take place in the drilling fluid simultaneously as temperature is varied, an interpretation of the observed results will only be possible in cases whereby some of the effects are predominant and as such be easily identified. As shown in Figures **11-12**, the rheological properties of the mud samples decreased steadily with increase in temperature for all values of aging time. The viscosity of the mud before adding additives was also higher than when additives (both local and foreign) were added at any given temperature, and the resulting viscosities when the additives were added can be comparable.

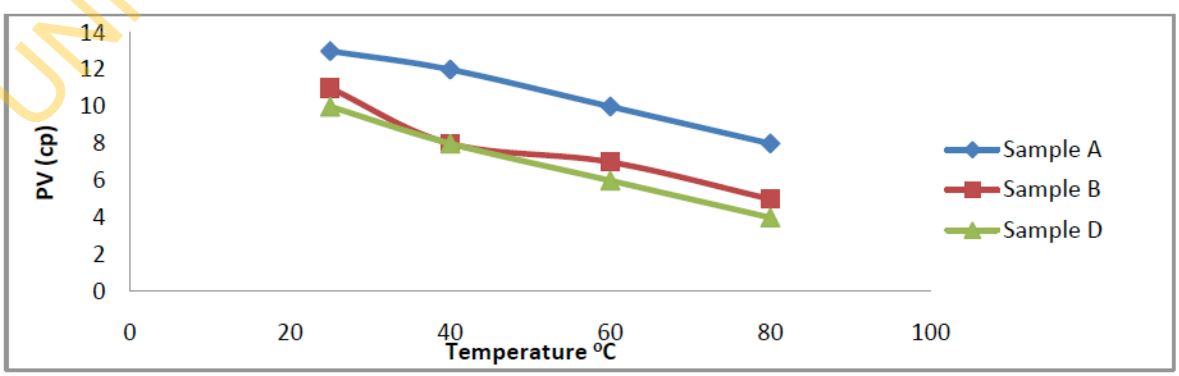

Figure 11: Effect of temperature on mud apparent viscosity for all samples.

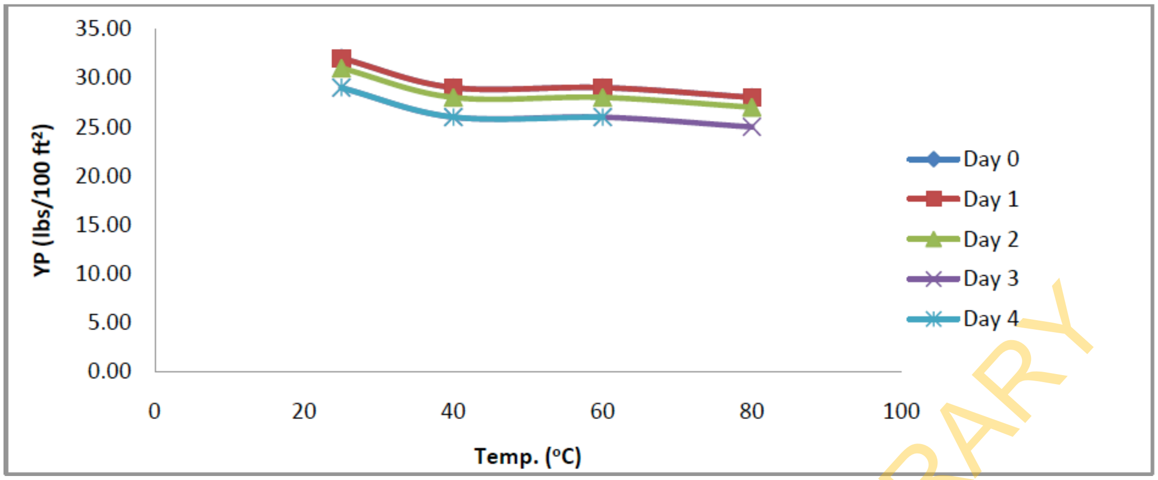

Figure 12: Effect of temperature on mud yield point for all samples.

CONCLUSIONS

The concentration of mud additives is vital when controlling the rheological properties of drilling mud. Significant changes in mud density and rheology were noted to correspond to changes in the concentration of mud additives. The density of mud remained constant with increasing temperature and aging but reduced when lignite and palm wine were added respectively and the results were comparable. Although the pH of mud does not change with temperature, the pH of the mud reduced when lignite and palm wine were added this can be attributed to the acidic nature of both additives and their result were comparable. Filtration loss increased with increased temperature and aging. The addition of the viscosity reducers caused a reduction in filtration.

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Received on 30-05-2016 Accepted on 15-06-2016 Published on 03-04-2017

DOI: http://dx.doi.org/10.15377/2409-787X.2016.03.02.1