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COMPARATIVE ANALYSIS OF LOCAL AND FOREIGN BENTONITE AS DRILLING MUD IN NIGERIA PETROLEUM INDUSTRY.

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ABSTRACT

Nigeria has a large deposit of bentonite clay, which have many significant uses in different aspects of the oil and gas industry. Therefore, there is a need to look inward in harnessing the local resources in providing solutions to challenges obtainable in the oil and gas industry. The bentonite samples were crushed to finer particles and sun dried for 5 days, using a mortal to obtain the powder form. Further, the bentonite powder is activated by chemical reaction with soda ash resulted in improved montmorillonite content. The activation process increased the clay yield and swelling power, bentonite sample was then modified using oxalic acid and CTMABr. Bentonite powder is calcined at temperature of 600 ^oC for 1 h. Analytical techniques such as X-ray Flourescence (XRF), Infrared spectroscopy in transmission mode (FTIR) and Thermal analysis (TGA) were employed to characterize the samples. The characterization results show that the chemical constituents of natural bentonite phase are Al, Si, Ca, Fe and Ti. Wyoming silica, alumina, sodium and calcium contents for bentonite are (45 wt%, 17 wt%, 2.7 wt%, 1.77 wt%; 61.55 wt%, 20.55 wt%, 2.41 wt% ,1.32 wt%; 61.80 wt%, 20.44 wt%, 2.1 wt%, 1.4 wt%; 48.35 wt% , 12.15 wt %, 3.65 wt%, 6.68 wt%) respectively. However, in this work the silica (SiO_2) values of the Local and Foreign bentonite are comparable. Therefore, this study is useful as reference materials for further
studies and policy decision making.

Keywords: Bentonite clay, XRF analysis, FTIR analysis, Thermal analysis, Drilling mud.

1. INTRODUCTION

Many demands are put on the drilling fluid and the primary functions of the drilling fluid are to; lug cuttings from beneath the little bit, transport them up the annulus, allow their separation at the surface, lower friction between the exploration string and the side of the hole, preserve the security of uncase sections of the borehole, avoid inflow of fluids from absorptive rocks passed through, reduced leaks in the structure filter cake which seals pores and various other openings in formation passed through by the little bit, help in the collection and analysis of details readily available from piercing cuttings, and electrical logs (Werner et al., 2017. Drilling fluid is lowered from surface via the drill pipe to the bit face, it raises the created cuttings and also brings them to surface area, where separation tools remove the cuttings from the drilling fluid, which is flowed with the aid of effective pumps back to the wellbore. In this research work, Nigeria bentonite is evaluated to ascertain its applicability as a drilling fluid based on the performance characterization. Exploration liquids perform added features, mostly; they regulate subsurface pressures, support the subjected rock, protect against contamination of subsurface formation hydrocarbon fluids, offer buoyancy, as well as trendy and also lubricate the bit. Such liquids must be carefully picked to make sure that they do not damage the formations which are being drilled.

Oil and gas market is the primary remain of the Nigerian economy due to its enormous contributions to foreign exchange. While this places the oil and gas sector in a calculated setting in the Nigerian economic situation, the current global collapse in crude oil production has stopped and also restricted the profits of the Nigerian federal government from unrefined oil sales while putting some monetary restraints on the major stakeholders in the oil market. Different works have been done on bentonite from different sources as drilling fluid. The Egyptian bentonite sediments which are characterized as having inferior hydration, plastic and rheological properties as compared with foreign bentonites were found to exhibit properties which match the required specifications for drilling muds when beneficiated and activated with alkaline agents (Olugbenga *et al.,* 2013). Low grade Indian bentonite clay was beneficiated using sodium dithionite and a mixture of sodium sulfide and oxalic acid. Beneficiated clay was found to have properties comparable to the standard properties of bentonite accepted by oil industry for use as drilling fluid (Afolabi *et al.,* 2017). Furthermore Arabi et al, (2018) reported vast improvements in the rheological and filtration properties of bentonite samples obtained from the Pindiga formation in the Borno basin of Nigeria, upon beneficiation with sodium carbonate, potash and starch. The studies showed that beneficiation provided greater promises for such clay as regards its use in drilling operations. Bentonite clay is primarily light tinted and also expands when blended with water (Vryzas et al., 2017). Bentonite are made up of primarily the montmorillonite mineral, which is a subset of the smectites team. Calcium montmorillonite clays are the significant components of bentonites happening globally yet are mainly defined by low swelling ability when contrasted to the salt montmorillonite clays.

Nigeria has a large deposit of **bentonite** clay, which have many significant uses in different aspects of the oil and gas industry. Therefore, there is a need to look inward in harnessing the local resources in providing solutions to challenges obtainable in the oil and gas industry. This would help in reducing the importation of materials and conserving financial resources for the indigenous oil companies (Agwu et al, 2015). Bentonite clay deposits spans the length and breadth of the Nigerian nation (Afolabi et al, 2017), and is estimated to be above 700 million metric tons (Torsvik et al., 2016). iWith the rising demand for bentonite clays as oil and gas exploration shifts to deep offshore, there is a growing need to enhance the properties of local Nigerian bentonite clay to meet the American Petroleum Institute (API) standard. This research intends to upgrade the local bentonite as well as characterize both the local and foreign bentonite for comparative study based on their composition.

2. MATERIALS AND METHODS

The chemicals, reagents, local and foreign bentonite clay were purchased from authorized vendors. The samples were crushed to finer particles and also sunlight dried for 5 days to reduce pulverizing as well as sieved. The treatments were duplicated till the entire clay example passed through the filter (Temraz and Hassanien, 2016). 10 g of the reduced clay sample was calcined with a muffle furnace (carbolyte) of optimum temperature of 1200 ^oC. The home heating was performed at 850 ^oC for 6 h to trigger the clay. Further 10 g of the bentonite sample was socked with distilled water to age for 24 h. 0.63 g of CTMABr was included right into the bentonite slurry at 90 ^oC. The last decanted debris was dried for 12 human's resources at 105 oC making use of oven. Also, 10 g of the clay example was treated using 0.6 g oxalic acid in 10 mL distilled water for 125 min as well as at 100 ^oC utilizing a consistent temperature trembling water bathroom. The activated samples were based to fine dimension.

2.1. CHARACTERIZATION OF BENTONITE

The composition of the bentonite clay samples was determined by X-ray fluorescence (XRF) Bruker S4 Pioneer spectrometer. The Infrared spectroscopy transmission setting (FTIR) with a Vertex 70 spectrometer (resolution 4 cm-^{1}) outfitted with KBr windows. The field of wave numbers is in between 400 as well as 4000 cm-^{1}. The ranges were taped in transmission setting on self-supported or weakened in KBr pellets. These are acquired by grating a small amount of the analyte with powdered potassium bromide. Thermo-gravimetric analaysis evaluations were carried out with a Q600 SDT TA instruments within air circulation (100 ml/ min) at temperature increase of 5 ° C/min.

3. RESULTS AND DISCUSSION

3.1 FTIR Analysis

As shown in Figure 1, most intense bands of the spectrum were found in the low-frequency region. The bands at 1115 cm^{-1} and 1113 cm^{-1}; 998 cm^{-1} and 1004 cm-^{1} for GA and GT respectively were produced by the stretching mode of Si–O (out-of-plane) for MMt and Si–O stretching (in-plane) vibration for layered silicates, respectively. Bands at 1110 cm-1, 1115 cm-^{1}, 1116 cm-^{1}, 1125 cm-^{1} and 1150 cm-^{1}; 1007cm- ^{1}, 1030 cm-^{1}, 1035 cm-^{1}, 1038 cm-^{1}, 1045 cm-^{1} were reported from different literature for the Si-O stretching out of plane and in-plane respectively.

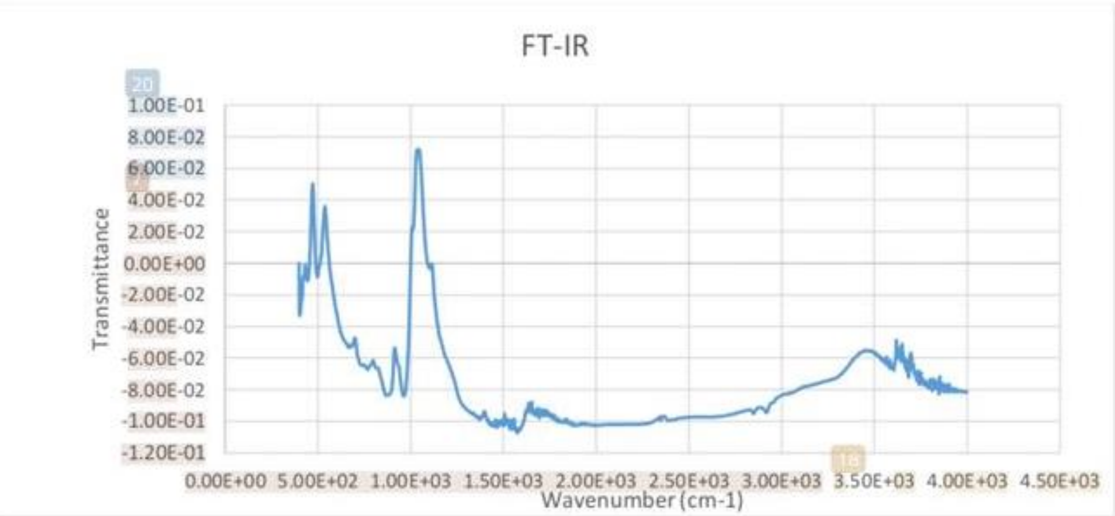

Figure 1. FTIR analysis of local Bentonite

From Figure 2, FTIR spectra of the bentonite samples in this study, the bands at 3693cm-^{1}, 3693cm-^{1} and 3622cm-^{1}, 3622cm-^{1} are assigned to OH stretching vibrations in the Si-OH and Al-OH groups of the tetrahedral and octahedral sheets of the GA and GT clay samples. Werner et al, (2017); Temraz and Hassanien (2016); Afolabi *et al.,* (2017); Achachlouei *et al.,* (2018) reported values of 3698 cm^{-1} and 3620 cm^{-1}; 3693 $cm^{-1}$and 3620 cm^{-1}; 3695 cm^{-1}; 3698 cm^{-1} and 3620 cm^{-1} for the OH stretching vibrations in the Si-OH and Al-OH groups respectively. The band of low intensity located at lower frequencies at 1639cm^{-1} for both samples are produced by the bending vibration mode of adsorbed water, this was in agreement with the values reported by Dutta and Singh, (2014); Abdullahi *et al.*, (2007);; Abdullahi and Yilmazer, (2011). Aftab *et al.*, (2013); Ademibawa *et al.*, (1999) reported values of 1630 cm^{-1} and 1636 cm^{-1} respectively.

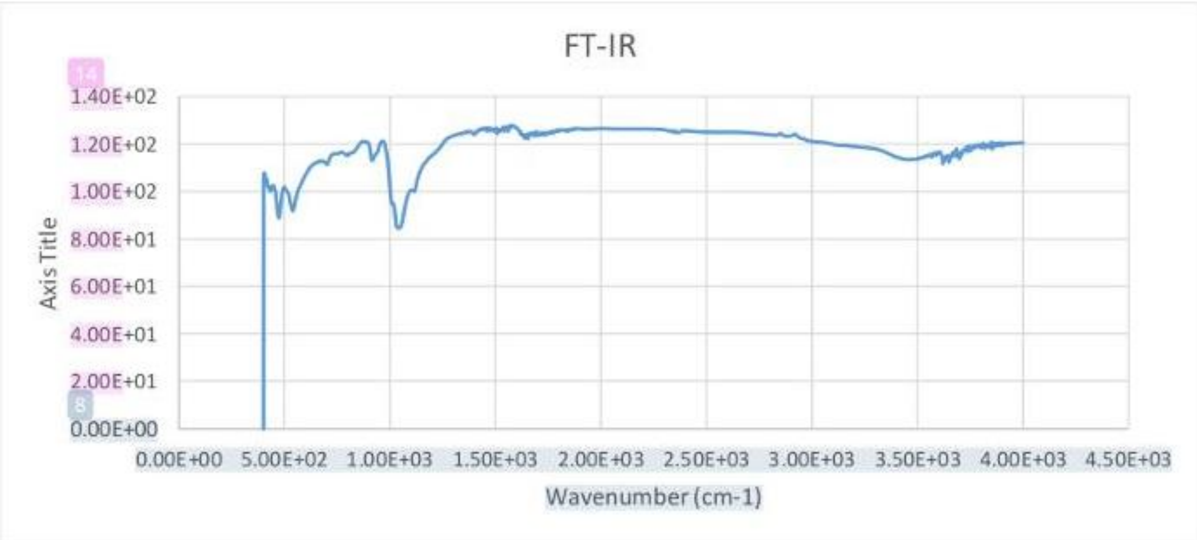

Figure 2. FTIR analysis of foreign Bentonite

3.2. XRF Analysis

The chemical compositions are shown in Figure 3, summarizes the comparison of the chemical compositions of the two bentonite samples. The results of the chemical compositions of the two bentonite samples were similar to those of previous workers (Nweke et al., 2015; Agwu et al. 2015; Manoufali et al., 2013; Abdullahi and Yilmazer, 2011; The most abundant oxides in both of the bentonite samples are SiO_2 and Al_2O_3. The silica (SiO_2), alumina, (Al_2O_3), iron (Fe_2O_3), calcium (CaO) and potassium (K_2O) contents of bentonite from foreign bentonite are higher than those of the local bentonite, while for the sodium (Na_2O), titanium (TiO_2) contents, the values are higher. Nweke et al,. (2015); Kelessidis 2017; reported silica, alumina, sodium and calcium contents for Wyoming bentonite as (45 wt%, 17wt%, 2.7 wt%, 1.77 wt%; 61.55wt%, 20.55wt%, 2.41 wt% ,1.32 wt%; 61.80 wt%, 20.44 wt%, 2.1 wt%, 1.4 wt%; 48.35 wt%, 12.15 wt %, 3.65 wt%, 6.68 wt%) respectively. The silica (SiO2) values of the Local and Foreign bentonites (48.16wt % and 49. 87wt %) are similar to the values reported by Arabi, (2018) [45 wt%]; Afolabi et al., (2017) [48.35 wt%] for Wyoming bentonites. All the sodium contents of the bentonite samples (Local and Foreign) from this study (0.06 wt% and 0.52 wt %) respectively, have values lower than the Wyoming bentonites. Fe_2O_3 values reported for both the bentonite samples in this study are lower than those reported by Olugbenga et al., (2013).

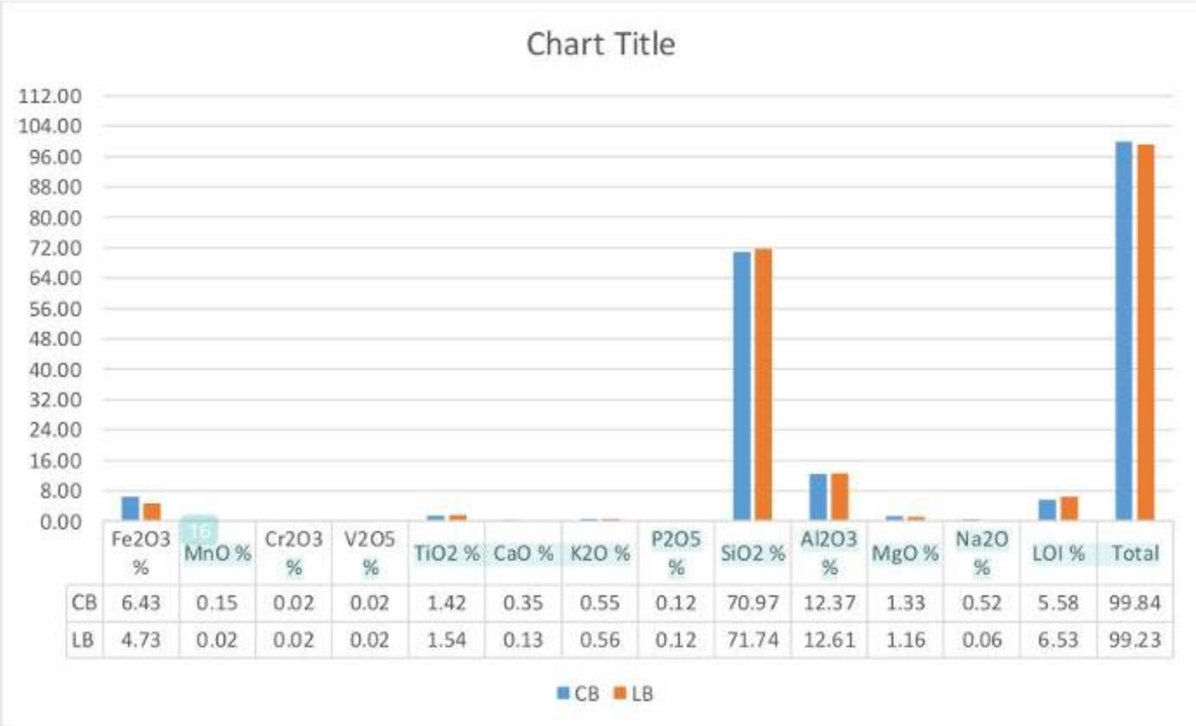

Figure 3. XRF analysis of local and foreign bentonite

3.3. TGA Analysis

Thermal decomposition has a detrimental effect on the adsorption capacity and thermal stability of both adsorbents produced (Figure 4). In the case of the functionalized activated kaolin, there's loss of functionality as the temperature increases. From the thermal stability results, the temperature is controlled below 100°C for further investigating the pre-treatment temperature for the CO_2 adsorption–desorption procedure.

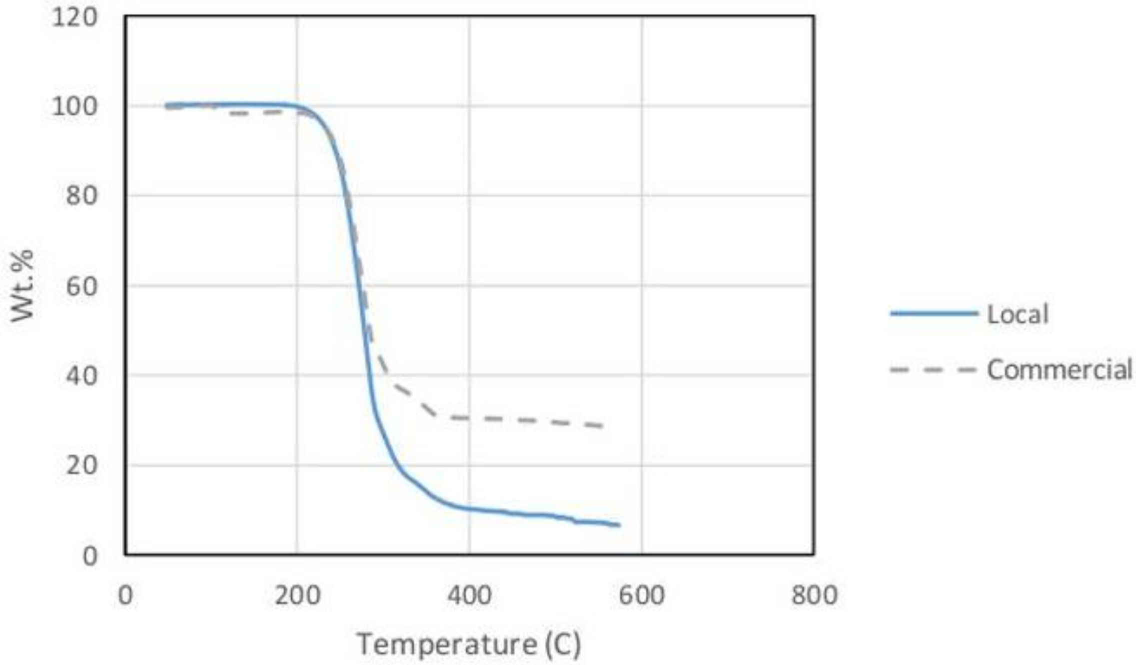

Figure 4. TGA of local and foreign bentonite

4. CONCLUSION

The comparative analysis of local and foreign bentonite clay has been performed. The local clay was successfully treated with readily available additives to improve its properties to meet API minimum specifications. A significant economic opportunity exists for large scale production of local clay in formulating drilling mud. But the clay must however be acquired at the right depth and strata to ensure good Laboratory response to treatment. The local bentonite is rich montmorillonite clay and should be purified and treated using the simple and cheap process described here, so as to be useable in oil well Drilling application. With this final product of the treatment process, the local bentonite can be effectively used as drilling fluid additives to drill the upper sections of oil well, where oil zone is not reached and formation damages caused by filtration is not critical. This will save a huge amount of the drilling cost, if these local resources of cheap drilling fluid are utilized.

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