Nigerian Research Journal of Engineering and Environmental Sciences 3(2) 2018 pp. 674-679

Nigerian Research Journal of Engineering and Environmental Sciences
Journal homepage: www.rjees.com
RJEES

Original Research Article

Beneficiation of Usen Clay with Local Additives for Improved Mud Properties

***Christopher, E.F. and Ohenhen, I.**
Department of Petroleum Engineering, Faculty of Engineering, University of Benin, PMB 1154, Benin City, Nigeria.
*christopheredoborfrankie@gmail.com

ARTICLE INFORMATION

Article history:
Received 29 August, 2018
Revised 14 October, 2018
Accepted 15 October, 2018
Available online 30 December, 2018

Keywords:
API
Rheological properties
Viscosity
Additives
Potash

ABSTRACT

The cost of importation of Bentonite for drilling activities in Nigeria runs to millions of dollars annually and this has been detrimental to the Nigerian economy considering that about 4% to 18% of the cost of drilling well accounts for cost of drilling fluids. This study investigated the effect of beneficiation of local mud (Usen clay) with local additives like potash and ginger in order to meet American Petroleum Institute (API) standard. API RP-13B standard procedures were employed throughout the laboratory work to determine mud properties. The mud weight and gel strength of the local mud increased appreciably to API standard when beneficiated with 1.0 g potash and 25 g ginger. pH values of the mud increased when treated with 1.0 g of potash, and the modification raised the mud pH within the API standard range of 9.5 to 12.5. The viscosity of the local mud did not meet standard requirement of 30 cp, but appreciated favorably to the standard requirement when beneficiated with 25 g of ginger. It is concluded that local additives can improve local mud properties.

1. INTRODUCTION

Drilling mud, the fluid mixture used in rotary drilling, is as important to petroleum resource development as blood is to the human body (Bergaya, 2005) The petroleum drilling in Corsicana, Texas (1890s), and Spindletop, Texas (1901), established the use of natural drilling mud (drilling muds from local clays) as part of rotary drilling (Darley et al.,2017). The first major changes to drilling mud occurred in the 1920s with the addition of weighting materials (barite, iron oxides) and usage of mined bentonite clays (Neff, 2015) This gave rise to the first commercial drilling mud companies such as NL Baroid.

Bentonite is an absorbent aluminum phyllosilicate, essentially impure clay consisting mostly montmorillonite (70 -90%). Accompanying impurities are gravel, shale, limestone, quartz and other minor minerals such as mica and fieldspar (Bergaya, 2005). Bentonite is employed in the industry because of its high specific area and thermal stability and other properties such as crystal shape and size, cation exchange capacity (CEC), hydration and swelling, thixotropy, bonding capacity, impermeability, plasticity and

tendency to react with other compounds (Abdulkadir et al., 2013). Bentonite is among the exportable mineral commodities in Nigeria. There is so much demand for foreign bentonite which is used in producing drilling fluids. There is no massive pressure on production of drilling fluids using local bentonitic clay in Nigeria. There should be a reduction in importation of foreign bentonite and proper harnessing of Nigeria solid minerals (bentonite). Bentonite has many industrial applications such as viscosity improver in drilling fluids, as foundry sand bonding materials and many others (Aderinto, 2018). Onu and Ohenhen (2014) reported that stibnite can be use a as a substitute weighting material for drilling mud.

Studies by Akanaga and Okoro (2016) on the suitability of some Imo state clays for preparing drilling muds showed that the clay did not show good drilling property in their natural states of occurrence, but on chemical treatment, they could be used as drilling muds but at low temperature and pressure conditions. Irawan et al. (2009) used local additives like corn cob and sugar wastes as viscosifier in drilling mud. They discovered that the plastic viscosity and yield point of the mud is directly proportional to the amount of local additives added. From previous works, the local mud lacks the properties of foreign mud and does not meet API standard. This work entails using local additives to treat the local mud in order for the local mud to be used as a substitute to foreign mud.

The aim of this work was to beneficiate Usen clay with local additives for improved mud properties.

2. MATERIALS AND METHODS

2.1. Location and Geology of Study Area

Usen is located in Ovia South-West Local Government Area of Edo State, Nigeria. Its geographical coordinates are 6° 45' 0" North, 5° 21' 0" East. The local government headquarters is Iguobazuwa. In terms of climatic conditions in this community, it has a mean annual rainfall of 1600mm - 1800mm and mean temperature of 28 – 29℃.

2.2. Sample Collection and Preparation

The clay sample used for this work was collected at the appropriate depth of about 4 feet and at appropriate horizontal strata. The local bentonite was collected by the use of a spade to till the soil at the bank of the Ada River, in Usen, Edo State. Experiment was carried out in two phases:

- Phase1: Formulation of local clay mud and foreign bentonite mud without additives
- Phase2: Formulation of local clay and foreign bentonite mud containing potash and ginger

The clay sample was dried under moderate temperature of 60 ^{o}C by spreading out in a plastic tray in a drying oven. The dried clay sample was then subjected to pulverization by pounding it in a mortal. The pulverized clay sample was sieved to obtained fine powdered clay particles 0f 250 microns sizes. The sieved clay sample was collected in a beaker and labeled appropriately. Samples of the sieved clay, 17.5g, 21.0g and 24.5g were weighed using a spatula into separate mixer cups with the help of weighing balance and labeled appropriately. Distilled water (350ml) was then measured into the already weighed clay samples. The mixture of the clay and water was stirred with the aid of multi-beach mixer for 2 minutes to obtain homogeneous mixture.

2.3. Determination of Drilling Mud Properties

API RP-13B standard procedures (API practices 13B section 5) were employed throughout the laboratory work to determine mud properties. All the mud samples were based on the formulation of 350 ml of fluid that contains only fresh water.

2.3.1. Determination of rheological properties

This was done to obtain the rheological properties of the mud such as viscosity at 600 rpm and 300 rpm, 10 minutes and 10 seconds Gel strength, plastic viscosity and yield stress. The equipment used was an OFITE 900 Model viscometer.

2.3.2. pH determination

To determine the pH of the mud, the following were followed; the freshly prepared mud was re-stirred to obtain homogeneous mixture. About one-inch strip of the pH-hydrion dispenser paper was removed and placed gently on the surface of the mud and sufficient time was allowed to elapsed (about few seconds) for the paper to soak up filtrate and change color. The soaked paper strip was matched with chart on the dispenser from which the strip was taken. The pH range of the mud was read and the value recorded.

2.3.3. Determination of mud weight

The mud density test was conducted in order to determine the weight per unit volume of the mud. This test was done to determine whether the prepared local mud samples possessed API minimum weight for oil well drilling. The procedures used to determine the weight of the prepared mud were: the instrument base was set up so that it was approximately leveled. The freshly prepared mud was poured into a clean, dried mud balance cup and covered with the lid. The reading of the mud balance scale was taken and recorded properly against the mud type. The mud cup was then emptied, washed, dried and kept for future use.

2.3.4. Determination of sand content

The Baroid sand content tube was used to carry out this experiment. API RP-13B standard procedures (API practices 13B section 5) were applied in carrying out this experiment.

2.4. API Standard Tests and Analysis Values of Drilling Mud

The American Petroleum Institute (API) standard specification is very important for drilling mud and these specifications are for all the montmorillonite clay family as contained in API practices 13A section 5 as presented in Table 1.

2.5. Beneficiation of Drilling Mud

In this study, local additives (ginger and potash) were used for the beneficiation of the sample, to achieve improvement of mud weight, rheological properties (i.e. viscosity and gel strength) and pH. Ginger (25g) and potash (1 g) were added to each of the mud samples at the various concentrations. The mixtures were stirred for 2 minutes to obtain a homogenous mixture. For the experimental analysis and comparison of the local mud with foreign clay with respect to API standard, only 24.5g concentration of mud was used.

Table 1: API Standard Numerical Value Requirement for Drilling Fluids (API practices 13A section 5)

Drilling Fluid Property	Numerical value requirement
Mud density (lb/gal)	8.65-9.60
Viscometer dial reading @600rpm	30cp
Plastic viscosity (cp)	8 – 10
Yield point (Ib/100ft^2)	3 x plastic viscosity
Fluid loss (Water)	15.0ml maximum
pH level	9.5min – 12.5max
Sand content	1 - 2% maximum
Screen analysis	4 (maximum)
Moisture content	10% (maximum)
Ca^{2+} (ppm)	2.50 (maximum)
Marsh funnel viscosity	52 – 56 sec/q+
Mud yield (bbi/ton)	91 (maximum)
API filtrate (ml)	30 (minimum)
Montmorillonite	70 – 130
Vermiculite	100 – 200
Illite	10 – 40
Kadinite	3 – 15
Chlorite	10 – 40
Marsh funnel viscosity for water	26 sec/q+ ± 0
N-Factor (power law index)	1 (maximum)
Yield Point/Plastic viscosity ratio	3.0 (maximum)

3. RESULTS AND DISCUSSION

Table 2 shows that mud weight of the local mud was 8.50lb/gal before beneficiation. This did not meet API minimum numerical value standard (8.65lb/gal). The pH of the local mud was 6.0. This showed that the local mud was a little acidic and fell short of API minimum numerical value standard (i.e. 9.5). The sand content of the local mud was 0.3%. This was within API standard requirement (0-2%). The viscosity @600rpm of the local mud was 6.0cp and this is low compared to the 30cp API minimum numerical value standard for drilling mud. The gel strength of the local mud sample was 0.7lb/100ft^2. The Yp/PV ratio of the local mud was 0.0. From Table 3, the mud weight of the foreign mud was 8.70lb/gal. The pH of the foreign mud was 10.0. The sand content of the foreign mud was 0.1 %. The viscosity @600rpm and gel strength of the foreign mud was 42.0cp and 0.7lb/100ft^2 respectively. From Table 3, the Yp/PV ratio of foreign mud was 1.5. These results met the citations of Abdulkadir et al. (2013), hence local mud needed treatment with chemical additives to improve the mud properties.

Table 2: Result of local clay sample without beneficiation after 24 hours of aging

Properties	24.5g in 350ml of water
Mud weight (lb/gal)	8.5
Mud pH	6.0
Viscosity@600rpm (cp)	6.0
Viscosity@300rpm (cp)	3.0
Mud sand % volume	0.3
Mud PV (cp)	3.0
Mud AV (cp)	3.0
Mud gel strength @ 10seconds (lb/100 ft^2)	0.9
Mud gel strength @ 10 minute (lb/100 ft^2)	0.9
Mud yield point (lb/100 ft^2)	0.0
Yp/PV ratio	0.0

Table 3: Result of foreign (bentonite) mud without beneficiation after 24 hours of aging

Properties	24.5g in 350ml of water
Mud weight (lb/gal)	8.7
Mud pH	10.0
Viscosity@600rpm (cp)	42.0
Viscosity@300rpm (cp)	30.0
Mud sand % volume	0.1
Mud PV (cp)	12.0
Mud AV (cp)	21.0
Mud gel strength @ 10seconds (lb/100 ft^2)	0.7
Mud gel strength @ 10 minute (lb/100 ft^2)	11.0
Mud yield point (lb/100 ft^2)	18.0
Yp/PV ratio	1.5

From Table 4, when the local mud was beneficiated with 25g Ginger and 1g Potash, the mud weight improved from 8.50lb/gal to 8.65lb/gal. This was in line with API numerical value standard (8.65-9.6 lb/gal). This conformed to the report by Akanaga and Okoro (2016). The pH of the local mud was 10.0 after beneficiation with 1.0g Potash. This showed that the local mud was within API numerical value standard (i.e. 9.5-12.5). This result is in-line with what Onu and Ohenhen (2014) reported. The viscosity of the local mud @600rpm was 38.8cp after beneficiation with 25g ginger and this is satisfied the 30cp API minimum numerical value standard for drilling mud. This was comparable with the observations of Irawan et al. (2009). The sand content was 0.4%. This was still within the API standard requirement of 0.2%-2%. The gel strength @10sec of the local mud sample was 0.5lb/100ft^2 after beneficiation with 25g Ginger and 1.0g Potash. This conformed to report of Abdulkadir et al. (2013).

Table 4: Result of local clay sample after beneficiation with 25g of ginger and 1.0g of potash after 24 hours of aging

Properties	24.5g in 350ml of water
Mud weight (lb/gal)	8.7
Mud pH	10.0
Viscosity @600rpm (cp)	38.8
Viscosity @300rpm (cp)	25.8
Mud sand % volume	0.4
Mud PV (cp)	13.0
Mud AV (cp)	19.4
Mud gel strength @ 10seconds (lb/100 ft^2)	0.5
Mud gel strength @ 10 minute (lb/100 ft^2)	0.6
Mud yield point (lb/100 ft^2)	12.8
Yp/PV ratio	1.0

4. CONCLUSION

From the work, the following conclusions were drawn:

- Sand content and Yp/PV ratio of the local clay mud met the minimum required API specification.
- The local clay samples showed desired results when treated with local additives (25g Ginger and 1.0g Potash) and met API standard values.

- Local clay mud if beneficiated with right additives, could be used as a substitute to foreign mud.

5. ACKNOWLEDGMENT

The authors wish to acknowledge the assistance and contributions of Mr Isuk Nsisong and Mrs Florence Ajayi, laboratory staff of Department of Petroleum Engineering, University of Benin, Benin City towards the success of this work.

6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

Abdulkadir, L.A., Osawemwenze O. and Adogbo G.M. (2013). Rheological and Filtration Properties of Kaolinite Based Drilling Mud. *International Journal of Scientific and Engineering Research*, 4(7) pp. 2214-2220.

Aderinto, A. (2018). *Composition and Properties of Drilling Fluids*. Penn well Publishing Company, 7 Ed, Minna, Nigeria.

Akanaga, R.C. and Okoro, F.I. (2016). Improving rheological and filtration properties of drilling muds with addition of Chemicals. Paper presented at the 7th Institute of Geology and Mineral Exploration, (IGME) the National Congress on Mechanics, Lagos, Nigeria.

Bergaya, F., Theng, B.K.G. and Lagaly, G. I. (2005). *Handbook of Clay Science*. 2 Ed., Elsevier, Oxford, UK, pp. 423-434.

Darley, H.C.H. and Gray, G.R. (2017). *Composition and Properties of Drilling Fluid and Completion Fluids*. 2 Ed., Derry Publishing Company, Houston Texas.

Irawan, S., Zakuan, A., Azmi, A. and Saaid, M. (2009). Corn Cobs and Sugar Cane Waste as a Viscosifier in Drilling Fluid. *Pertanika Journal Science and Technolgy,*17 (1), pp. 173 – 181

Neff, J.M. (2015). Composition, Environmental Fates, and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to the Marine Environment: A Synthesis and Annotated Bibliography, Prepared for Petroleum Environmental Research Forum and API, Duxbury, MA.p.73

Onu, O. V. and Ohenhen, I. (2014). Antimony Sulphide (Stibnite) and Potash as Local Substitute to Barite and Lignosulfonate as Drilling Mud Weighting Additives. *Society of Petroleum Engineers,* 14(1), pp. 173 – 181.