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Research Article

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Investigation of Drilling Fluid Property of Suspected Bentonite Clay

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Abstract This paper is aimed at determining and comparing the rheological property, mud weight, pH and sand content of the suspected bentonite clay from Ejeme-aniogor of Aniocha South Local Government Area in Delta State. The clay was collected from a depth of about 3ft, dried, crushed and sieved using 212 mesh size, low, mid and high viscous mud was prepared using the fann-VG meter and the various parameters were analyzed.
Before beneficiation, it was observed that the sand content was 0.25 % using the sand content kit which is very good compare to API standard for mud sand content of 1-2 %. The mud pH was also observed to be 7 and upon beneficiation using 0.1g of potassium hydroxide (KOH) the pH was observed to increase to a value of 12 which is appreciably good with reference to minimum and maximum of 9.5-12.5 for API standard. The viscosity of the clay at various concentrations in grams of 17.5, 21.0 and 24.5 was also observed to be far below the required value of 30 cp at 600 rpm, but upon beneficiation with 1.0 g of hydroxyl ethyl cellulose and allowed to age for a period of five days the viscosity was observed to meet up to standard of 30 cp at 600 rpm. The mud weight was also improved to meet up with standard using 0.5 g of barite. From the analysis it could be seen that if properly beneficiated and allowed to age, the clay could serve as substitute for foreign clay used in drilling.

Keywords Formulation, Circulating, Operation, Mud, Fluid

Introduction

Nigeria is one of the major oil producing nations of the world and her economy largely depends on the oil and gas sector. This work is aimed at using local clay in the formulation of drilling mud used in the oil and gas industry in carrying out drilling operation. This work centers on rheological properties, thixotropic property, mud weight and mud pH.
Drilling mud is a circulating fluid used in rotary drilling to perform any of all the various function required in drilling operation. Drilling fluids are separated into three major types which are:
pneumatic fluids ,oil based fluids and Water based fluid. This work is limited to water based mud. Water based mud is divided into: Inhibitive Fluids, Non-Inhibitive and Polymer Fluid [1].

Inhibitive Fluids

Those which appreciable retard clay swelling, and achieve inhibition through the presence of cation; typically sodium (Na^{+}) calcium (ca^{++}) and potassium generally K^{+} or Ca^{++} or a combination of two produce the greatest inhibition to clay swelling. The system is generally used for the drilling of hydrate clays and sand containing hydratable clays. Because the source of the clay is generally a salt, disposal can become a major portion of the cost of using an inhibitive fluid.

Non-Inhibitive

Those which do not significantly suppress clay swelling, and are generally comprised of native clays or commercial bentonite with some caustic soda or lime. They may also contain defflocculant and or dispersant such as lignite, lignosulfonate, phosphates. Non-inhibitive are generally used as spud muds, native solids are allowed to disperse into the system until rheological properties can no longer be controlled by water dilution

Polymer Fluid

Those which rely on macromolecules, either or without clay interaction to provide mud properties, and are very diversified in their application. The fluid can be inhibitive or non-inhibitive depending upon weather an inhibitive cation is used. Polymers can be used to viscosify fluids, control filtration properties, deflocculates solids.

The thermal stability of polymer system can range upwards to 400 ^{o}F. In spite of their diversity, polymer fluid have limitations such that are major threat to successful running of effective polymer mud system.(Amoco Production Company drilling fluid manual pg.1-3)[2].

Function of Drilling Mud [3]

1. Removal of cuttings
2. Cooling and lubricating of the bit and drill string
3. Support weight of casing and pipe
4. Saves as medium for mud logging
5. Prevent corrosion of bit, casing and surface facilities
6. Helps to suspend cutting when drilling is interrupted.
7. Controls subsurface pressure
8. Helps in transmitting hydraulic horse power to the bit
9. Amongst others.

Clay Chemistry

Clays are hydrous silicate of aluminum characterized by sheet silicate structure of composite layers. They may be product of extensive chemical weathering, hydrothermal or pneumatolytic alteration of different rock types. Clay result from erosion of earth's crust over vast spans of time, what was originally the mineral feldspar in igneous rock, primarily granite, breaks down over time and becomes the Microscopically fine particle clay deposits [4].

Clay Minerals in Order of Relative Abundance

The order of the relative abundance of clay mineral is as follows [5]:

1. Illite
2. Montmorillonite and mixed-layer illite-montmorillonite.
3. Chlorite and mixed-layer chlorite-montmorillonite
4. Kaollinite and septechlorite
5. Attapulgite, palygorskite and sapiolite.

Most layer silicate are usually in microscopic size, also occur as submicroscopic particles.

Clay Properties

Physical properties of clay are its

1. Shape
2. Structure.

while it physiochemical properties are

1. Base exchange capacity
2. Adsorption and retention of water
3. Deflocculation and Flocculation.

Clay Swelling

Swelling property of clay is a function of its structure, chemical composition and the amount and type of exchange cation.

Swelling due to hydration occur as a result of

1. Expansion of crystal itself.
2. Expansion of water on the surface of the clay particle. (https://www.metu.edu.tr/.../PETE321_...).

Clay used for drilling and its properties

Bentonite is used for drilling because it is composed of sodium montmorillonite , which provide the viscosity and fluid lose characteristic s that are vital to fresh water bentonite mud. The abilty of bentonite to hydrate make it useful in formulating drilling mud with desirable properties [6].

Properties

rheological propertise, thixiotropic properties , mud weight or density, filtration property, sand content and mud pH.

Objectives of Study

The objectives of this work are

- To investigate the rheological properties of the local clay from Ejeme-Aniogor.
- To compare these properties with API standard.

Relevance of Study

The quest for the use of local material in the oil and gas industry, has importance of reducing the cost of production, expansion of the oil and gas industry as the success of this work will reduce or stop the importation of foreign clay.

Methodology

The methodology applied in this project work involves extraction of the sample from it source from a depth of about 3ft, then dried, crushed and sieved using 212 mesh size. The sieved sample where weighed to obtain 17.5 g, 21.0 g and 24.5 g of clay which were separately added to fresh water of 350ml and the agitated and allowed to age for 24hours before Other parameters where determined using the following equipment:-

1. Fann V-G Meter
2. Bariod Mud Balance
3. Triple Beam Balance
4. Sand Content Kit
5. pH paper
6. Retort Stand.

The following formulae was also used

Apparent viscosity (AV)=(θ600/2)cP

Plastic viscosity (PV)=(θ600rpm-θ300rpm)cP

Yield point (YP)=(θ300rpm-PV)lb/100ft^3

Power law index=3.32 log(θ600rpm/θ300rpm)

Consistency index ‘’k’’ =5.1×θ600rpm/y^n, where y is equal to 511 and 1022 and n is the power law index.

Table 1: Results of the clay sample before beneficiation

Clay conc. (g)	Viscosity reading (Cp)		Mud gel strength		Consistency Index(‘k’) (Dyne sec/cm^3)		Mud power law index “n”	Mud (PV) cP.	Mud (AV) cP.	Mud (yp)lb/100ft^3	Mud weight lb/gal	Mud pH
	600rpm	300rpm	10sec	10min	@511	@1022						
17.5	1.0	0.5	0.1	0.1	0.01	0.005	0.99	0.5	0.5	0	8.6	7.0
21.0	1.5	0.5	0.2	0.1	0.0004	0.0001	1.58	1.0	0.75	-0.5	8.6	7.0
24.5	1.5	0.5	0.2	0.1	0.0004	0.0001	1.58	1.0	0.75	-0.5	8.6	7.0

The sand content was 0.25

Table 2: Test results after allowing the clay to age in fresh water for 24 hours with beneficiating

Mud conc. (g)	Viscosity reading (Cp)		Mud gel strength		Consistency index “K” Dynes sec/cm^3		Mud power law index “n”	Mud (PV) Cp	Mud (AV) CP.	Mud (YP) lb/100ft^3	Mud Density Lb/gal	Mud pH	Sand content (%).
	600 Rpm	300 rpm	10 Sec	10 min	@511	@1022							
17.5	1.3	0.6	0.1	0.1	0.0065	0.0030	1.11	0.7	0.65	-0.1	8.6	7.0	0.25
21.0	1.7	0.7	0.2	0.1	0.0012	0.0029	1.28	1.0	0.85	-0.5	8.6	7.0	0.25
24.5	1.5	0.5	0.2	0.2	0.0040	0.0001	1.58	1.0	0.75	-0.5	8.6	7.0	0.25

Table 3: showing the result of the sample after aging for five days

Clay conc. (g)	No. of day aged	Viscometer reading (cp)		Mud gel strength		Consistency index "K" Dynes sec/cm^3		Mud power law index	Mud (PV) cp.	Mud (AV) cp.	Mud (YP) lb/100ft^3	Mud Ph	Mud weight lb/gal.	Sand content (%)
		600 rpm	300 rpm	10sec	10min	@511	@1022							
17.5	2	9	5	0.1	0.2	0.22	0.13	0.85	4.0	4.5	0.5	12	8.67	0.25
	3	12	7	0.3	0.5	0.50	0.29	0.77	5.0	6.0	1.0	12	8.67	0.25
	4	23	11	0.4	0.8	2.5	1.6	0.62	8.0	11.5	7.0	12	8.67	0.25
	5	36	24	0.5	0.7	4.9	3.3	0.58	12	18	12	12	8.67	0.25
21.0	2	11	6	0.1	0.3	0.24	0.11	0.87	5.0	5.5	1.0	12	8.80	0.25
	3	17	12	0.3	0.8	3.84	2.71	0.50	5.0	8.5	7.0	12	8.80	0.25
	4	25	17	0.4	0.6	3.88	2.63	0.56	8.0	12.5	4.5	12	8.80	0.25
	5	38	25	0.7	1.0	4.6	3.0	0.60	13.	19	12	12	8.80	0.25
24.5	2	14	9	0.1	0.3	1.32	0.84	0.64	5.0	7.0	4.0	12	8.93	0.25
	3	22	12	0.2	0.5	0.490	0.27	0.87	10	11	2.0	12	8.93	0.25
	4	31	21	0.8	1.0	4.813	3.26	0.56	10	15.5	5.5	12	8.93	0.25
	5	42	28	1.0	2.1	5.75	3.84	0.58	14	21	14	12	8.93	0.25

Table 4: API standard values

Mud parameters	Numerical value requirement
Mud density (lb/gal)	8.65-9.60 (min & max)
Viscosity dial reading at 600rpm	30cp (minimum)
Plastic viscosity (cp)	8-10cp
Yield point (lb/100ft^3)	3 x plastic viscosity
Fluid loss	15.0ml (maximum)
pH level	9.5(min) – 12.5 (max)
Sand content	1-2% maximum
YP/PV Marsh ratio	3.0 (maximum)
"N"- factor (power law index)	1 (maximum)

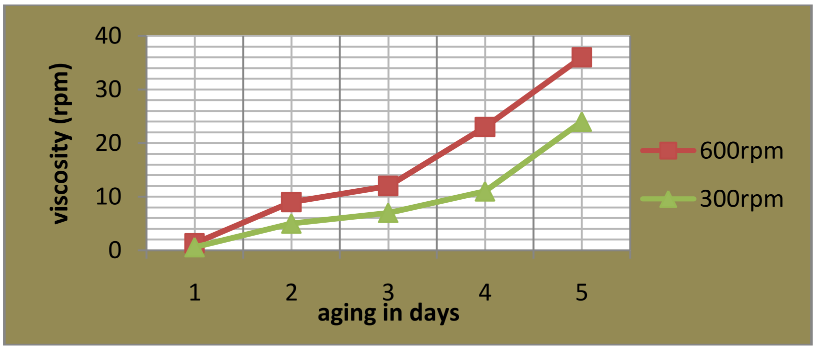

Figure 1: A graph of viscosity in revolution per against aging effect in days (low viscos mud 17.5g)

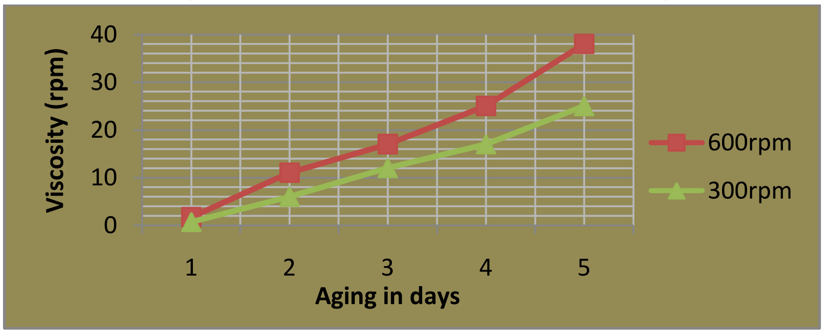

Figure 2: A graph of viscosity in revolution per against aging effect in days (mid viscos mud 21.05g)

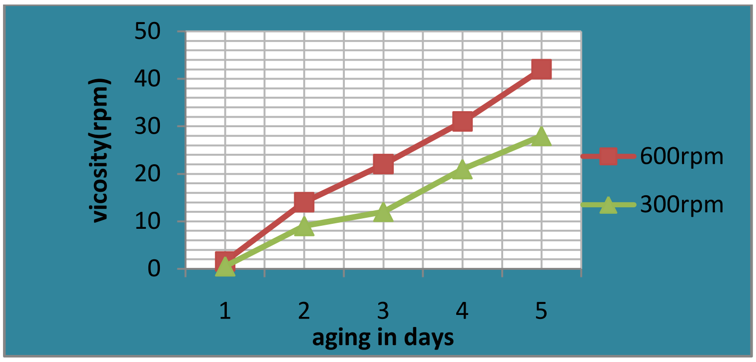

Figure 3: A graph of viscosity in revolution per against aging effect in days for high viscos mud 24.05g

Analysis of Results

On the addition of 0.1 g of KOH, the mud pH increased from 7 to 12.

An addition of 0.5 g of barite also increased the mud weight from 8.6 to 8.67, 8.80 and 8.90 the deferent concentration of 17.5 g, 21.0 g and 24.5g.

Also on the addition of 1.0g of hydroxyl ethyl cellulose the vicosity was observed to be improving as shown in the table 3 above.

It was also observed that the power law index was less than one with reference to the API value with maximum of 1.

The plastic vicosity at day 4 and 5 for the respective concentration of 17.5, 21.0 and 24.5 are respectively considerate with reference to the API range of 8 to 10.

Conclusion

From the result obtained from this analysis if the clay sample is beneficiated and allowed to age for a period of five days it will meet up the API standard and hence could be used for the purpose of drilling.

Recommendation

It is recommended that other viscosifers and pH enhancer be used in the treatment of this clay.

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