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Evaluation of the Potential of Periwinkle Shell as pH Enhancer in Water Based Mud

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Abstract:
In a quest to provide a direct substitute for foreign chemicals as pH enhancers in drilling mud in the oil and gas industry in Nigeria, the suitability of periwinkle shells, a small gastropod sea snail as a pH enhancer in water-based mud was investigated. The potential evaluation of periwinkle shell as pH enhancer was carried out to determine the effect of periwinkle shell on the pH and mud weight. In this research, the water-based mud sample was formulated using bentonite clay, distilled water (deionized water) with calcined periwinkle shells in varying weight proportions and the pH measurements and mud weight measurements were taken at 25 °C. The results obtained, shows that the periwinkle shell increased the pH value within the range of 64.3% to 92.8% due to incremental addition of 1g to 4g of calcined periwinkle. However, there was little or no increase in the mud weight as the mud weight eventually increased by 0.56%. Consequently, results show that the periwinkle shell has a very high potential for pH enhancement with a reduced potential for mud weight increase.

Keywords: *Periwinkle shell, bentonite clay, pH enhancer, mud weight, and drilling mud*

1. Introduction

Drilling experts no longer rely solely on a water-clay mixture as a drilling fluid in recent years. Instead, they meticulously develop compounds and combinations with both local and foreign elements to fulfil specific drilling needs in a variety of drilling circumstances. Drilling fluids, both modern and customized, are the lifeblood of wells.

Drilling fluids are a mixture of chemical, water, oil, and clay elements that enhance drilling operations (Udoh and Okon, 2012). The importance of drilling fluid, often known as 'drilling mud,' cannot be overstated, as knowledge of drilling fluid is a requirement in the petroleum industry's rotary drilling operation (Udoh and Okon, 2012).

Water-based drilling mud (if water is present) is the liquid version of these drilling fluids. Water-based mud is a drilling fluid made up of water, bentonite, and heavy minerals, as well as other additives for weight and effectiveness.

Periwinkles are sea snails, and their shells have been used as conglomerate in concrete reinforcement by residents in coastal states such as Nigeria's Rivers State. These shells have been used for a variety of purposes, including construction of homes, soak-away systems, slabs, and roads. Periwinkle shells have gathered in significant quantities in several parts of the country, including Bori, Western Ijaw, Burutu, Agoro, Ogalaga, and Lotugbene (Dahunsi, 2003). Periwinkles are particularly beneficial in Nigeria's riverine locations; aside from being consumed as food, periwinkle shells have been utilized as conglomerate in concrete reinforcement by residents of coastal states such as Nigeria's Rivers State (Festus et al, 2012). These shells have been utilized for a variety of purposes, including building of homes, soak-away systems, slabs, and roads. The periwinkle shell has a wide range of uses in the glass, water treatment, construction (Kolapo et al, 2012), paper, and paint industries, as well as soil stability, bead manufacture, decoration, and diet formulation. The suitability of periwinkle shell ash as a partial replacement for regular Portland cement was assessed by Festus et al. According to Festus et al., the most technical application of periwinkle shell ash in Nigeria has been in the area of Civil Engineering, where periwinkle shell ash has been used as a partial replacement for conventional Portland cement in concrete. The effectiveness of this in concrete should spur investigation into its use in other fields of engineering, such as

evaluating the possibility of periwinkle shellas as a pH enhancer in Water Base Mud. Given the Nigerian National Petroleum Corporation's (NNPC) local content strategy, which encourages the development and use of local content in the oil and gas sector, this would have a good influence on the Nigerian economy and environment. The goal of this study is to improve the pH of water-based mud by employing periwinkle shell as a local additive to replace imported chemicals like potassium hydroxide (KOH) and sodium hydroxide (NaOH).

2. Methodology

2.1. Materials

The following materials were used; Periwinkle shells from northern part of Nigeria (F.C.T Abuja), distilled water and bentonite clay.

2.2. Equipment and Apparatus

The following apparatus were be used for the experiments; digital weighing balance, conical flask, beakers, oven, crushing machine, sieving machine, pH meter, pressurized mud balance, electric muffle furnace, thermometer, stopwatch, and graduated cylinder

2.3. Experimental Procedure

2.3.1. Sample Collection and Preparation for Analysis

Samples of the periwinkle's shells available in Abuja, Federal Capital Territory of Nigeria were collected from Gwagwalada main market, Abuja. The shells hence obtained were well washed with water and oven dried at a temperature of 80ºC for 30 minutes. After drying, the periwinkle shells were heated in an electric muffle furnace at 1000ºC. Thereafter, the shells were first crushed into smaller shapes with the aid of a hammer to increase the surface area then ground into fine powder using a grinding machine i.e., jaw crushers. A well coupled sieve machine was used to sieve the periwinkle shells to get homogenous particle sizes. The residue was discarded and the powdered samples stored in well labelled containers for analysis.

Figure 1: Samples of Periwinkles

Figure 2: Periwinkle Shells Before and after Grinding

Figure 3: Mass Balance and Weighed Samples

Figure 4: Jaw Crushers

Figure 5: Electric Oven

Figure 6: Sieving Machine

Figure 7: Electric Muffle Furnace

2.3.2. Preparation of Water Based Drilling Mud

A digital mass balance was used to weigh 22g of Bentonite, and a measuring cylinder was used to measure 350ml of distilled water. First of all, half of the distilled water and the bentonite clay were poured into the stainless-steel container and the mixture was stirred for about 5 minutes using the OFFITE mixer. After about a few minutes the remaining distilled water was added to ensure that no lumps appeared in the mixture. Nine samples of water-based mud were prepared and a mud balance was used to determine the mud weight of each of the sample and the readings were taken. Following standard practice, a pressurized mud balance was used to determine the mud weight of each sample. The mud balance was calibrated using distilled water. The balanced cup was cleaned, dried and filled to the brim with the mud sample to be measured. The lid was placed on the cup as some mud flowed out of the hole on the lid to ensure that there was no trapped air in the cup. The cup and lid were wiped to dry off any mud on the surface in order to obtain accurate measurement as the knife edge was placed on the fulcrum and the rider adjusted until the cup content and the rider was at equilibrium. The density of the mud sample was read on the calibrated arm of the mud balance.

The pH meter was calibrated using deionised (distilled) water and the mud sample to be measured was poured into a glass beaker. The pH meter probe was immersed in the mud sample and at steady pH value indicated on the meter. This was recorded as the pH value of the mud sample.

The periwinkle shell samples (1g, 2g, 3g, 4g) were added respectively to the water-based mud and stirred vigorously with a mixer for 5 minutes until it was ensured that there were no lumps then the aforementioned procedures for the determination of the mud weight and pH measurement were repeated to determine each value of the mud weight and pH measurement respectively.

Figure 8: Mud Balance

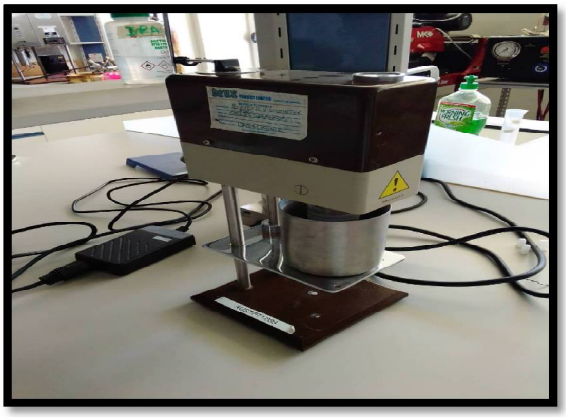

Figure 9: Ophite Mixer

3. Results and Discussion

The mass of calcined periwinkle shell ash (1g, 2g, 3g, and 4g) as well as Mud pH and Mud weight were all altered (ppg) as shown below.

Mass of Calcined Periwinkle Shell (G)	Mud Weight (Ppg)
0	8.85
1	8.85
2	8.85
3	8.85
4	8.90

Table 1: Mud Weight

Mass of Calcined Periwinkle Shell (g)	MUD pH
0	7
1	11.5
2	12.5
3	13
4	13.5

Table 2: MUD pH

4. Discussion of Results

4.1. Effect of Periwinkle Shell on Mud Weight

Table 1 presents the results of the effect of calcined periwinkle shell on the mud weight of the formulated water-based mud. The local additives (periwinkle shell) were combined in weight proportions with the control water-based mud which contains 350ml of distilled water and 22g of bentonite clay. The initial mud weight of the control sample was 8.85ppg and it was observed that an incremental increase of 1g each to the formulated water-based mud sample had little or no effect in the increase of the mud weight.

When compared to the values obtained by (Onolemhemhen *et al* 2018) who worked on snail shell, egg shell and their combination showed a higher increase in mud weight properties of water-based mud.

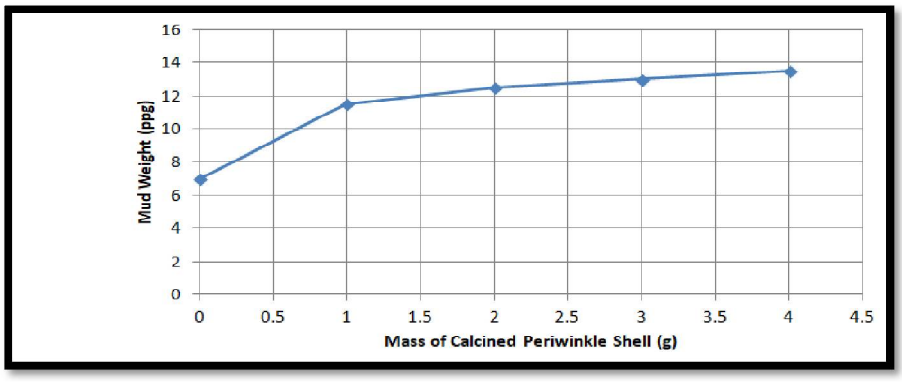

Figure 10: Effect of Additives on Mud Weight

4.1.2. Effect of Periwinkle Shell on Mud pH

Table 2 presents the results of the effect of the calcined periwinkle shell on the pH of the formulated water-based mud. The initial pH value of the control water-based mud sample was 7.0 and the analysis showed that the pH of the

water-based mud increased by 64.3%. The addition of 1g further increased by 8.70%. With the addition of another 1g of the calcined periwinkle shell, the pH increased by 4%. On the addition of the final 1g of the calcined periwinkle shell, the final pH increased by 92.9%.

When compared to the values obtained by (Onolemhemhen *et al* 2018) who worked pH snail shell, egg shell and their combination, the difference in the values could be attributed to the difference in the calcium carbonate.

The result confirms that the periwinkle shells are very effective as pH enhancers and furthermore we can also confirm that the steady incremental addition of the periwinkle shell increases the pH of the water-based mud.

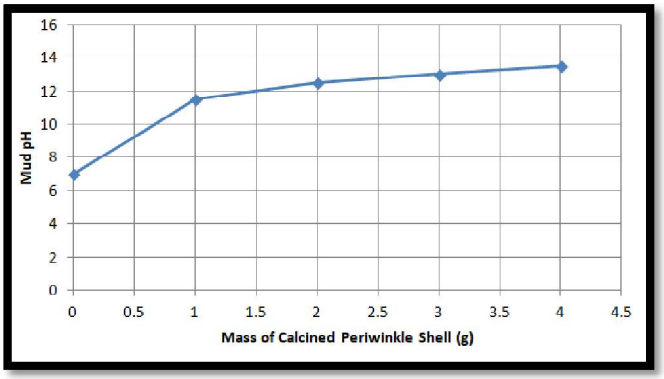

Figure 11: Effect of Additives on Ph of Mud Samples

5. Conclusions

The analysis of the influence of calcined periwinkle shell on water-based mud confirms periwinkle shell as an effective enhancer with a pH enhancing quality comparable to Sodium Hydroxide and a lower potential to increase the water base drilling mud weight. In comparison to Sodium Hydroxide, which is widely used as a pH enhancer in the drilling industry, these local additives, i.e., periwinkle shells, measure up favourably because they are considered waste, are locally sourced and easily accessible, and are biodegradable, making them environmentally friendly substances.

The higher the amount of the periwinkle shell added to the water-based mud, the higher the rate of increase of pH in the water-based mud i.e., incremental addition of the additives increases the pH of the mud.

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