PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 25 (4) 561-566 April 2021

Evaluation of pH of Drilling Fluid Produced from Local Clay and Additives

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ABSTRACT: Maintaining the pH of drilling fluid with suitable additives is one of the important operation for efficient drilling operations. However, commercial hydroxides are mostly used to control the pH of the drilling fluid. This paper evaluates locally sourced pH additives of burnt plantain heads (BPH), burnt ripe burnt ripe plantain peels (BRPP), and burnt banana plantain peels (BBPP) in comparison with conventional potassium hydroxide (KOH) and sodium hydroxide (NaOH) as suitable agents to control pH of drilling fluid. The drilling fluid as prepared with bentonite and local clay in different concentrations of KOH, NaOH, BPH, BRPP and BBRPP including Traona. The result of the study showed that pH of the drilling improved with respective use of conventional KOH, NaOH, BPH, BRPP and BBRPP as additives. In addition, KOH showed the maximum percentage of degree (%) of improvement on the drilling fluid with 38.46-45.45% compared with 27.2-40% for NaOH. On the other hand, BRPP achieved 27.2-41.2%, followed with 20-33% and 20-29.4% for BPH and BBPP respectively. Thus, the locally sourced additives could be used to enhance the pH and properties of drilling fluid.

DOI: https://dx.doi.org/10.4314/jasem.v25i4.11

Keywords: Conventional pH additives, locally sourced pH Additives, Bentonite, Drilling Mud.

Drilling is one of the processes involved in upstream crude oil production. Drilling involves the use of drilling mud, which are complex mixtures of different interactive components. The properties of the drilling mud changes and majorly it is a function of pressure, temperature, time, rate of penetration and nature of formation of the drill and location of the well (Abdulsalam *et al.*, 2020; Okorie, 2009). These interactions among the different component leads to varying degree of changes in properties such as viscosity, filtration, solid content, and importantly the pH of the drilling fluid during drilling operations. Hence, the properties of the drilling mud are controlled during drilling, in order to avoid challenges that could develop during drilling operations. Hence, it is very important to understand changes in drilling fluid characteristics. Apparently, drilling mud ease to transport the cuttings to earth surface, and consequently, cleaning the wellbore. Series of diagnostics tests are conducted on the drilling mud, which is mainly aimed to control the properties of the drilling mud. Pal, (2011) and Mahmood *et al*., (2016) reported that the presence of dissolved gases such as carbon dioxide, hydrogen sulfides in drilling mud leads to corrosion, which substantially impacts the reliability of down-hole equipment. Importantly, the pH of drilling mud is one of the key parameters to determine its performance. As such, it performs better within pH range of 8.0 to 10.5 for water base mud (Peretomode, 2018). Drilling mud lower than pH 7 suggests it being acidic, which leads to pitting, corrosive to materials and equipment, and simultaneously result in environmental pollution (Okorie, 2009).Therefore, maintaining the pH of the drilling fluid within defined standard range is important during drilling operations. Maintaining the pH of drilling fluid at 8.0 to 10.5 has been reported by using conventional chemical such as soda ash (Na_2CO_3) and the hydroxides of: sodium (NaOH), potassium (KOH), and calcium ($CaOH_2$). Although, a lot of success has been recorded with these aforementioned chemicals, it has led to drastic changes in the rheological properties of the drilling mud. Therefore, controlling the pH of drilling mud properties is still required. Use of the conventional chemicals mentioned inevitably leads to occurrence of contaminants such as chlorides, sulfides and the calcium carbonates. The contaminant result in mud thickness and or thinness, separation of mud components, consequently, leading to drastic changes in the drilling mud properties. At this point, treating the drilling mud or its modifications in regards to its pH by using pH additives becomes necessary. Review of the scientific literature showed that there is limited information on production of locally pH additives from solid waste products (Abo Taleb *et al*., 2020) such as burnt plantain peels and palm heads. Therefore, investigation on use of waste product to produce pH additives, in order to compliment conventional chemicals would be necessary. The use

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of locally sourced additive has been reported to be environment friendly, leads to no substantial negative effects on subsurface formation. Importantly, this approach would reduce cost of drilling and importantly it is in line with the Nigerian Local Content Laws in the Petroleum Industry (Abdulsalam *et al*., 2020). Omole *et al.*, (2010) investigated the rheological and filtration properties of drill mud prepared with clay and reported that the clay may be as good as the conventional clay if it is properly treated. Peretomode, (2018) reported on the comparative analysis of using plantain peels powder and burnt palm head sponge powder with commercial NaOH as additives on drilling mud. The result showed that there was no substantial difference in rheological properties of drill mud following the use of NaOH and the locally sourced additives. Recently, Abdulsalami *et al*., (2020) investigated the effect of local pH additives sourced from plantain and banana peels on pH and viscosity of in drilling fluid systems, and concluded that the locally sourced were good pH enhancers for the formation of water-based drilling mud. These previous studies have shown the *feasibility* of using locally sourced materials as pH additives. However, it is not clear if the concentration of the pH additives had any substantial effect on drilling mud. Therefore, the main aim of this study is to evaluate the pH of drilling fluid prepared by using local clay Ameloko *et al*., (2020)., Akinade *et al*., (2015) and additives in varying concentrations.

MATERIALS AND METHODS

The local clay used for this research was obtained from Irhodo village in Ethiope West Local Government area of Delta State, Nigeria. The geographical directions are longitude 5º50’41”E (5.82811) and latitude 5º52’44”N (5.86216), and elevation of 23m, 75.46ft, 905.51 above sea level. The palm head and plantain peel were collected from Oleh (Lat. 5º27’32.17, 5,458936 and Long. 6º12’11.13, 6.203092) town, in Isoko south local government area of Delta State. Also, the Trona (AK-P) popularly called Akanwu was purchase at Oleh local market.

Sourcing and Processing of Local Clay sample: The clay was obtained from a depth of 3 feet above the sea level and the large visible particle were removed and stored in a black cellophane bag to prevent it from being contaminated. For purification, the raw local clay sample was diluted with de-ionized water (Ahmend *et al*. 2012) and allowed to swell for 72hours, while being stirred at every 12 hours. This is in order to release inherent organic materials. After 72hours, the clay sample was sieved with 200-mesh Tyler’s sieve and allowed to hydrate before being transferred into jeans bag for de-watering. Then, the dewatered clay sample was spread over a plane surface and allowed to sundry for 7days in accordance to James *et al*., (2008). Thereafter, the clay was grinded with mortar and pestle to fine particles and then sieved with a 200 mesh.

Preparation of local pH Additives: The pH materials (BPH, BRPP, and BBPP) were dried under sun, burnt and grinded into powder ash before sieving with 200 mesh size (74 microns) to further remove impurities in accordance to Okorie, (2009). The Trona (AK-P) was crushed to fine powder with a native mortar and pestle. Then sieved with a 200 mesh size of 74 microns to obtain a fine talc size powder, package and stored in cupboard prior to further use.

Experiment Procedure: An equivalent one barrel of laboratory drill mud (spud mud) sample was prepared by diluting 24.5g of clay for both local (pH 6.0) and conventional bentonite (pH 9.5) and 0.5ml of sodium hydroxide (NaOH) as additive with 350ml of distill water (pH 7.0). The addition of sodium hydroxide enhances the bentonite quality (Karaguiliizel C et al., 2010). The resultant mud sample was stirred in a mud mixer for 20 min. Then the mixture was allowed to stand for 24 hours at room temperature, after which it was stored in a cupboard before further analysis. Six samples of additives were prepared; two from conventional bentonite (KOH and NaoH) and four from local additives (BPH, BRPP, Trona and BBPP). Each sample was prepared into ten (10) different concentrations of 1ml, 2ml, 3ml, 4ml, 5ml, 6ml, 7ml, 8ml, 9ml and 10ml.

*pH Test***:** For analysis, the each sample was stirred for 3min followed with pH test using pH paper (the 1inch universal) strip indicator and pH meter (Model Jenway 3520) at a temperature of 26^0 C.

*Test for additives level of impartation on drill mud pH***:** The influence of both locally sourced pH additives and conventional additives on the drilling mud samples formulated with local clay and foreign bentonite was tested. Firstly, with distilled water and then, drill mud samples at a varying concentrations of pH additives solutions of 1mls, 2mls, 3ml, 4ml, 5ml, 6ml, 7ml, 8ml, 9ml, and 10ml using pH paper strip and pH meter as mentioned previously.

RESULTS AND DISCUSSION

The data obtained from the different additives at varying concentrations in distilled water is presented in Figure 1. As shown in Figure 1, locally sourced and conventional P^H additives showed impressive results of neutral solution (p9iwith a pH7.0) at all concentrations. However, the pH values was found to remain constant with further increase in concentration of the additives but still remained within the range of 7.5 to 11.0. This finding suggests that the additives contain a strong base element. Furthermore, the burnt ripe plantain peel (BRPP) additive at a concentration of 4ml was found to attain a pH value of 10.0. This also indicates consisting of much stronger base element, and also being very reactive when compared to other additives such as BPH, BBPP. Also shown in Figure 1, the pH values of all the additives remain unchanged at concentrations of 8.0 to 10.0ml. This phenomenon could be due to the strong cohesive bond of the respective additive, which might have resisted further reaction in electron sharing. The conventional additives of KOH and NaOH showed good results of maintaining an alkaline medium, especially, KOH that had a high pH from the beginning till when its pH value remained constant at 11.0. On the other hand, the local additives (BPH, BRPP, BBPP and Trona) also showed promising result of an alkaline medium, which was found to be within the pH scale (API, 2010). In comparison, both locally sourced additives have similar pH when compared with that of conventional additives in the distill water and as such the local additives could use to complement its counterpart. Although, there was variations in the mud pH value obtained from different additives, all additives were found to have pH value that is within standard range of 8.5 to 10.5. KOH was found to be better when compared to NaOH, as it attained pH value at lower concentrations. For the locally sourced additives, BRPP was found to be better when compared to BPH and BBPP. BRPP showed closer similarities with that of the conventional KOH additives.

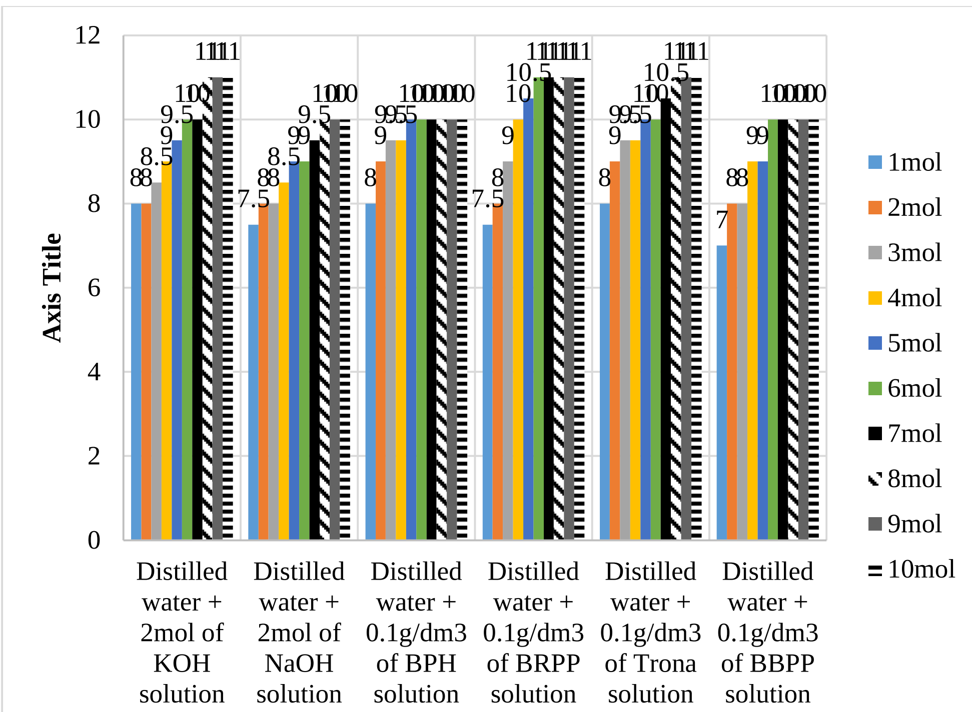

Fig1: pH of different additives at varying concentrations in distilled water of pH of 7.0

The data obtained for the pH of the difference additives in drill mud formulated with local clay (Irhodo) is shown in Figure 2. Generally, in the pH scale of reference (API, 2010), the numerical value of 7.0, indicate a neutral solution, while less than 7.0 is acidic and those greater than 7.0 are alkaline. Based on the data presented in Figure 2, the conventional additives in the drill mud prepared with the local clay obtained from Irhodo village at initial concentration showed had a pH value of 7.0, which means neutral and not acidic. Further increase in concentration, the pH values for both conventional additives (KOH and NaOH) increased from 7.0 to 11.0. However, the mud pH remained constant with increase in concentration. This suggests that both additives started exhibiting alkalinity with increase in concentrations. The KOH display an impressive result at all level of the test from 2ml to 10ml when compared with NaOH. Hence, KOH could be a more suitable pH additive to prepare drill mud when compared to NaOH in drilling operations of oil and gas wells. On the other hand, the pH additives sourced from local waste materials; BPH, BRPP, BBPP except Trona in drill mud, exhibited characteristics of acidic, neural and alkaline. This was clearly seen in BPH having a pH value of 7.0 (neutral), while BRPP and BBPP showed 6.0 and 6.5, respectively, while Trona have a test value of 7.5 and is an indicative of alkaline medium. The values 6.0 and 6.5 indicate an acidic value, which could be due to the swampy environment where the clay was obtained that is largely known to be associated with acidic formation. The BPH at 1ml, on beneficiation, showed high alkalinity that subdues the acidic properties in the drill mud. In addition, Trona at 1ml showed a pH value of 7.5, which is alkaline. This may be mostly due to high concentrations of alkaline in Trona that could have reduced the influence of acid in the drill mud. Also, this may be the major reason why Trona performed better than the rest of local additives (BPH, BRPP and BBPP). Although, the conventional pH additives were good, the locally sourced additives could be used to complement the conventional additives, if consciously beneficiated or treated.

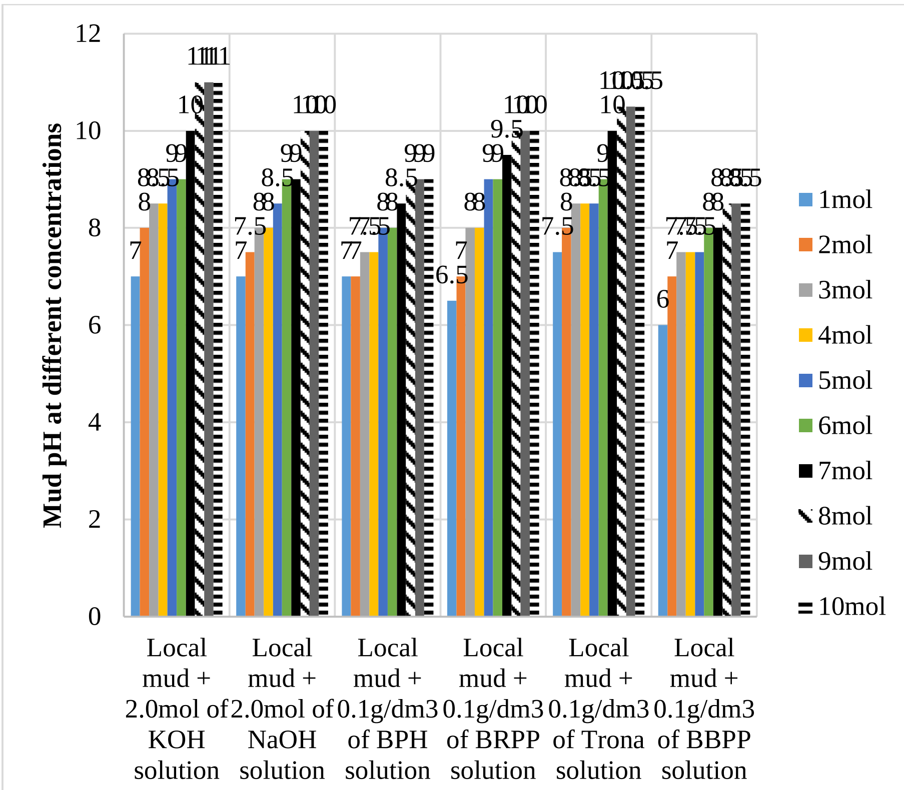

Fig 2: pH of different additives in drill mud formulated with local Irhodo clay at pH of 6.0

The results of the pH values of the different additives prepared with conventional clay (pH value of 8.0) are presented in Figure 3. As illustrated in Figure 3, the conventional pH additives of KOH and NaOH at the beginning of beneficiation at 1ml, exhibited high value of alkaline, especially, KOH having a value of 9.5. This may be due to the KOH being more resistive to dilution and thereby maintaining its concentration much longer than NaOH. Hence, this showed that KOH may perform very well than NaOH in the drill mud as mentioned previously. Furthermore, the locally sourced pH additives (BPH, BRPP and BBPP) except Trona,, exhibited an alkaline medium on beneficiation with 1ml of solution. This was expected as Trona that had the maximum pH value of 9.0 while BPH, BRPP and BBPP have their respective pH of 8.5, 8.0 and 8.0. The swelling value of 8.5 of Burnt Palm Head over the BRPP and BBPP may be due to presence of high base content. In summary, KOH showed the maximum percentage of degree (%) of improvement on the drilling fluid with 38.46-45.45% compared with 27.2-40% for NaOH. On the other hand, BRPP achieved 27.2-41.2%, and this was followed with 20-33% and 20-29.4% for BPH and BBPP respectively. The aforementioned data suggest that the locally sourced additive e.g. BRPP perform relatively when compared with conventional KO and NaOH. This finding reaffirms that BRPP and BBPP may be used as a pH enhancing additives for drilling fluids. Although, the main focus of this study was evaluating pH of locally sourced additive, previous studies has reported their effects on other parameters such as viscosity of the drilling fluid. For example, Abdulsalami *et al*., (2020) reported that banana peel powder led to an increase of the drilling from 7.00cP to: 11.50cP, and to 19.00cP for plantain peel additives. Also an increased in pH for plantain powder (9 to 11.75) and banana powder (up to 11.42) additives was reported. Peretomode (2018) reported increased in pH of drilling mud from 9 to 11-135 for commercial NaOH, then from pH 9 to 10-12 for plantain peels powder, while the burnt palm head sponge powder achieved increased in pH from 9 to 10.5-13. In addition, plastic viscosity and apparent viscosity of 4-6cP and 6.5-12.5cP for NaOH, 5cP and 6.5-11cP for locally sourced additives was reported. In the present study, the pH was found to be within range of previous report, which could also suggest the trend in viscosity may be similar. This study has shown that solid waste agricultural products could be used to produce local additives to complement conventional ones. Such activities would reduce pollution, reduce cost of production (Samson and Saheed, 2021) and improve the economy.

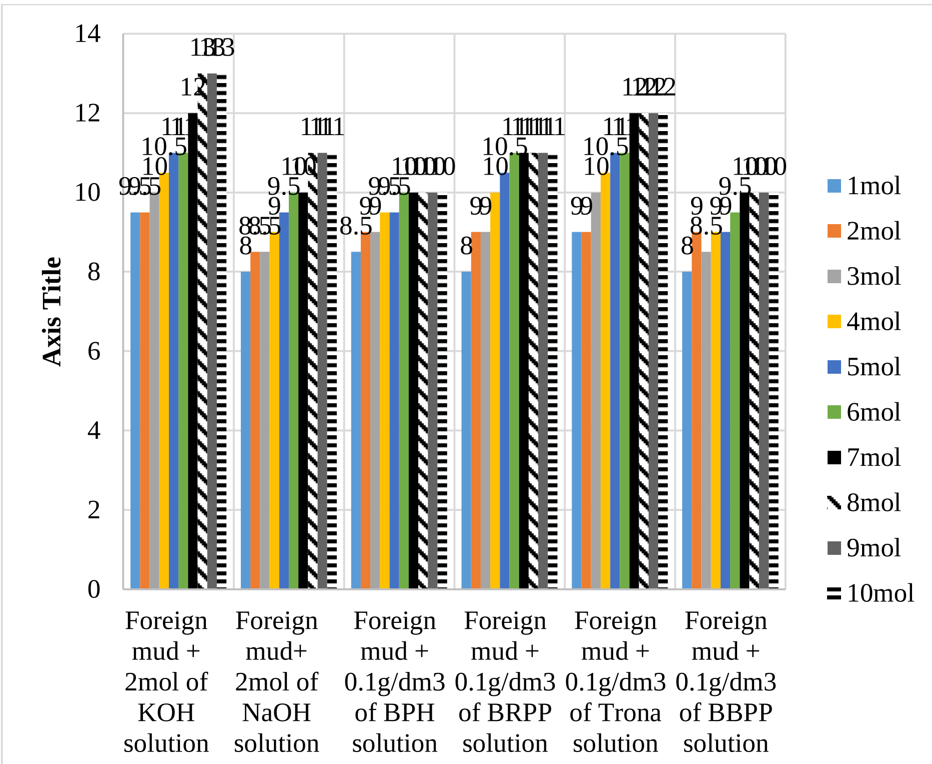

Fig3: pH of different additives in mud formulated with conventional clay of pH value of at 8.0

Conclusion: This study evaluated the pH additives obtained from local and conventional materials. The result showed that waste materials are useful to produce additives, of similar properties when compared with those from conventional materials. KOH could be more suitable pH additives to prepare drill mud than NaOH in drilling operations of oil and gas wells. The additives BPH, BRPP, BBPP except Trona from local waste materials characterized with acidic, neural and alkaline. BPH was found more suitable when compared to BRPP and BBPP.

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