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Corn Cobs and Sugar Cane Waste as a Viscosivier in Drilling Fluid

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ABSTRACT

The present project investigated the potential of utilizing corncobs and sugar cane waste as viscosivier in drilling fluid. For this purpose, the synthetic-based drilling fluid, Sarapar 147, was used as the base fluid. Both the materials were subjected to pre-treatment of drying, dehumidifying, grinding and sieving process prior to rheological tests. The rheological tests were conducted in accordance with the API 13B specifications to measure mud density, plastic viscosity, yield point, 10-second and 10-minute gel strength. The study found that plastic viscosity and yield point had a direct relationship with the amount of materials added. To drill fluid additive with corn cobs, the density, plastic viscosity and yield point were increased when the amount of additives were increased. Based on these experiments, both additives were found to have the potential to be used as additive in drilling fluid. In particular, they were able to improve its rheological properties by increasing the density, plastic viscosity and yield point. The suitable concentration for the corn cobs and sugar cane is 6.45 lb/bbl and 9.43 lb/bbl, respectively.

Keyword: Drilling fluid, rheology, additives, corn cobs, sugar cane

INTRODUCTION

Wells are drilled through different formations which require different mud properties to achieve the optimum penetration and stable borehole conditions. Therefore, the design of a particular mud program needs to take into consideration a number of factors such as the availability of additives, temperature and contamination. Generally, drilling fluid can be classified into two categories, water based fluids (WBF) and non-aqueous based fluid (NABF). The NABF can be further divided into sub-categories, namely oil-based fluids (OBF), enhanced mineral oil-based fluids (EMOBF) and synthetic-based fluids (SBF). The NABF has been widely used because of its superior performance in drilling operations. However, due to an environmental issue in the use of OBF, it was changed to SBF. The purpose of developing SBF was to cater difficult drilling targets and the capability in reducing environmental impacts (McKee, 1995). The SBF is synthesized from the components of petroleum products or has non-hydrocarbon derivatives (Imran, 2006). Drilling and production discharges to the marine environment present different environmental concerns to those in the offshore areas. Among the potential impacts to the marine environment include toxicity, bioaccumulation and biological oxygen demand (BOD).

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Agriculture is one of the main economic activities in Malaysia. The industry produces a large amount of wastes, which could be utilized for other better purposes. From the perspective of oil and gas industry, this agriculture waste can be reused in formulating drilling fluids. Furthermore, most agriculture waste is harmless to both human and the environment. In this study, corn cobs and sugar cane waste, two examples of the waste, derived from the local agriculture activities, were explored for their practical use as viscosivier in drilling fluid. These wastes were extracted to be used as loss circulation materials and viscosivier in drilling fluid formulation. Samples of mud added with the treated waste materials were subjected to rheological measurement and lost circulation. The rheological properties, measured with a rotational viscometer, are commonly used to indicate solid build-up flocculation or deflocculation of solids, lifting and suspension capabilities, as well as to calculate hydraulics of a drilling fluid. At a given temperature and pressure, fluids are characterized by their behaviour under transient conditions, as manifested by their response time to change conditions of flow.

METHODOLOGY

The experiment was conducted in accordance with the standards stipulated in the American Petroleum Institute - API 13B-2, and recommended by the Practice Standard Procedure for Testing Oil-Based Drilling Fluid. Sarapar 147, which is the product from Shell, was used as the base fluid in the present study.

The Preparation of Additives

First, sugar cane waste was dried so as to remove leaves and other particles. Next, the sugar cane stalks were squeezed, bagasse, to release sap and sugar water. The same procedures were repeated for corn cobs. Corn kernels were to obtain the cobs. Both additives were dehumidified in an oven for 24 hours at 70°C. A Mortar Grinder was used to grind the additives into small pieces. Then, a Sieve Shaker was used separately obtain the desired particle size of 125-500 microns.

The Preparation of the Mud Sample

In this study, the Hamilton Beach Multi mixer was used extensively to prepare the mud samples. The oil-water ratio was set at 70:30, as recommended by the API 13B. Firstly, the required volume of Sarapar 147 was poured into the mixing container, followed by primary emulsifier and secondary emulsifier. Next, the required mass of lime was added, followed by Brine (calcium chloride + water) and additives. In the final step, the required amount of bentonite was mixed and stirred. These mixing stages are illustrated in *Fig. 1*.

Properties Measured

Three parameters were measured to assess the rheological performance of the prepared mud samples. These were density (lb/gal), plastic viscosity (cP) and gel strength (cP).

(i) Density

The procedure was to fill the cup with mud and put it on the lid. The excess mud was wiped off from the lid. The rider was moved along the arm till a balance was obtained, before the density (lb/gal) reading was recorded.

(ii) Plastic Viscosity and Yield Point

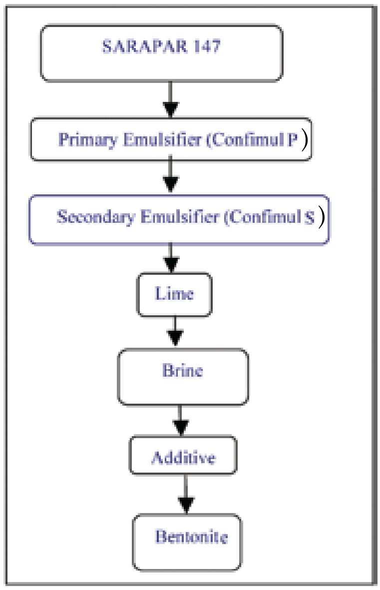

Fig. 1: Flowchart of the mud mixing process

Fann Viscometer Model 35SA was used for the rheology test. The temperature of the mud sample was within 120°F ± 2°F throughout the tests. For this part, the mud sample was kept at 120°F ± 2°F throughout the test. The thermal cup was filled with 2/3 full of the mud sample. The thermal cup was placed on the viscometer stand and the rotary sleeve was immersed into the thermal cup. The mud sample was then heated at 120 ± 2°F. The dial reading was taken when the viscometer was run at 600 rpm. The speed was then changed to 300 rpm and the dial reading was taken. The dial reading was also taken for 200 rpm, 100 rpm, 6 rpm and 3 rpm. The characteristics, which can be obtained from this procedure, are Plastic Viscosity (PV) and Yield Point (YP).

(iii) Gel Strength – 10 Seconds & 10 Minutes

For the 10-second gel strength measurement, the viscometer was turned to 600 rpm for 10 seconds, and the toggle was switched off and the mud was allowed to stand for 10 seconds. After 10 seconds, the viscometer was run at 3 rpm and the maximum dial reflection was recorded. For the 10- minute gel strength reading, the same procedures were applied, but it was allowed to operate for 10 minutes (API Standard 13 B, 1995).

RESULTS AND DISCUSSION

Mud Density

In the experiment, the mud density was intentionally set around 8 lb/gal to observe any changes. From the experiment conducted, it was shown in *Fig. 2* that the mud density would increase when the amount of additives was increased. For the mud additives added in 125-microns and 500-microns corn cobs, the trends of density were found to remain the same. Initially, both corn cobs sizes were indicated to have the same density until the amount of 0.013 lb was achieved. Further addition of additives would cause the curve to diverge. As for the 500 microns of the particle size, the increment might be due to the solid content as the size was larger as compared to 125 microns. In this study, a small amount of additives was found to significantly increase the mud density.

Fig. 3 shows the density of the mud added with sugar cane waste. It was found to have the same measurement density trend as that of the corn cobs added mud. Thus, it can be stated that the amount has a direct relationship with the density of the mud. However, the particle size was found to yield lesser effect. For this, it was observed that the density was almost similar throughout the addition of the additives. The densities started to increase when the amount of corn cobs or sugar canes exceeded 0.013 lb.

Plastic Viscosity

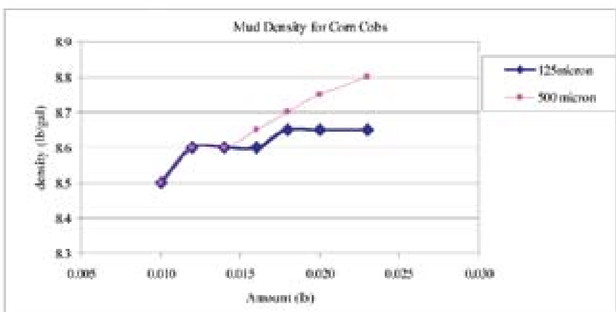

Fig. 2: Mud density of corn cobs

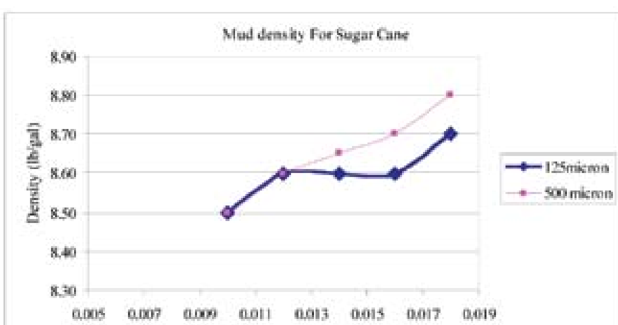

Fig. 3: Mud density of sugar cane

Fig. 4 shows that the plastic viscosity of mud added increased linearly with the amount of corn cobs added. Without any additive, which was the base sample, it gave a reading of 19 cP when 0.011 lb of additive was added; the plastic viscosity was measured up to 22 cP. At the amount of 0.022 lb, it gave a reading of 24.5 cP for 125 microns and 26 cP for 500 microns. Further increment of the corn cobs would decrease the value of the plastic viscosity. As expected, 500 microns showed a slightly higher value of plastic viscosity as compared to 125 microns due to its particle size. The larger the particle, the more viscous of the fluid would be.

Fig. 5 illustrates the trend of plastic viscosity for mud added sugar cane. Unlike the corn cobs, sugar cane additives experienced its optimum value in the earlier amount of the addition. It was observed that the amount 0.011 lb initially added to the additives and the plastic viscosity increased as compared to the base fluid, which was 16 cP. Interestingly, the trend was found to be still valid if the amount of 0.012 lb was added. However, it started to decrease at 0.013 lb. If the additives were continuously added, the curves of the graph would tend to decrease. The curve of 500 microns gave a higher reading as compared to 125 microns due to its particle size. Based on the observation of both the figures (4 and 5), there must be an optimum of plastic viscosity value for the formulation to work affectively. As for the corn cobs, the optimum value was found to be around 0.019 lb and this was about 0.013 lb for sugar cane

Yield Point

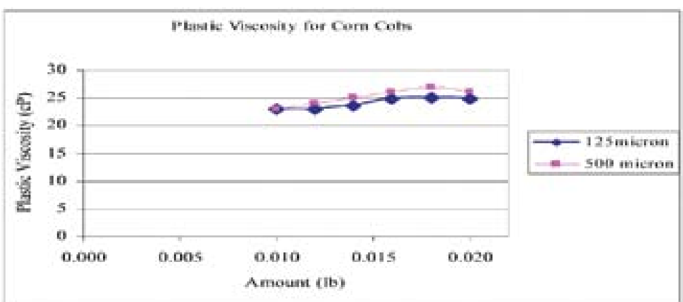

Fig. 4: Plastic viscosity for corn cobs additive

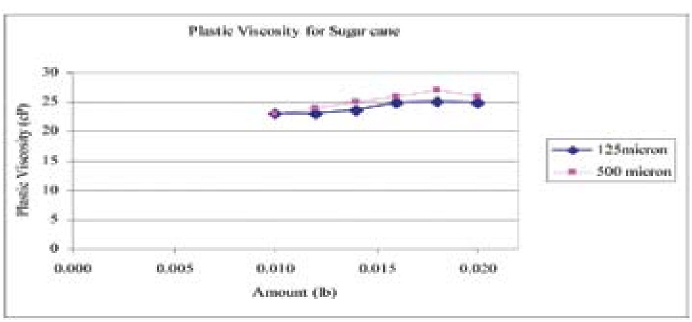

Fig. 5: Plastic viscosity for sugar cane additive

From *Fig. 6*, the value yield point decreased as the amount increased for corn cobs, in both sizes. For the 125 and 500 microns, the minimum reading was revealed at 0.022. It important to highlight that further increment of the amount of additives would cause the curve to keep on decreasing.

Based on *Fig. 7*, the trend of graph for sugar cane was found to behave better when compared with the corn cob curves. It basically showed the same trend, with a reduction in the yield point as the amount was increased. The 500 microns was found to have a lower value compared to 125 microns. This was due to the fact that there is more solid content in the fluid sample of 125 microns as compared to 500 microns, thus decreased the distances between inter-particles. Further increment of the amount would result in the value of yield point to decrease. The yield point is sensitive to the electrochemical environment, indicating the need for chemical treatment. The yield point might be reduced by the addition of substances which neutralize electric charges such as thinning agent and by addition of chemicals to precipitate the contaminants.

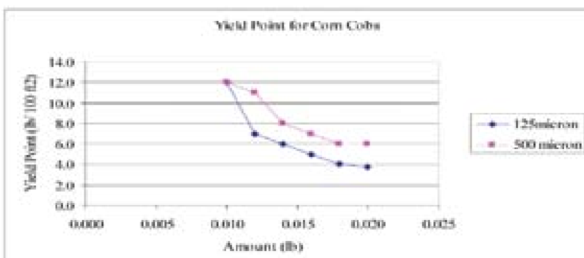

Fig. 6: Yield point for corn cobs

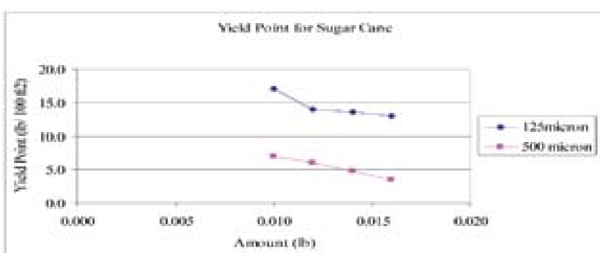

Fig. 7: Yield point for sugar cane

Gel Strength

For the corn cobs in the sizes of 125 and 500 microns, the highest value was found at the amount of 0.011 lb, while the lowest value was at the amount of 0.022 lb, as shown in *Figs. 8* and *9*. A similar trend was also obtained for the sugar cane additives depicted in *Figs. 9* and *10*. For both the additives, the particle size of 500 microns showed a higher value as compared to 125 microns. The trends of the graph, for the gel strength of both additives, are almost identical with the yield point graph. This could probably due to the attractive forces in the mud system.

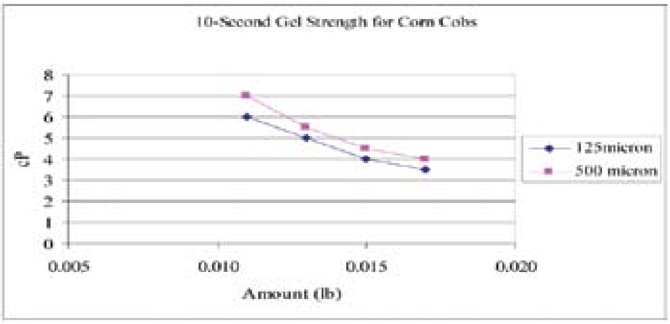

Fig. 8: 10 second gel strength for corn cobs

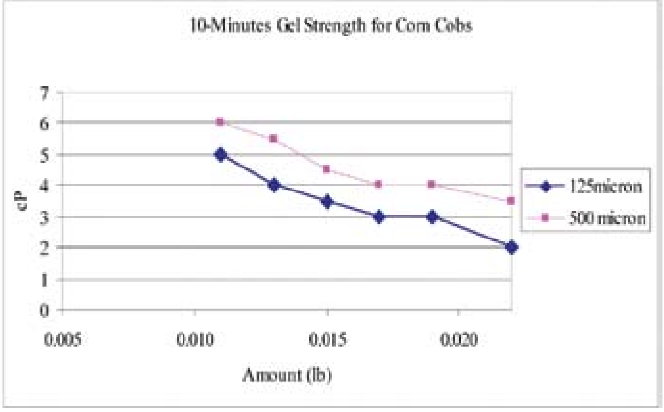

Fig. 9: 10 minutes gel strength for corn cobs

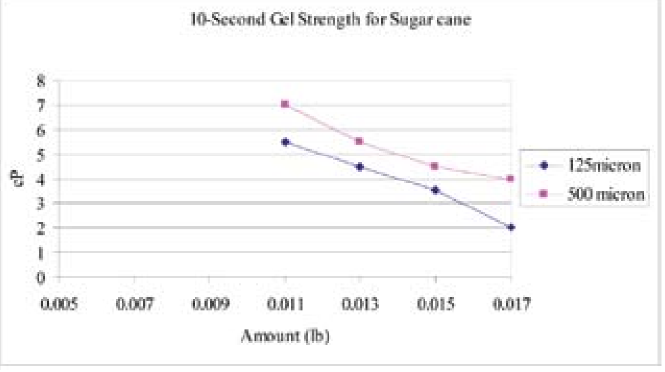

Fig. 10: 10 seconds gel strength for sugar cane

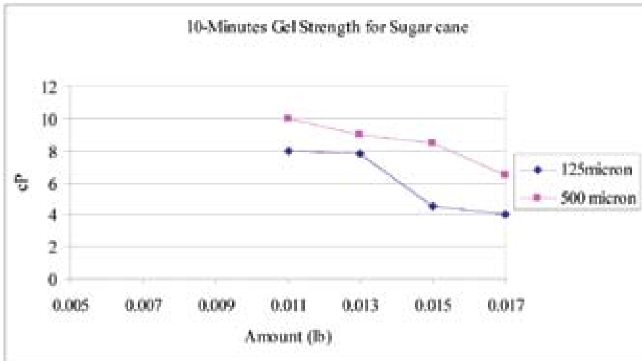

Fig. 11: 10 minutes gel strength for sugar cane

CONCLUSIONS

The present study found that corn cobs and sugar cane could serve as a viscosifier. The plastic viscosity was found to have a direct relationship with the added amount. On the contrary, the yield point and gel strength showed a reverse relationship with the added amount. The optimum value or the best concentration was obtained at the amount of 0.019 lb for the corn cobs, and this was 0.013 for the sugar cane, with the concentration of 9.43 lb/bbl for corn cobs and 6.45 lb/bbl for sugar cane.

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