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Research Article

Experimental Study of Sugarcane Bagasse Ash and Corn Starch as Fluid Loss Additives in Oil-Based Drilling Mud

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Abstract

Fluid loss is one of the biggest problems faced by the drilling engineers; the drilling fluids invades in the formation resulting in the fluid loss, which increases the overall cost of the drilling. The objective of this study is to use biodegradable natural ingredients as fluid loss additives in oil-based mud as the industrial based polymers which are normally used as fluid loss agents are highly expensive. In this study, corn starch and sugarcane bagasse ash were used at 1, 3, 5, and 7% wt./wt. separately as fluid loss additive in Oil-based mud. The drilling mud mixed with 1% of SCBA yielded the best result for fluid loss. Similarly, corn starch at 1% wt./wt. exhibited the best fluid loss characteristics. However, their effect on other mud properties was; plastic viscosity, apparent viscosity, yield point, and gel strength increased with increasing the concentration whereas, they have no or little effect on pH and mud weight.

Keywords: *Sugarcane bagasse ash, corn starch, oil-based mud, fluid loss additives, mud properties.*

1. Introduction

An effective drilling procedure depends upon the recipe and formulation of the drilling mud. The drilling mud performs several functions at a time. Drilling mud is used to keep the drill bit cool and to carry out the cuttings to the surface. The major problem encountered by the drilling engineer is fluid loss; fluid loss is defined as the invasion of drilling mud into the formation. This invasion can cause formation damage and reduce the permeability near the wellbore, resulting in a decreased production rate; moreover, the presence of shale formation zones can increase the problem as they swell when they come in contact with the filtrate. That is why the drilling selection and its formulation should be considered before the start of drilling (Amanullah, M., *et al*. 2005).

To avoid the fluid loss problem, many industrial polymer-based additives are normally used as the additives in the mud (Ismail, I., *et al*. (1997). The cost of these industrial control agents is very high, increasing the cost of the drilling operation (Ismail, I., *et al*. 1997). Normally the fluid loss agents that are used in the oil industry are hydroxyl ethyl cellulose (HEC) and polyanionic cellulose (PAC) (Ismail, I., *et al*. 1997). These polymer-based control agents can be replaced by natural biomass like starch, which is massively present in nature (Katopo, H., *et al*. 2002).

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The cost of these natural ingredients is much lower than that of PAC and HEC (Ismail, I., *et al*. 1998).

Many researchers have tried and investigated other less expensive sources like corn (Amanullah, M., *et al*. 2004; Chike-Onyegbula, *et al*. (2012), sago (Ismail, I., *et al*. 2001), potatoes, cassava (Caenn, R., *et al*. 1996) and sugarcane bagasse ash (S. Kafashi *et al*. 2016) as an additive in the drilling fluids as fluid loss control agent and to enhance the rheological characteristics of the drilling fluid.

Many researchers have carried out experimental studies using different additives in order to check the effect of the natural additives on mud properties.

N.A. Ghazali *et al*. (2015) investigated the effect of corn starch on the water-based mud. He concluded that by increasing the concentration of corn starch, the filtration characteristics of the sample improves.

Samavati R *et al*. (2014) finds out that the cassava derivate (fufu) as the potential to improve the filtration characteristics of the water-based mud.

James A. Sampey, (2006) concluded that the sugarcane bagasse ash can improve the filtration characteristics of both oil and water-based mud.

Prasenjit Talukdar *et al*. (2018) worked with banana peel and corn flour. The result indicated that both the starches work effectively on filtration characteristics.

2. Methodology

This section includes the procedure and the methods used to prepare the samples and to check the effects of additives on the prepared mud.

2.1 Materials

The materials used for the preparation of conventional oil-based mud are diesel, fresh water, emulsifier bentonite, barite, caustic soda and xanthan gum. Whereas corn starch and sugarcane bagasse ash were added as additive for fluid loss control at 1, 3, 5, and 7% wt./wt.

2.1 Additives preparation

Sugarcane bagasse was collected and was dried under direct sunlight to reduce the moisture content. The dried bagasse was grinded and burnt in a furnace at 1200 ^{o}C for three hours as shown in Fig. 1.

Fig. 1 Sugarcane bagasse ash

2.3 Sample preparation

Nine samples of oil-based mud were formulated. One sample was of diesel-based mud, in four samples corn starch was added as in additive and in another four sugarcane bagasse ash was added as additive.

2.4 Equipment used

- Rotational viscometer
- Mud balance
- Multimixer
- pH meter
- Filter Press

2.5 Rheological properties

Rheological properties were calculated using rotational viscometer at two different speeds of 300 and 600 rpm. Using the data plastic viscosity, gel strength, yield point, apparent viscosity and pH of the sample were calculated using following equations.

Apparent Viscosity (μa), (cp) = $\frac{\emptyset 600}{2}$ (1)

Plastic Viscosity (μp), (cp) = $\emptyset 600 - \emptyset 300$ (2)

Yield Point (Yp), (lb./100 ft2) = $\emptyset 300 - \mu p$ (3)

Where, ⍰ = Torque readings (rpm)

2.6 Fluid Loss determination

Fluid loss properties were measured using API Filter press. The experiment was conducted at 100 psi pressure for 30 minutes. The amount that was collected after 30 minutes was recorded.

2.7 Experimental work

As discussed earlier, different samples were made with varying concentration of corn starch and sugarcane bagasse ash and the fluid loss as well as other mud properties were determined as shown in Table 1 & 2.

Table 1 Measured mud properties with corn starch

Mud Properties	Ref. Mud	1%	3%	5%	7%
θ600	31	38	38.5	39.5	40
θ300	18	23	23.5	24	24.5
Plastic Viscosity (cp)	13	15	15	15.5	15.5
Apparent Viscosity (cp)	15.5	19	19.25	19.75	20
Yield Point (lb/100 ft2)	5	8	8.5	8.5	9
Gel Strength @ 10 Secs (lb/100 ft2)	7	9	10	11	11.5
Gel Strength @ 10 min (lb/100 ft2)	9	10	10	11.5	12
Fluid loss @ 30 mins (ml)	10	8	7.5	7	7

Table 2 Measured mud properties with SCBA

Mud Properties	Ref. Mud	1%	3%	5%	7%
θ600	31	36	41	44	47
θ300	18	22	25	27	29
Plastic Viscosity (cp)	13	14	16	17	18
Apparent Viscosity (cp)	15.5	18	20.5	22	23.5
Yield Point (lb/100 ft2)	5	8	9	10	11
Gel Strength @ 10 Secs (lb/100 ft2)	7	10	10	11.5	12
Gel Strength @ 10 min (lb/100 ft2)	9	10	10	11.5	12
Fluid loss @ 30 mins (ml)	10	8	8.5	8.5	9

3. Result & discussion

The experimental study yielded the following results.

3.1 Mud weight

Corn Starch shows no variation on mud weight, even with increasing the concentration of the corn starch the mud weight remained unchanged. However, mud weight was slightly reduced as sugarcane bagasse ash (SCBA) was added and further addition of the SCBA mud weight of the sample was further reduced as shown in Fig. 2.

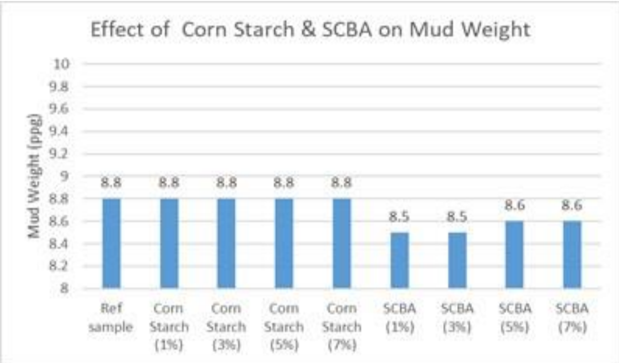

Fig. 2 Effect of corn starch and SCBA on mud weight

3.2 Plastic Viscosity

The addition of corn starch at 1% increased the plastic viscosity from 13 to 15 cp, the further addition of corn starch showed little or no impact on plastic viscosity. On the other hand, with addition of SCBA, the plastic viscosity increases by increasing concentration of SCBA as shown in Fig. 3.

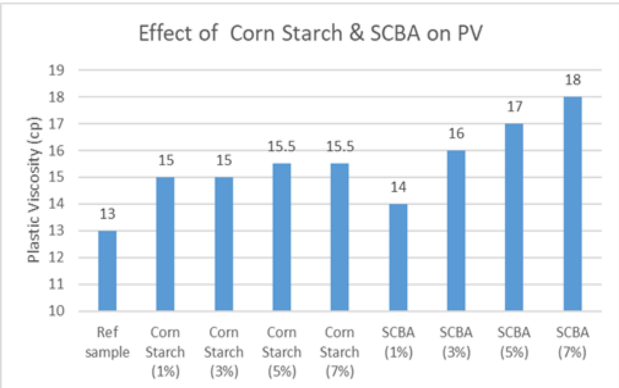

Fig. 3 Effect of corn starch and SCBA on PV

3.3 Gel Strength

The gel strength was calculated directly form the rotational viscometer. The first reading was taken after the 10 seconds and the other after 10 minutes. The corn starch at 1% increased the gel strength at 10 sec from 7 to 9 and after 10 mins 9 to 10. While increasing the concentration of corn starch the gel strength started to increase. The samples having corn starch concentration of 3, 5, and 7% increased the gel strength from 7 to 10, 11, and 11.5 at 10 seconds reading and 10, 11.5, and 12 at 10 minutes reading. Whereas the SCBA acted similarly like corn starch with increment of concentration of SCBA in the sample the gel strength of the sample increased. The sample having SCBA concentration 1, 3, 5, and 7% has the readings of 9,10,11, and 11 after 10 seconds, while 10, 10, 11.5, and 12 at 10 minutes reading. As shown in Fig. 4.

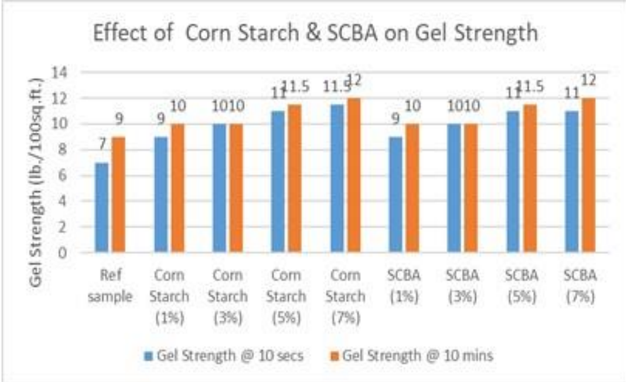

Fig. 4 Effect of corn starch and SCBA on gel strength

3.4 Yield Point

The results indicated that the yield point of the sample increased from 5 to 8 lb./100ft^2 with addition of 1% of corn starch, by increasing the concentration of corn starch the results were 8.5, 8.5, and 9 lb./100ft^2, which indicated that the further increment has a very little effect. The SCBA showed steady increment on yield point, the results were 8, 9, 10, and 11 lb./100ft^2 at 1, 3, 5, and 7% wt./wt. As shown in Fig. 5.

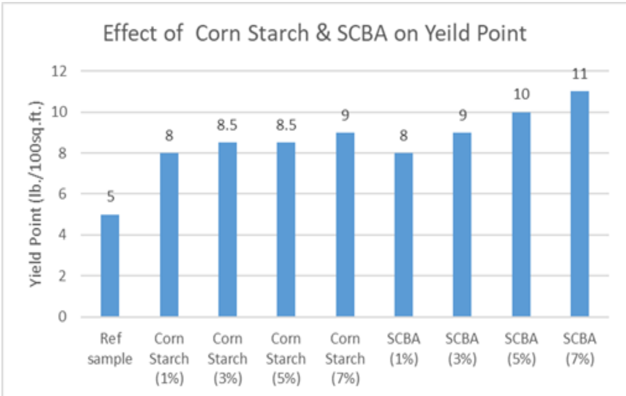

Fig. 5 Effect of corn starch and SCBA on yield point

3.5 Apparent viscosity

The apparent viscosity is calculated by taking the value through rotational viscometer at 600 dials reading and dividing it by 2. It was observed that apparent viscosity was increased from 15.5 to 19 cp by the addition of 1% of corn starch. However, increment in the concentration showed little increase of apparent viscosity. The results obtained at 3, 5 and 7% was 19.25, 19.75 and 20 cp. Whereas, the sugarcane bagasse ash (SCBA) increased the apparent viscosity of the sample. The apparent viscosity obtained from the results are found at 1, 3, 5 and 7% is 18, 20.5, 22 and 23.5 cp respectively, as shown in Fig. 6.

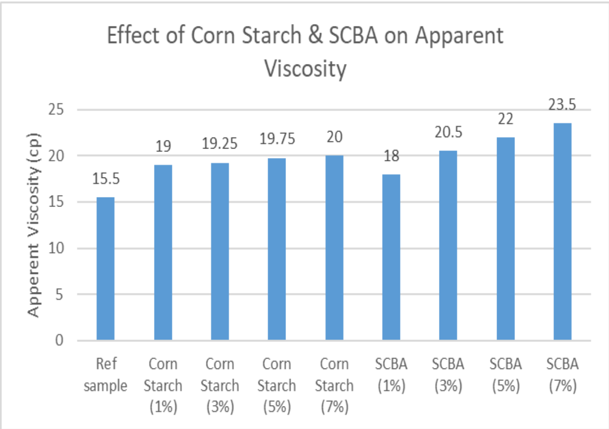

Fig. 6 Effect of corn starch and SCBA on apparent viscosity

3.6 pH

Corn starch showed no effect on pH. While, SCBA has slightly increased the pH of the sample. The results were at 1%,3% 5%, 7% SCBA concentration pH values were 9.2,9.2,9.3,9.3 respectively.

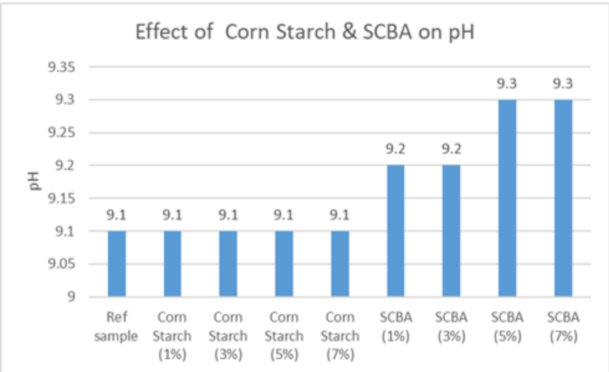

Fig. 7 Effect of corn starch and SCBA on pH

3.7 Fluid Loss

The fluid loss reading was taken at pressure differential of 100 psi and after 30 minutes. The addition of corn starch yielded best result at 1% as the fluid loss was decreased from 10 to 8 ml. Further addition of corn starch resulted in lower fluid loss, 3%, 5%, 7% addition of corn starch resulted in 7.5, 7, 7 ml. Similar trend was observed for the Sugarcane bagasse ash (SCBA) with the addition of the 1% of SCBA the fluid loss was reduced form 10 ml to 8 ml. However, further increment of SCBA resulted in increase in fluid loss, as the concentration increases the fluid loss started to increase, the values recorded from the experiments are 3%, 5% and 7% bagasse ash has resulted in 8.5,8.5- and 9-ml fluid loss.

The above results concluded that both the additives corn starch and the sugarcane bagasse ash can be used as fluid loss additives and according to this study both the additives work best at 1% wt./wt. concentration.

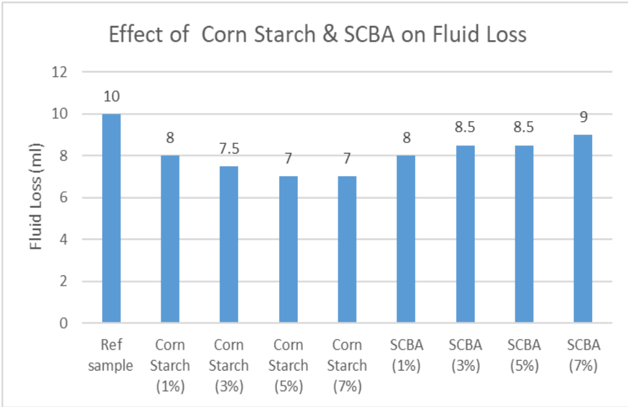

Fig. 8 Effect of corn starch and SCBA on fluid loss

Conclusion

1) The corn starch has no effect on mud weight while SCBA has little impact on mud weight.
2) corn starch increased the plastic viscosity at 1% later very little effect was observed by increasing concentration. Whereas, SCBA steadily increased the plastic viscosity.
3) both the additives increased the yield point; however, corn starch has little impact when concentration is increased on the other hand SCBA worked steadily.
4) Increment in gel strength was observed with both the additives.
5) Apparent viscosity increased with increasing the concentration of both the additives.
6) corn starch exhibited no effect on pH, while SCBA has very little impact on pH.
7) Both the additives can be used as fluid loss additives and both worked best at 1% wt./wt. concentration.

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