THE PERFORMANCE OF SAGO STARCH AND MODIFIED STARCH (FL-7 PLUS) IN THE KCL-STARCH MUD SYSTEM

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ABSTRACT

The readily available of local starch together with the many possibilities as to chemical modification constitute the basis for the great versatility of starch derivatives. An experiment was conducted on sago starch and modified starch (hydroxypropyl starch), used as fluid loss control additive in the KCl mud system, which comprised of the study of the stability of the blended mud system with contaminants in the wellbore, such as formation water during drilling operation and also the thermal stability of the mud system. Consequently, the desired functions of the mud were stunted. Contamination tests were performed at temperature and pressure of 250°F and 500 psi respectively, to evaluate the ability of the mud to be safely used under the field condition. Nevertheless, the experimental results revealed that the modified starch gave better performance despite the presence of contaminants and high temperature compared to sago starch, which was sensitive to the Ca^{++} contamination and high temperature, in terms of filtration and rheological properties.

Keywords: Sago starch, Modified starch, KCl mud.

INTRODUCTION

In the petroleum upstream activities, oil is produced from a production zone via an oilwell. The development of an oilwell requires a production hole to be drilled through the production zone. In the drilling operation, many hole problems may be encountered such as clay swelling, fluid loss etc.

KCl-based mud is one of the widely used muds in the drilling operation to overcome clay swelling problem in the formation. However, this mud system is found to be incapable of preventing formation damage due to the invasion of fluid from the mud system. Generally, formation damage reduces well productivity. Thus, natural polymer such as starch or modified starch (Thomas, 1982, and Adeline, 1987) is used in the mud to reduce fluid loss into formation (Gray and Darley, 1981).

Two types of mud were used in this laboratory study—sago starch and FL-7 Plus. Sago starch is a natural polymer and consists of two polysaccharide; amylose and amylopectin (Beynum and Poel, 1985), while FL-7 is a modified starch—a type of starch that has undergone the process of modification to its chemical structure to gain different properties, thus make it more temperature-stable and no longer susceptible to bacterial degradation. The experimental results revealed that the sago starch could not outperform FL-7 Plus in terms of rheological properties and fluid loss control performances, particularly at high temperatures and Ca^{++} contaminated environment.

MATERIALS AND METHODS

This research study utilised sago starch that was purchased from the nearby supermarket, while the FL-7 Plus was sponsored by Kota Minerals & Chemicals Sdn. Bhd. (KMC). The research equipments used to conduct the tests were of standard typed, such as Baroid Rheometer, HPHT filter press etc. and the experiments were carried out as per the API RP 13B.

The laboratory tests on sago starch and FL-7 Plus were performed by varying the concentrations, temperatures, and the presence of contaminants, as shown in Table 1. Those two mud systems were prepared with concentrations from 4.0-10.0 ppb and tested at temperatures ranging from 80-250°F for their rheological properties and HPHT fluid loss. The thermal stability tests on the sago and FL-7 Plus mud samples— by elevating the temperature of the fluid loss test—were carried out with and without the presence of contaminants such as sodium and calcium cations.

RESULTS AND DISCUSSIONS

The research study has produced several encouraging results as follows:

The Effect of Concentration

Figure 1 shows the relationship between the concentrations of sago starch and FL-7 Plus and their rheological properties and API fluid loss at temperature of 150°F. It was found that the API fluid loss decreased as concentration of sago starch and FL-7 Plus increased.

In the sago mud system, higher concentration of sago would increase the ability of the mud to form impermeable filter cake. This was due to its amylose that were capable of absorbing free water and then formed sponge-like bags.

In the FL-7 Plus mud system, the filtrate collected was lower than the sago mud. This was due to the thinner and less permeable filter cake formed on the filter paper. Generally, the FL-7 Plus' particles size distribution to about 10 micron are capable of forming an initial seal on the larger pore openings and filling the space between the larger particles that deposited on the filter paper.

The rheological properties of sago starch—plastic viscosity, yield point, and gel strength—were found to be comparable to FL-7 Plus. Xanthan gum, as recommended by KMC, was added into the sago and FL-7 Plus mud systems in order to achieve the required viscosity. The amount of xanthan gum required by sago mud was higher than the FL-7 Plus. Generally, FL-7 Plus enhances the low shear rate viscosity of a fluid containing xanthan gum. This unique polymer combination is synergistic and yields improved static suspension and pseudoplastic behaviour under dynamic conditions.

The Influence of Temperature

In the temperature study, mud systems with concentration of 8 gm of sago and FL-7 Plus were chosen based on their HTHP fluid loss and rheological properties performances.

Figure 2 shows the influence of temperatures on the performance of sago and FL-7 Plus mud systems. The experimental results of HPHT fluid loss experienced by sago and FL-7 Plus were found to be proportional to temperature. By comparing the sago and FL-7 Plus, it was found that the FL-7 Plus experienced lower fluid loss. The sago mud system experienced higher fluid loss because higher temperatures destroy the long chain of thus polymer, thus retard the ability of the sago filter cake to prevent fluid loss into formation. This phenomenon has also affected the performance of sago's rheological properties.

Generally, FL-7 Plus was found to be stable at higher temperatures in term of fluid loss and rheological properties due to the modification of its chemical structure. Unfortunately, no further informations could be furnished in this paper as the modification is proprietary of TBC-Brinadd.

The Effect of Contaminants

The experimental results, as shown in Figure 3, revealed that the plastic viscosity of sago mud decreased from 10 cp (without contamination) to 8 cp with the presence of 40 000 ppm of sodium chloride as contaminant. Yield point gave similar performance as plastic viscosity, which decreased from 16 lb/100 ft^2 (without contamination) to 13 lb/100 ft^2. The plastic viscosity and yield point of FL-7 Plus were found to experience similar declination as sago mud. Both mud systems experienced slight increase of API fluid loss when exposed to sodium chloride.

Figure 3 also shows that the sago mud system gave higher fluid loss with the presence of calcium ions, which will would lead to severe formation damage. The volume of fluid loss had increased from 4.7 ml (without contamination) to 13.4 ml. The presence of calcium ions was found to have less effect on the fluid loss performance of FL-7 Plus, where the volume of fluid loss increased marginally by 0.5 ml.

CONCLUSIONS

(1) FL-7 Plus has shown better overall performance than sago. experimentally.
(2) Sago starch has the potential to be used as fluid loss control additive, but requires modifications on its chemical structure.

(3) Higher concentration of sago is required to control fluid loss.
(4) Sago starts to experience degradation at temperature higher than 200°F. At 250°F, FL-7 Plus is found to have no problem in controlling fluid loss.
(5) The presence of sodium and calcium ions have affected the performance of rheological properties of sago and FL-7 Plus. Sago gives the worst performance in term of fluid loss when exposed to calcium ions.

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REFERENCES
Adeline, T., 1987. "Temperature-Stable Polymeric Fluid Loss Reducer Tolerant to High Electrolyte Contamination." *SPE Drilling Engineering*, Sept. 1987. 209.

American Petroleum Institute, 1978. *Standard Procedure for Testing Drilling Fluid.* API RP 13B. 7th Edition. Dallas: American Petroleum Institute.

Beynum, G. M. A. V. and Poel, J. A., 1985. *Starch Conversion Technology.* London: Marcel Dekker.

Gray, G. R. and Darley, H.C.H., 1981. *Composition and Properties of Oil Well Drilling Fluids.* Houston: Gulf Publishing.

Thomas, D. C., 1982. "Thermal Stability of Starch- and Carboxymethyl-Cellulose-Based Polymers Used in Drilling Fluids." *Journal of Petroleum Technology*, April 1982. 171-80.

Figure 3 Rheological properties for FL-7 Plus at different temperatures

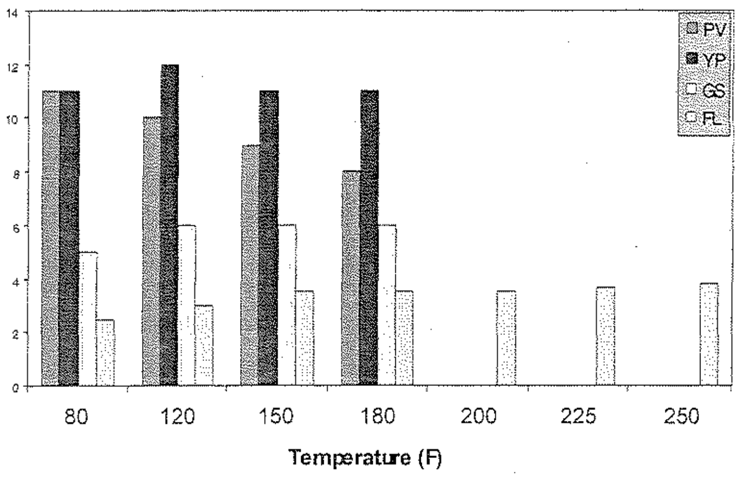

Figure 4 The effect of contaminants on rheological properties of sago and FL-7 Plus muds

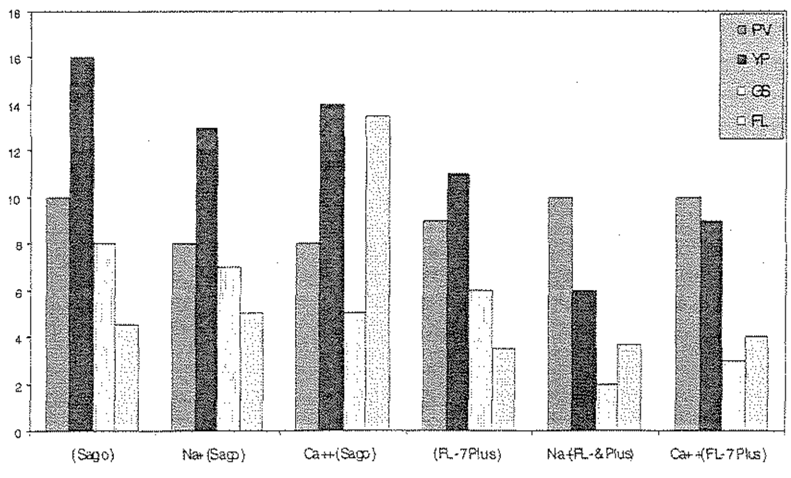

Figure 1 Rheological properties of mud at 150F

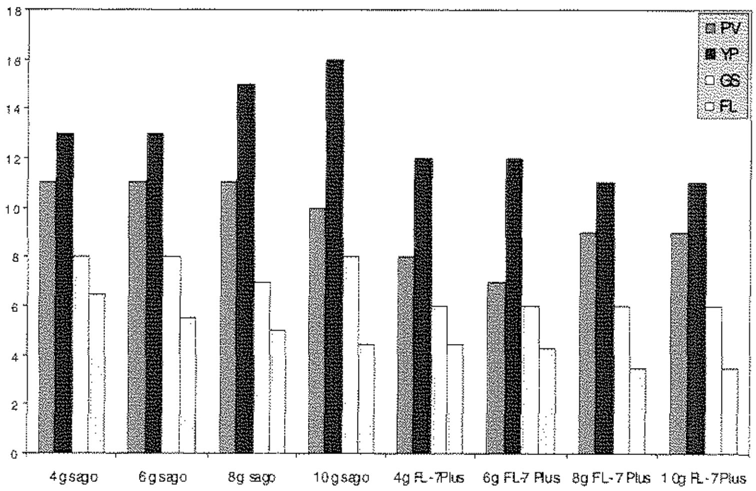

Figure 2 Rheological properties of sago mud at different temperatures