Use of Sodium Lignosulphonate in Aqueous Drilling Fluid System for Mud Property Enhancement

Mohmad Afzal Mohmad Sidik[1], Azfarhaad Kadri[2], Rishabh Raj[3] and Bhairab Jyoti Gogoi[4]

[1]Student, Dept. of Petroleum Engineering, Presidency University Bangalore, Karnataka, India
[2]Student, Dept. of Petroleum Engineering, Presidency University Bangalore, Karnataka, India
[3]Student, Dept. of Petroleum Engineering, Presidency University Bangalore, Karnataka, India
[4]Assistant Professor, Dept. of Petroleum Engineering, Presidency University Bangalore, Karnataka, India

---***---

Abstract - *Sodium Lignosulphonate (SLS) is yellowish brown powder which is completely soluble in water. It is an anionic surfactant with high molecular weight polymer. It is also rich in sulfo and carboxyl group and has better water-solubility, surf-activity and dispersion capacity. Sodium Lignosulphonate is stable at high temperatures ranging from (150 °F to 250 °F) which occur in well bores during drilling. It acts as a deflocculant which prevents coagulation of bentonite and also as a stabilizer to stabilize emulsions and as thinning agent in drilling fluids. In this study SLS is used as an additive in aqueous drilling fluids and its results are compared with other drilling fluid samples of different compositions.*

Key Words**: Sodium Lignosulphonate, drilling fluid, deflocculant, thinner, additive.**

1. INTRODUCTION

Sodium Lignosulphonate (SLS) contains lignin or Lignosulphonate which is second most abundant natural raw and organic material on the planet and stable at high temperature and pressure. It is mainly an industry waste discharge from paper mills. A lot of SLS is produce from these industries which lead to a disposal problem. Sodium Lignosulphonate has a deflocculant property which can be used as an additive in drilling mud [1]. Drilling mud is a Non-Newtonian fluid. The main purpose of using drilling fluid during any drilling operation are providing hydrostatic head, removal of drill cuttings, lubricating and cooling the drilling bit. In drilling operations the properties of the drilling fluid depend on the well program and the down hole conditions. To avoid problems like blowout, stuck pipe and lost circulation, engineers have to choose the drilling fluid which is best suitable for the job and has minimum side effects. One of the main components of drilling fluid include bentonite which is a clay. Sometimes due to some conditions it is required to deflocculate clay in order to prevent changes in its rheological properties. So, in order to deflocculate clay engineers have to use mud thinners or deflocculant. The present study focuses on uses of sodium Lignosulphonate as a mud thinner in the drilling fluid. Previously sodium Lignosulphonate has been used in enhanced oil recovery as a surfactant as it reduces the surface tension [2].

2. EQUIPMENT

API Filter Press (FANN): It is the most effective means of determining the filtration properties of drilling muds and cement slurries (Figure 1).

OFITE Model 900 Viscometer (OFITE): The 900 viscometer is a direct indicating, automatically operated, rotational viscometer. It is used to find the apparent or effective viscosity of the drilling fluid by applying a shear rate. We use 600 RPM to find the apparent viscosity of the fluid (Figure 2).

Differential sticking tester (FANN): It measures the "Stuck Pipe Tendency Coefficient" of drilling mud, and also determines how effective lubricants or treatments might be with any given drilling fluid (Figure 3).

EP Lubricity tester (FANN): The Lubricity tester is a high-quality instrument used to measure the lubricating quality of drilling fluids (Figure 5).

Fig -1: API LPLT filter press (Fann)

Fig -2: OFITE Model 900 Viscometer

Fig -3: Differential sticking tester (Fann)

Fig -4: Mud cake thickness scale (Fann)

Fig -5: EP Lubricity Tester (Fann)

2. MATERIALS AND METHODOLOGY

2.1 Material Used

The raw materials used in the preparation of Sodium Lignosulphonate (SLS), Bentonite (API Grade), Barite (Industry Grade), Starch (Karnataka Fine Chem), Xanthan gum(Karnataka Fine Chem), Sodium hydroxide(Karnataka Fine Chem), Potassium chloride(Karnataka Fine Chem), Poly aluminium chloride(Karnataka Fine Chem), Nut plug, Calcium carbonate(Karnataka Fine Chem).

2.2 Preparation of Drilling Fluid

In this study we prepare a water-based drilling by mixing 1000 mL water with varying composition of the following additives: Bentonite, Barite, Starch, Xanthan gum, Sodium hydroxide, Potassium chloride, Poly aluminium chloride, Nut plug, Calcium carbonate and Sodium Lignosulphonate copolymer (Table 1).

2.3 Mud Property Test

In this study we performed four experiments using four different equipment's to check the properties of the drilling fluid. Each sample of the mud used in each experiment contains different additives in varying composition.

In Experiment I, we use OFITE Model 900 viscometer to determine the rheological properties of the mud such as Plastic viscosity (μ_p), Apparent viscosity (μ_a), Yield point (τ_y) and Gel strength. By using viscometer, we determine Θ600 and Θ300 values. Then by using the given formula we determine the rheological properties [3]:

$\mu_a = \Theta_{600}/2$

$\mu_p = \Theta_{600}-\Theta_{300}$

$\tau_y = \Theta_{300}-\mu_p$

Table -1: Sample Composition

Sample	Water (ml)	Bentonite (g)	Barite (g)	NaOH (g)	Xanthan gum (g)	Starch (g)	KCl (g)	PAC (g)	Nut plug (g)	CaCo3 (g)	SLS Copolymer (g)
1	1000	60	30	0	0	0	0	0	0	0	0
2	1000	60	30	0	0	0	0	0	0	0	0
3	1000	60	30	0	0	0	5	0	3	0	0
4	1000	60	30	5	10	10	5	0	3	3	0
5	1000	60	30	5	10	10	5	2	3	3	0
6	1000	60	30	5	10	10	5	2	3	3	10

In Experiment II, we use a LPLT filter press to determine the filter loss and mud cake thickness (Figure 4) of a drilling fluid.

In Experiment III, we use a differential sticking tester to measure pipe sticking coefficient. If the sticking coefficient is less than the mud has the less tendency to stick drill string.

In Experiment IV, we use a lubricity tester to determine the lubricity coefficient of the drilling mud. It is recommended for the lubricity coefficient to be less than 0.15(API). The lower the lubricity coefficient the better is the lubricity of the drilling mud.

3. RESULTS AND DISCUSSION

The main purpose of this study was to find out the effect of SLS on the properties of drilling fluid. We used six samples in all the experiments and the 6th sample contained SLS with various other additives as mentioned previously.

Results from experiment I (Table 2) indicate that as we add SLS copolymer there is a further decrease in plastic viscosity and apparent viscosity. The yield point increases and there is no much effect on gel strength.

Results from experiment II (Table 3) indicate that as we add SLS, filtrate loss value decreases and we got a moderate filter cake.

Results from experiment III (table 4) indicate that with the addition of SLS there is a decrease in differential sticking coefficient hence there is less tendency for stuck pipe condition to arise.

Results from experiment IV (Table 5) indicate that there is a significant decrease in the lubricity coefficient after addition of SLS copolymer in the drilling fluid. The lower the lubricity coefficient the better is the lubricity 0f the drilling fluid. After adding the SLS we achieve L.C less than the recommended value i.e. 0.15.

Table -2: Rheological Properties from Viscometer

Sample No.	ϴ600 RPM	ϴ300 RPM	μ_a (cp)	μ_p (cp)	τ_y(lb/100ft^2)	Gel Strength (lb/100ft^2)	
						Initial	Final
1	7	5	3.5	2	3	3	2.5
2	9	6	4.5	3	3	4	2
3	180	155	90	25	130	75	75
4	135	105	67.5	30	75	50	45
5	110	90	55	20	70	35	35
6	105	90	52.5	15	75	36	36

Table -3: LPLT Filter Press Results

Sample No.	Filtrate (ml)	Mud Cake Thickness (1/32in)
1	150	0.5
2	120	1
3	28	5
4	30	4
5	30	3
6	29.5	3

Table -4: Differential Tester Results

Sample No.	Differential Sticking Coefficient
1	0
2	0
3	0

4	0.57
5	0.63
6	0.43

Table -5: EP Lubricity Tester Results

Sample No.	Lubricity Coefficient (LC)
1	0.4
2	0.42
3	0.37
4	0.33
5	0.2
6	0.11

4. CONCLUSIONS

From this study we can conclude that Sodium Lignosulphonate has a significant effect on the properties of the drilling mud.

Chart 1 and 2 indicate a decrease in the plastic viscosity and apparent viscosity, respectively after the addition of the SLS. Hence the copolymer can be used as a mud thinner.

Chart 3 indicate a slight increase in the yield point in the presence of SLS therefore indicating an increase in the ability of drilling mud to carry cuttings.

Chart 4, 5 and 6 indicate gel strength, mud filtrate and mud cake thickness, respectively. These are the properties which are not affected by the presence of Sodium Lignosulphonate.

SLS has a significant effect on differential sticking coefficient and lubricity coefficient of the drilling mud indicated by chart 7 and 8, respectively. There is a decrease in both the properties which is beneficial since differential sticking is not desired during drilling and the recommended lubricity coefficient is less than 0.15 (API recommended). Since the lubricity coefficient is less the lubricity of the drilling mud will be higher.

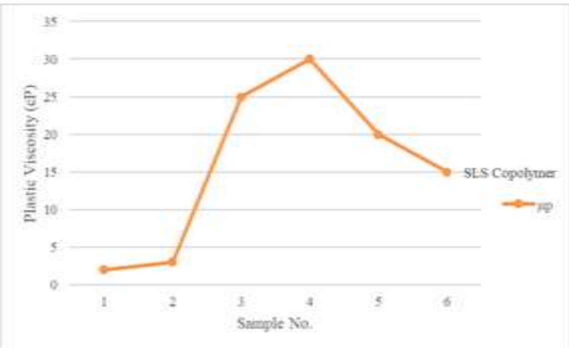

Chart -1: Comparison of plastic viscosity

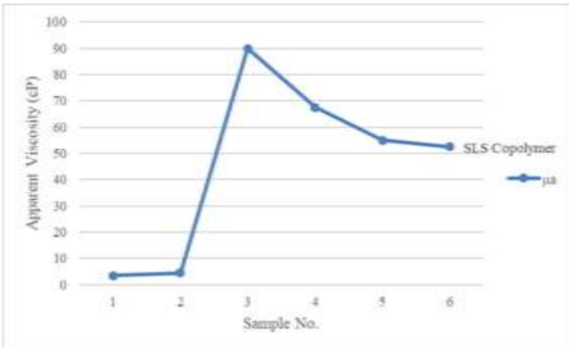

Chart -2: Comparison of Apparent viscosity

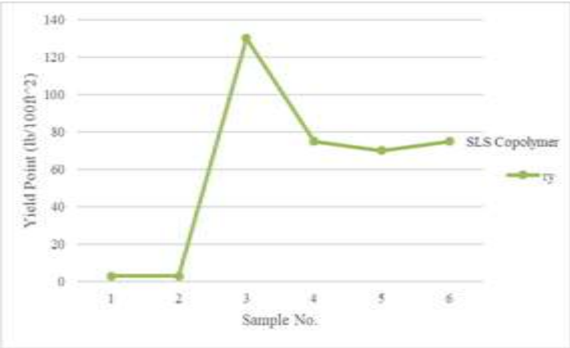

Chart -3: Comparison of Yield point

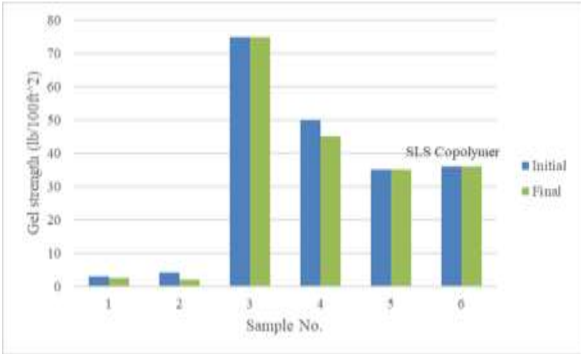

Chart -4: Comparison of Gel strength

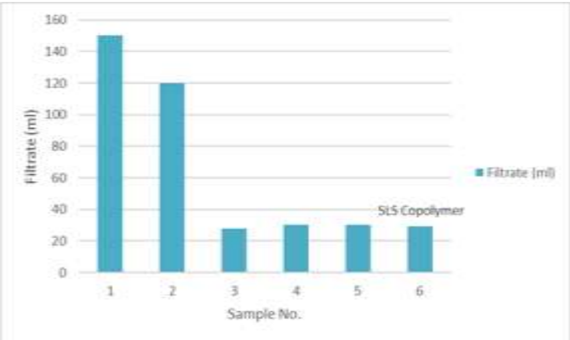

Chart -5: Comparison of Mud filtrate

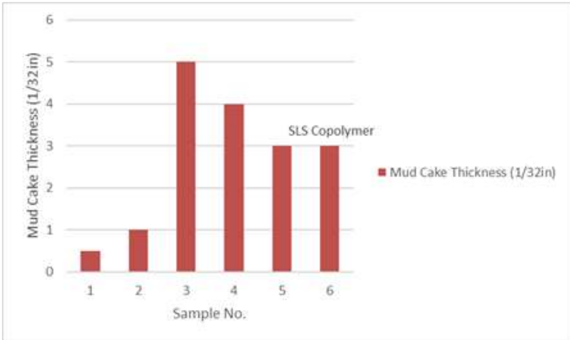

Chart -6: Comparison of mud cake thickness

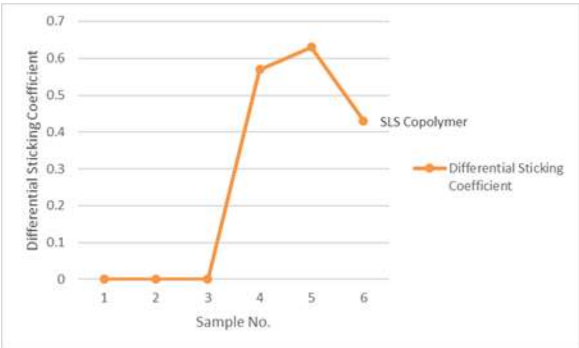

Chart -7: Comparison of Differential sticking coefficient

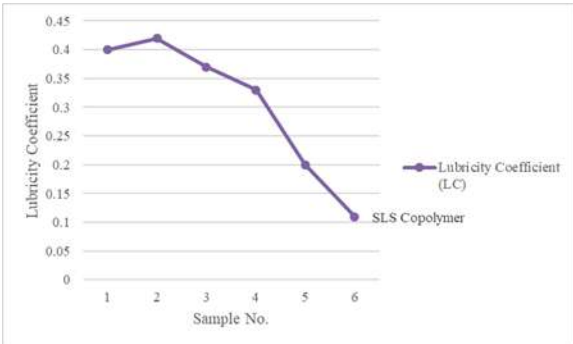

Chart -8: Comparison of Lubricity coefficient

ACKNOWLEDGEMENT

We would like to express immense gratitude towards our department and university for helping us with our project and a sincere thanks to the supervisor, Mr. Bhairab Jyoti Gogoi, Assistant Professor, Department of Petroleum Engineering who supported and guided us throughout. We are also thankful to Dr. Suman Paul, Head of the Department of Petroleum Engineering and to all the faculties and staff of Petroleum Department.

REFERENCES

[1] Ibrahim, Mohamad & Idris, Azreena & Mohamad Yusof, Nor Nadiah & Saaid, Ismail. (2006). Lignin Graft Copolymer as a Drilling Mud Thinner for High Temperature Well. Journal of Applied Sciences. 6. 10.3923/jas.2006.1808.1813.

[2] Gunanto, Sudarmoyo & Swadesi, Boni & Andini, Aulia & Siregar, Septoratno & Kurnia, Rani & Buhari, Ari & Budiaman, I Gusti. (2018). Laboratory study: The development of a sodium lignosulfonate (SLS) surfactant formulation for light oil reservoir to improve oil recovery. AIP Conference Proceedings. 1977. 030033. 10.1063/1.5042953.

[3] Caenn, R., Darley, H. C., & Gray, G. R. (2017). Composition and properties of drilling and completion fluids. Cambridge, MA: Gulf Professional Publishing, an mprint of Elsevier. K. Elissa, "Title of paper if known," unpublished.