International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Influence of Common Weighing Agents on Rheological Behaviour of Drilling Mud

Venkata Swamy Nalajala, K.Rajesh Kumar, Venkata Ramana Avula

Abstract: ***Drilling fluid or mud is essential fluid in drilling operation which has many important properties and one of the important properties is the viscosity of the drilling fluid and the viscosity is further classified as yield viscosity and plastic viscosity which means different in terms of its function. This paper is attempting to show the rheological characteristics of the different samples of the drilling fluid using Xanthan Gum and Physillum husk and different weighting agents Barite and Calcium Carbonate at ambient conditions. The results showed that xanthan gum acts as good viscosifying agent as compared with physillum husk. In addition that, the water based drilling mud with barite which act as weighing agent proved better as compared with calcium carbonate. The following paper will be valuable to the graduates, future graduates and also to the Industry personnel have a basic idea about the rheology and how the parameters related to the rheology are valuable in mud design.***

Keywords: Additive, Drilling fluid, Rheology, Weighing Agent.

I. INTRODUCTION

Drilling fluid or mud act as most important fluid in drilling operation as the features involved in using the drilling fluid have many, such as it optimizes the rate of penetration, it cools the drilling bit, it suppresses the formation pressure, and it brings the rock cuttings via circulation of drilling mud from the drill pipe to the annulus between the pipe and the formation[1]. This paper is concerned about the rheology of the drilling mud that is yield point and the plastic viscosity. Since yield viscosity has an important factor which is needed to be maintained the suspension of drill cuttings when the drilling operation is stopped. If not the rock cuttings would fell down either the problems can come of the stuck up pipe problem or again the drilling fluid should be circulated which leads to the investment of power and hence to the investment of the money. This paper is concerned about the rheology of the drilling mud that is yield point and the plastic viscosity. Since yield viscosity has an important factor which is needed to be maintained the suspension of drill cuttings when the drilling operation is stopped.

Manuscript published on November 30, 2019.
* Correspondence Author
Venkata Ramana Avula*, Department of Petroleum Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram-522502, Andhra Pradesh, India.
Venkata Swamy Nalajala, Department of Chemical Engineering, Vignan's Foundation for Science, Technology and Research, Vadlamudi, Guntur (Dist.), Andhra Pradesh, India.
K. Rajesh Kumar, Department of Petroleum Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram-522502, Andhra Pradesh, India.

This paper is concerned about the rheology of the drilling mud that is yield point and the plastic viscosity. Since yield viscosity has an important factor which is needed to be maintained the suspension of drill cuttings when the drilling operation is stopped. If not the rock cuttings would fell down either the problems can come of the stuck up pipe problem or again the drilling fluid should be circulated which leads to the investment of power and hence to the investment of the money. the plastic viscosity which acts when the drilling fluid is in motion means when the drilling mud is in circulation and the drilling activity is continued out [2-3]. Since, drilling mud used in drilling operation is a mixture of clay and fluid and other additives are mixed to get the required property needed. In this work, the rheological experiments are carried for different drilling fluids (nine samples) and characterized.

II. EXPERIMENTAL PROCEDURE

The experiment is performed using normal drilling fluid in which the addition of clay is done about 8 percent of the solution by weight, and the Xanthan Gum and Physillum husk along with most common weighting agents, namely, barite and calcium carbonate are mixed separately to the different sample of the drilling fluid and the rheological parameters are observed. Further rheological fluid control agents such as caustic soda for pH control, poly-sal for filtration control, and XC-polymer for viscosity control are added [4-6]. The mud weight is measured by mud balance unit. The pH value of drilling fluid is recorded by the electronic pH meter. The equipment, Fann G Viscometer which gives the dial reading at 600 rpm and 300 rpm of drilling fluids. The obtained readings from Viscometer are used to calculate rheological parameters namely, yield point and plastic viscosity. Further, the data are used to examine the drilling mud behavior for different non Newtonian fluids. Nine drilling fluid samples are prepared which consists of three of Xanthan gum, three of Physillum husk and three of Barite. These Nine samples are presented in the paper through Table 1 which explains the composition of each and every component by weight. Also, two samples of drilling fluid used indicated in Table 2 to analyse the rheology of fluid with the addition of barite and calcium carbonate separately. Here the density of water is taken as 1.0 g/cc. The observed viscometer dial readings at 600 rpm and 300 rpm along with rheological properties of nine samples are reported in Table 3. Mixing additive Xanthan gum about 0.5gm, 0.6gm, 0.7gm the observed value is presented. Similarly Physillum husk is mixed in different composition and the readings are observed. Also barite and calcium carbonate which are weighing agents are added separately to study the mud rheological properties in presence of weighing agents as shown in Table 4.

III. RESULTS AND DISCUSSION

It is observed that the sample-3(S3) showed more yield point and plastic viscosity as compared with other samples as shown in Table-3. This is due to the Xanthan gum influence on water based drilling mud which can act as effective viscosfier. Further, the samples from one to three indicates that the effect of Xantham gum, from four to six indicates that effect of Physillum husk and from seven to nine indicates that effect of weighing material i.e. barite in a drilling mud. A high yield point of drilling mud (S3) represent a non-Newtonian fluid and carries cuttings from bottom of well bore to surface enhanced than that of fluid (S1) of equal mud weight (8.8ppg as shown in table-3) but the lower yield point. Similarly, the plastic viscosity of the sample-3 (S3) is high, which represent, by more resistance caused to flow of drilling fluid. This is property of drilling mud that must be maintained within the effective drilling design limits. It is noted that, the plastic viscosity of samples from seven to nine is increased, but yield point is decreased, which represents the lifting capacity of drill cuttings low but fluid movement is high. Also, the density of the mud (sample from seven to nine) increased due to weighing material (barite) is added it. In Table-4 represents the drilling mud rheological properties of different weighting materials, i.e. barite and calcium carbonate. The drilling mud with barite showed better rheological behaviour than drilling mud with calcium carbonate. This is due to friction within the drilling mud that causes the interaction between solids, the liquids and the deformation of liquid (i.e. shear stress) is more in case of barite.Fig.1 indicates that the shear stress versus shear rate curve for nine samples. The sample-3 showed more shear stress with respective shear rate among nine samples. The behaviour of all samples showed as non-Newtonian fluid. In Fig.2 indicates that the shear stress versus shear rate curve for sample-A and sample-B. The sample-A showed more shear stress than sample-B which is non-Newtonian behaviour. Table- I: Nine drilling fluid samples (S1-S9) are prepared in varying densities using Xanthan gum, Physillum husk and Barite separately in varying amounts

	S1	S2	S3	S4	S5	S6	S7	S8	S9
Water (ml)	322	322	322	322	322	322	322	322	322
Bentonite (gm)	28	28	28	28	28	28	28	28	28
Xanthan Gum (gm)	0.5	0.6	0.7	-	-	-	-	-	-
Physillum husk (gm)	-	-	-	0.5	0.6	0.7	------	------	------
Barite	-	-	-	-	-	-	19	32	48
(gm)									
Caustic Soda (gm)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Soda Ash (gm)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Poly e-sal (gm)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table- II: Representing the Drilling fluid with different weighting agents

Components	Sample A	Sample B
Water	325 ml	325 ml
Bentonite	25 gm	25 gm
Barite	-------	205.0
Calcium Carbonate	300 **gm**	------
Caustic soda	0.2 gm	0.2 gm
Soda Ash	0.25 gm	0.25 gm
Poly- Sal	0.40 gm	0.40 gm
XC Polymer	1.0 gm	1.0 gm

Table III: Calculated rheological parameters for nine fluid samples (S)

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9
Q_{600}	120	174	185	27	34	39	92	70	99
Q_{300}	108	155	162	21	25	28	58	43	65
Yield point (Y.P) = Q_{600} - Q_{300}	96	140	139	15	16	17	24	16	31
Plastic viscosity = Q_{300} - Y.P	12	15	23	6	9	11	34	27	34
Mud weight (ppg)	8.75	8.8	8.8	8.75	8.8	8.8	9.0	9.2	9.6
pH	7.5	7.7	7.8	7.4	7.4	7.45	7.6	7.6	7.6

Table 4: Drilling fluid rheological properties for different weighing materials

Parameters	Sample A	Sample B
Q_{600}	330	148
Q_{300}	235	95
Yield Point	140	42
Plastic viscosity	95	53
Mud weight	9.85(lb/gal)	10.2(lb/gal)
pH	7.8	7.92

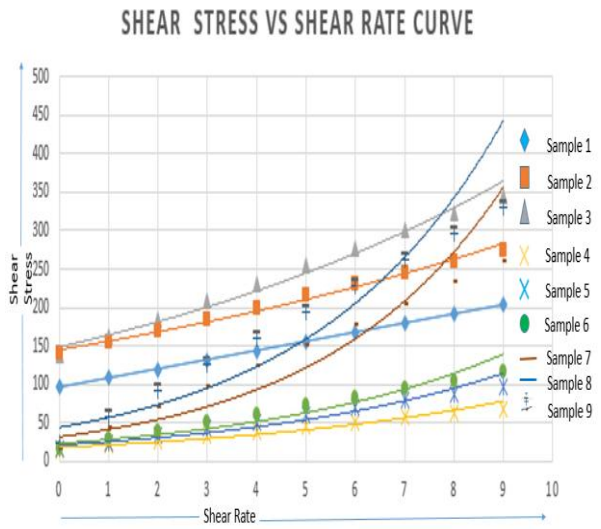

Fig. 1: The Shear Stress vs Shear Rate curve for the nine samples

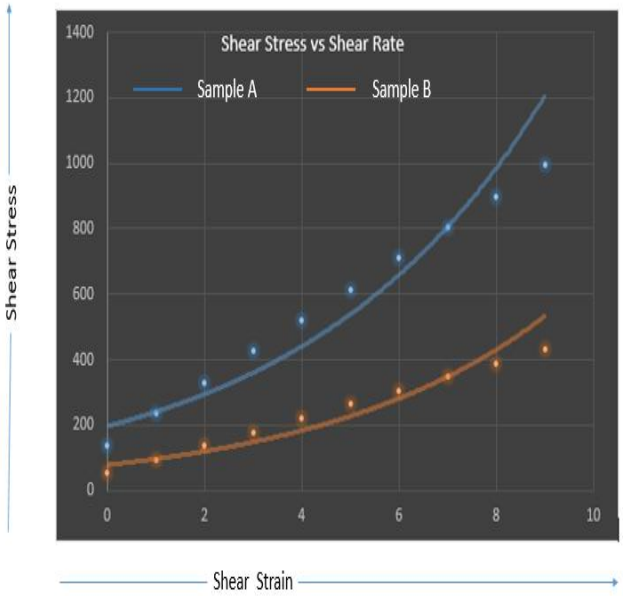

Fig. 2: Shear Stress vs Shear Rate curve for the sample A & Sample B

Sample A is indicated by blue points which is drilling fluid consists of barite as a weighting agent. Sample B is indicated by orange points which is drilling fluid consists of calcium carbonate as a weighting agent.

IV. CONCLUSION

In this work, the rheological experiments are conducted for nine samples which consists of water based drilling fluid with different viscosifying agents and varying amount of barite and calcium carbonate additives. It is observed conclusions from the experimental work as follows

i) It is found that the Xanthan Gum which is a viscosifier gives good viscosity at the same amount in comparison to the Physillum husk.

ii) In case of drilling fluid analysation of the rheological properties for weighting materials it is found that the barite gives a good viscosity than the calcium carbonate

REFERENCES

1. M. Benna, N. Khir-Ariguib, A. Magnin, and F. Bergaya, "Effect of pH on the rheological properties of purified sodium bentonite suspensions," J. Colloid Interface Sci., 1999, 218, pp. 442–455.
2. P. R. Kumar, V. Madhusudhanrao, B.N. Rao, M. Venkateswarlu, and N. Satyanarayana, "Enhanced electrochemical performance of carbon-coated $LiMPO_4$ (M = Co and Ni) nanoparticles as cathodes for high-voltage lithium-ion battery", Journal of Solid State Electrochemistry, 2016, 20, pp. 1855–1863
3. Narsimulu, B.N. Rao, M. Venkateswarlu, E.S Srinadhu, and N. Satyanarayana. "Electrical and electrochemical studies of nanocrystalline mesoporous $MgFe_2O_4$ as anode material for lithium battery applications", Ceramics International, 2016, 42, pp 16789-16797.
4. K. Hari Prasad, N. Naresh, Nageswara Rao, M. Venkateswarlu, and N. Satyanarayana, "Preparation of $LiMn_2O_4$ Nanorods and Nanoparticles for Lithium-ion Battery Applications", *Materials Today: Proceedings*, 3(10), 2016, pp 4040-4045.
5. M.S. Sudhir, P.M Mohan, and R.V. Nadh, "Simple and validated ultraviolet spectrophotometric method for the estimation of Febuxostat in bulk and pharmaceutical dosage forms", Oriental Journal of Chemistry, 29(1), 2013, pp 235-240.
6. G. Suresh, R. Venkata Nadh, N. Srinivasu, and N.K. Kaushal. "Novel coumarin isoxazoline derivatives: Synthesis and study of antibacterial activities", *Synthetic Communications*, 46(24), 2016, pp 1972-1980.

AUTHORS PROFILE

Venkata Ramana Avula received his PhD from Madras in 2016. He is currently working in KL University since 2016. His main areas of research interest are prediction of gas hydrate phase equilibrium conditions using thermodynamic models and rheology of drilling fluids.

Venkata Swamy Nalajala is currently working in Vignan University. He obtained B. Tech from VEC vadlamudi, M.Tech and PhD from IIT Guwahati. He is currently working in synthesis of nanomaterials and drilling fluids.

Kodi Rajesh Kumar is currently an assistant professor in the department of Petroleum Engineering at KL University and working in drilling fluids.