Effect of Nanoparticles on the Filter loss of an Ester based Drilling Fluid

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Abstract
In this study the effect of nanoparticles (bentonite based nanoclay) on the filtration loss property in a homogenized ester based drilling fluid (60% ester, 40% water, 1% UH-biosurfactant) was investigated. The rheological properties studied included the plastic viscosity and yield strength and the nanoclay content in ester was varied up to 1.5%. It was found that nanoclay increased the yield stress compared to the plastic viscosity. The fluid loss reduced by over 90% with 0.5% Nanoclay. Also, the electrical resistivity reduced with an increase in concentration nanoclay addition. Also, the electrical resistivity reduced with an increase in nanoclay content.

1. Introduction

Since several decades, oil based drilling fluids have been used due to the various advantages they offer. Due to strict EPA (Environmental Protection Agency) standards and environmental safety constraints, there is an urgent need to develop an eco-friendly drilling fluid which would cause less harm to the environment during and after its use while disposing unlike the oil based muds which generally contain diesel oil or mineral oil (Nasser J. et al., 2013). Also, oil based drilling fluids have high initial cost and environmental safety concerns. Since the 1930s, ester based drilling fluids are very popular due to their high bio-degradability, low toxicity and also their excellent performance in the field. One of the major concerns with the synthetic based muds is excessive fluid loss (Agarwal S. et al., 2012). Hence there is interest in better quantify the effect of a new additive on the flow properties of the ester drilling fluid.

2. Objective

The objective of this study was to investigate the effect of bentonite based nanoclay on the fluid loss and electrical properties of an ester based drilling fluid homogenized by UH-biosurfactant (60% ester, 40% water, 1% UH-biosurfactant).

3. Materials and Methods

The base fluid ester used to make the drilling fluid was synthesized using Soybean oil and methyl alcohol (SM). The control sample of ester based drilling fluid had 40% water and 60% ester and 1% UH-biosurfactant by weight of ester. Bentonite based nanoclay was added as a percentage by weight of ester content in the drilling fluid and was varied up to 1.5%. The fluid loss was measured using standard HPHT device. The electrical resistivity of every sample was measured by using a digital resistivity meter.

4. Results and Discussions

As shown in Fig.1, the filtration loss decreased by over 90% with 0.5% nanoclay content, indicating that the nanoclay interacted with the ester. Also an increase in the YP/PV ratio was observed. Based on these results the critical concentration of nanoclay for this ester based drilling fluid can be assessed.

Table.1. Rheological properties of SM with varying concentration of nanoclay (NC)

%NC	PV (cP)	YP ($lb/100ft^2$)	YP/PV	GS 10sec ($lb/100ft^2$)	GS 10min ($lb/100ft^2$)	Resistivity (Ωm)	30 mins fluid loss (mL)
0	26.5	8.5	0.3	4	5	504.0	73
0.5	27.7	20.6	0.7	9	10	68.1	5.25
1	29.3	29.5	1.0	12	12	42	5
1.5	25.6	28.0	1.1	11	11	24	11

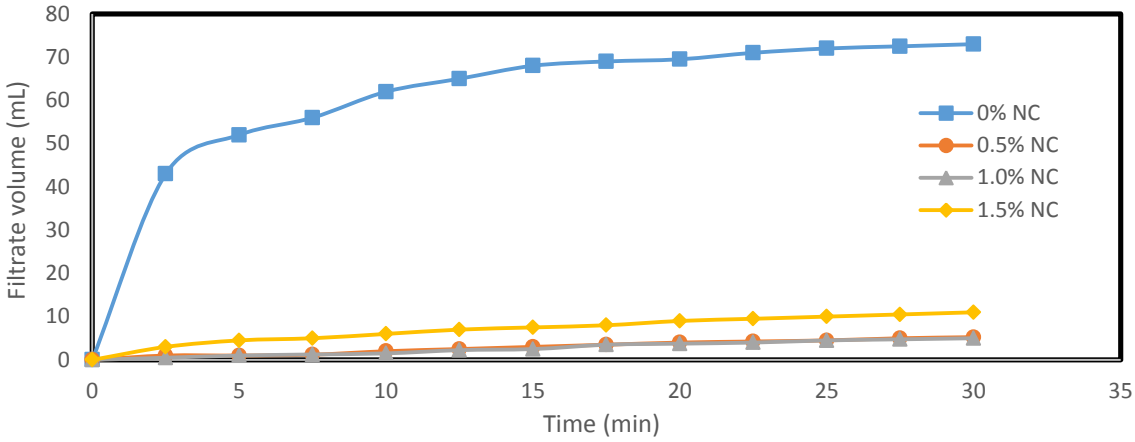

Fig.1. Variation of filter loss of ester based drilling fluid SM

5. Conclusion

Nanoclay affected the filtration loss of the proposed ester based drilling fluid system. A very low percentage of 0.5% of nanoclay in ester based drilling fluid reduced the fluid loss by over 90%. Addition of nanoclay also showed an increasing effect on the YP/PV ratio which determines the stability of the drilling fluid. The electrical resistivity reduced considerably with the addition of nanoclay. It was found that a critical concentration of 1% nanoclay gave the best rheological and fluid loss results for the proposed material.

6. Acknowledgement

This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT), University of Houston, Houston, Texas with funding from the Ultra Deepwater Program DOE/NETL/RPSEA (Project No. 10121-4501-01).

7. References

1. J. Nasser, A. Jesil, T. Mohiuddin, M. A. Ruqeshi, G. Devi and S. Mohataram, “Experimental Investigation of Drilling Fluid Performance as Nanoparticles”, World Journal of Nano Science and Engineering, 2013, 3, 57-61.

2. S. Agarwal, T. X. Phuoc, Y. Soong, D. Martello and R. K. Gupta, “Nanoparticle Stabilised Invert Emulsion Drilling Fluids for Deep-Hole drilling Of Oil and Gas”, The Canadian Journal of Chemical Engineering, Volume 9999, 2012.

3. J. Abdo and M. D. Haneef, “Nanoparticles: Promising solution to overcome stern Drilling Problems”, NSTI-Nanotech-Vol 3, 2010.