# Modeling the Effect of Nanoclay on the Fluid Loss of Drilling Mud

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**Abstract:** In this study, the effect of nanoclay on the fluid loss in a water based drilling mud was investigated. The nanoclay content was varied up to 1% (by weight of water). The nonlinear relationship between the fluid loss with the time was influenced by the nanoclay content. Hyperbolic constitutive model relationship was used to predict the relation between fluid loss and time at room temperature.

## 1. Introduction

Since of the nanoparticles are extremely small in size, nanoparticles are preferred to be used in drilling mud design as their abrasive forces are negligible with less kinetic energy impact. In addition to all advantage of using nanoparticles in mud design it is safer than conventional mud from the point of environmental view. Nanoclay was added to the mud in small amounts, up to a concentration of 1%. Nano-based drilling muds could be the fluid of choice in conduction drilling operations in sensitive environments to protect other natural resources (Amanullah et al. 2009). Typically nanoclay particles are in the range of 1 to 100 nm. The nanoclay is supposed to go in between the larger particles and block the flow through them. During the past decade the nanomaterial has been used to improve the performance and functionality of a variety of engineering materials (Nazzal et al. 2013). In this study, controlling filtration properties of nanoclay drilling mud was tested and quantified.

## 2. Objectives

The overall objective was to quantify the nonlinear fluid loss – time relationships of the drilling mud with varying amount of nanoclay at room temperature.

## 3. Methods and Materials

Nanoclay was used in preparing the drilling muds. Various amounts of nanoclay were mixed with fresh water using a blender. In this study, HTHP fluid loss device was used. The equipment designed for this purpose includes a heating jacket (with a bimetallic thermostat), a cell to contain the fluid, a means to pressurize the cell, and a means of collecting filtrate. Test results indicated the fluid temperature met the targeted test temperature within the API-recommended one hour heat-up period for the 500 mL HTHP cell.

The filtrate volume was measured according to API specification 13A Eqn.1.

$$\text{Filtrate volume (FL) mL} = 2 * Vc \quad \text{..... (1)}$$

Where Vc= volume filtrate collected between 7.5 and 30 minutes. The pressure used was 100 psi. The average of thickness of filter cake at the end of the test was measured using a Vernier caliper.

## 4. Results and Analysis

Increasing the nanoclay content in the drilling mud decreased the fluid loss of the drilling muds. Addition of 0.2%, 0.6% and 1% of nanoclay, the filter loss for 30 min were 68 mL, 26 mL and 10 mL respectively as shown in Fig. 1. Long – term fluid loss for 0.2% nanoclay drilling mud was 140 mL and when the nanoclay content was increased to 1% the fluid loss was 50 mL, about a 60% decrease. The relationship between fluid loss and time was nonlinear. Based on the inspection of the test data following relationship is proposed (Vipulanandan et al. 2014).

$$FL = \left(\frac{t}{A+B*t}\right) \quad \text{..... (2)}$$

A and B are model parameters and are summarized in Table 1, t: is the time (min.). The model

predications are compared to the experimental results in Fig. 2.
The filter cake thickness of the drilling mud using nanoclay increased by 75% with increasing the nanoclay content from 0.2% to 1% as shown in Fig.3.

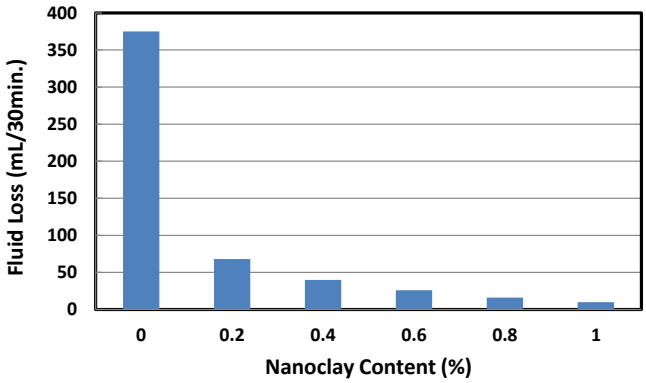


**Figure 1. API Fluid Loss versus Nanoclay Content**

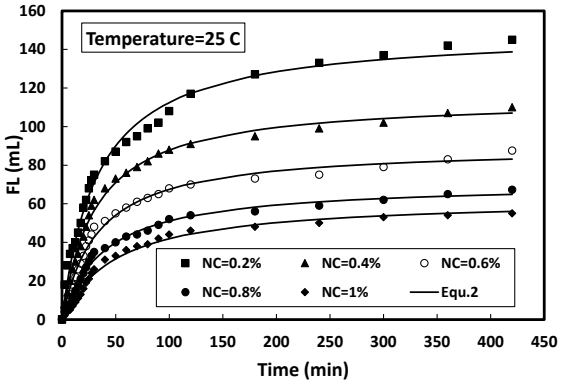


**Figure 2. Predict Fluid Loss versus Time for Drilling Mud with different percentage of Nanoclay**

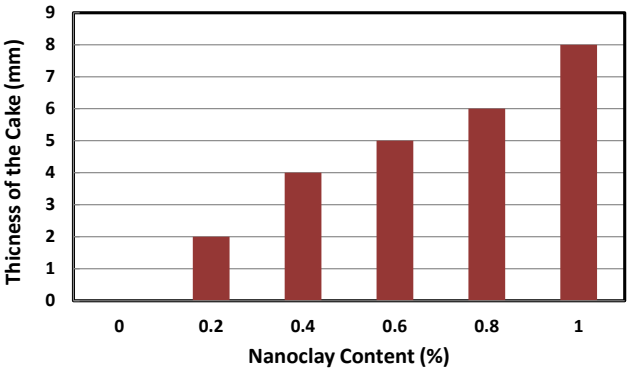


**Figure 3. Thickness of Filter Cake versus Nanoclay Content**

**Table 1. Model Parameters**

| NC (%) | A | B | $R^2$ |
|---|---|---|---|
| **0.2** | 0.222 | 0.007 | 0.98 |
| **0.4** | 0.270 | 0.009 | 0.99 |
| **0.6** | 0.368 | 0.011 | 0.99 |
| **0.8** | 0.549 | 0.014 | 0.99 |
| **1.0** | 0.794 | 0.016 | 0.98 |

## 5. Conclusions

Based on this study, fluid loss of the drilling mud decreased with increasing nanoclay content. Also the filter cake thickness increased with increasing the amount of nanoclay. Based on the coefficient of determination ($R^2$) the hyperbolic relationship predicated experimental data very well.

## 6. Acknowledgements

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## 7. References

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