

# The Effect of Nano- Sepiolite and Attapulgite on the Tribological Properties of Drilling Fluids

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The effects of adding nano additives to water-based drilling fluids (WBDFs) mainly nano-sepiolite NSP and nano-attapulgite NAT on the coefficient of friction (COF) of DF and the wear of the casing due to drillstring (DS) and casing contact were examined. Results showed that using sepiolite and attapulgite in nano-form, 4 wt. % and a size distribution between 30-60 nm have improved the stability of the WBDFs rheology, and significantly decreased the COF of the WBDFs and the DS wear. It was observed that NSP additives have better improved the WBDF COF and DS wear compare to NAT additives.

**Keywords:** Tribological properties of drilling fluids, Nano-sepiolite, Nano-Attapulgite, COF, Wear

## 1. Introduction

Drilling efficiency involves attaining certain drilling fluids (DF) rheology and tribological properties that are stable and perform well for the entire well depth which include extremely increasing in temperature and pressure in addition to a great change in formation. In this study the tribological properties of nano-enhanced WBDFs were examined experimentally. The effects of adding nano additives to WBDFs mainly NSP and NAT on the COF of DF and the wear of the casing due to DS and casing contact were examined. Figure 1 shows a schematic of a contact between the casing and the DS.

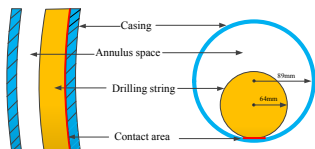


Figure 1- Contact between the casing and the DF

## 2. Method

NSP and NAT were prepared and added to the WBDFs. Lubricity and COF tests for the NSP and NAT modified WBDFs were performed utilizing OFIT instrument. Lubricity is a measure of COF between a moving part and a surface in contact with the part. The lower the COF, the greater the lubricity. The wear tests were performed using a pin-on-disk tribometer. Wear rates of specimens immersed in various WBDFs modified NSP and NAT content were examined.

## 3. Results and discussion

### 3.1. Effects of NSP and NAT on and COF of WBDFs.

The variation of WBDFs COF for samples containing 2 wt. %, 3 wt. %, 4 wt. %, and 5 wt. % of NSP and NAT nanoparticles with test time are shown in Figures 2A and B. The COF decreases significantly as NSP wt.% and the in NAT wt.% in WBDFs increased from 0 to 4 wt. % and the decrease is no longer obvious as the NSP wt.% and NAT wt.% increased from 4 to 5 wt. %. Therefore, the lubrication performance of the WBDFs increases as the

NSP and NAT content increases. Comparing the results in figures 2A and B, it can be noticed that both NSP and NAT reduced the COF, however, it was observed that NSP additives have better improved the WBDF COF and DS wear compare to NAT additives by about 10%.

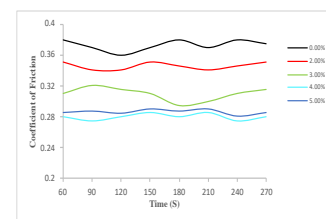
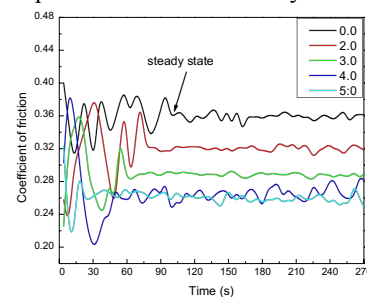


Figure 2- Variation of the COF of WBDFs with adding 0, 2, 3, 4 and 5 wt. % nanoparticles and test time. A) NSP and B) NAT

### 3.2 Effects of NSP and NAT on the Wear of the Casing

The change in wear rate with NSP and NAT of 1 wt. %, 2 wt. %, 3 wt. %, 4 wt. % and 5 wt. % were investigated. Results show that when NSP ratio increased from 0 to 1, there was a significant decrease in wear rate and the decrease slows down as NSP ratio increases from 3 to 4. The wear rate is almost steady as NSP ratio continues to increase from 4 wt. % to 5 wt. %. Almost same trend was exhibited when NAT was tested under the same ratios, however, the wear rate was higher.

## 4. References

- [1] J. Abdo, and M.D. Haneef, Clay nanoparticles modified drilling fluids for drilling of deep hydrocarbon wells. *Applied Clay Science*, 2013. 86: p. 76-82.