

# Eco-Friendly Approach to Enhancing Drilling Fluids properties: A Study of Titanium Dioxide Nanoparticles

## Introduction

The drilling fluid plays a vital role in the drilling operations, whereas an efficient drilling fluid can provide a very sufficient drilling operation, drilling fluid with appropriate rheological properties and a filtration rate can be used for various of sections of the drilled oil well. In this research Titanium Dioxide Nanoparticles will be added to the drilling mud used in the deep wells and experimentally tested on laboratory equipment's used in the current industry.

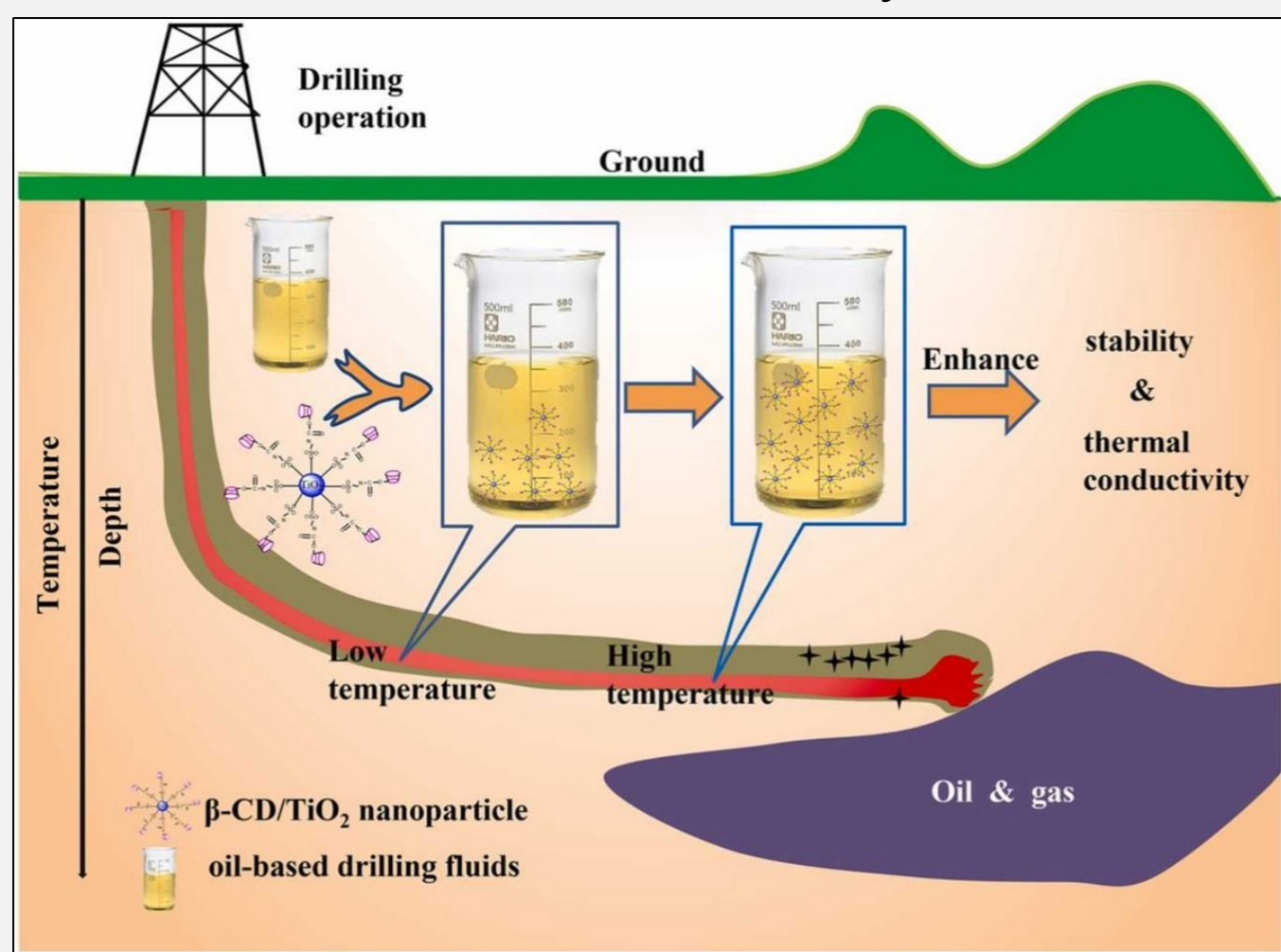


Fig. 1. Application of Titanium Dioxide Nanoparticles

## Statement of the Problem

Nanoparticles (NPs) as a nanotechnologies unit have a huge potential for improving drilling fluids. However, the role of NPs in this field is still in its infancy and consequently has attracted much more attention in the last years. Despite the potential benefits of using TiO<sub>2</sub> nanoparticles in drilling fluids, there is limited research on their effectiveness in enhancing the rheological properties of drilling fluids at elevated temperatures. Moreover, the effect of TiO<sub>2</sub> nanoparticles on the filtration and fluid loss properties of drilling fluids is not well understood. Therefore, this study aims to investigate the impact of TiO<sub>2</sub> nanoparticles on the rheological properties, filtration control, and fluid loss of drilling fluids at high temperatures. The findings of this study could contribute to the development of environmentally friendly drilling fluids that can withstand the high temperatures encountered in deep drilling operations while maintaining their rheological and filtration properties.

## Literature Review

- (Hoelscher et al., 2012) Nanoparticles improve the mechanical, thermal, electrical, and chemical properties of drilling fluids. Their small size enhances hydrodynamic behavior and makes them ideal for fluid property enhancement in oil and gas operations.
- (Rafati et al., 2018) Nanoparticles reduce frictional resistance in boreholes, enhance torque and drag control, and increase the thermal conductivity of drilling fluids, improving heat transfer especially in HPHT conditions.

## Objectives

1. Critically study and evaluate the properties of Titanium Dioxide nanoparticles and their previous implementation in drilling fluids.
2. Identify the characteristics of rheological properties of the water base mud under downhole condition experimental conditions.
3. Experimentally examine the rheological properties of water base mud after adding Titanium Dioxide nanoparticles under downhole condition experimental conditions.
4. Critically assess the effects of using Titanium Dioxide nanoparticles on the environment.

## Academic Innovation & Benefits to Oman

Developing sustainable, high-performance drilling fluids is vital for safe and cost-effective operations. Traditional fluids struggle in high-temperature environments and pose environmental risks. Incorporating TiO<sub>2</sub> nanoparticles enhances thermal stability, filtration control, and efficiency. This study offers scientific insights into nanoparticle-enhanced WBM for HPHT applications. The findings support broader innovation in nanotech across the energy sector. Incorporating TiO<sub>2</sub> nanoparticles in drilling fluids enhances thermal stability, filtration control, and drilling efficiency in HPHT wells. This supports increased oil and gas production in Oman, boosting national revenue. Environmentally, it enables the development of eco-friendly fluids, aligning with emission reduction goals. Technologically, it drives innovation in safer, more advanced drilling methods. Scientifically, it contributes to Oman's knowledge base in nanotechnology and materials research.

Table 1. Drilling Fluid Composition & Mixing Parameters

Component	Amount	Mixing Time	Purpose
Fresh Water	300 ml	-	Base fluid
Caustic Soda	0.25 g	2 min	pH adjustment
Sodium Chloride (NaCl)	91 g	10 min	Density & inhibition
Xanthan Gum	1 g	10 min	Viscosity modifier
Starch	3.5 g	10 min	Fluid loss control
<b>TiO<sub>2</sub> Nanoparticles</b>	<b>3, 6, or 9 g</b>	10 min	Nano-enhanced rheology
Calcium Carbonate (CaCO <sub>3</sub> )	17.5 g (6.5 ml)	10 min	Bridging agent
Barite	17.5 g (4 ml)	10 min	Weighting agent
Salt (additional)	- (35 ml volume)	-	Additional density/inhibition
<b>Final Volume</b>	<b>350 ml</b>	-	API Standard
<b>Water Used</b>	<b>304.5 ml</b>	-	Adjusted after solids

## Preliminary Results

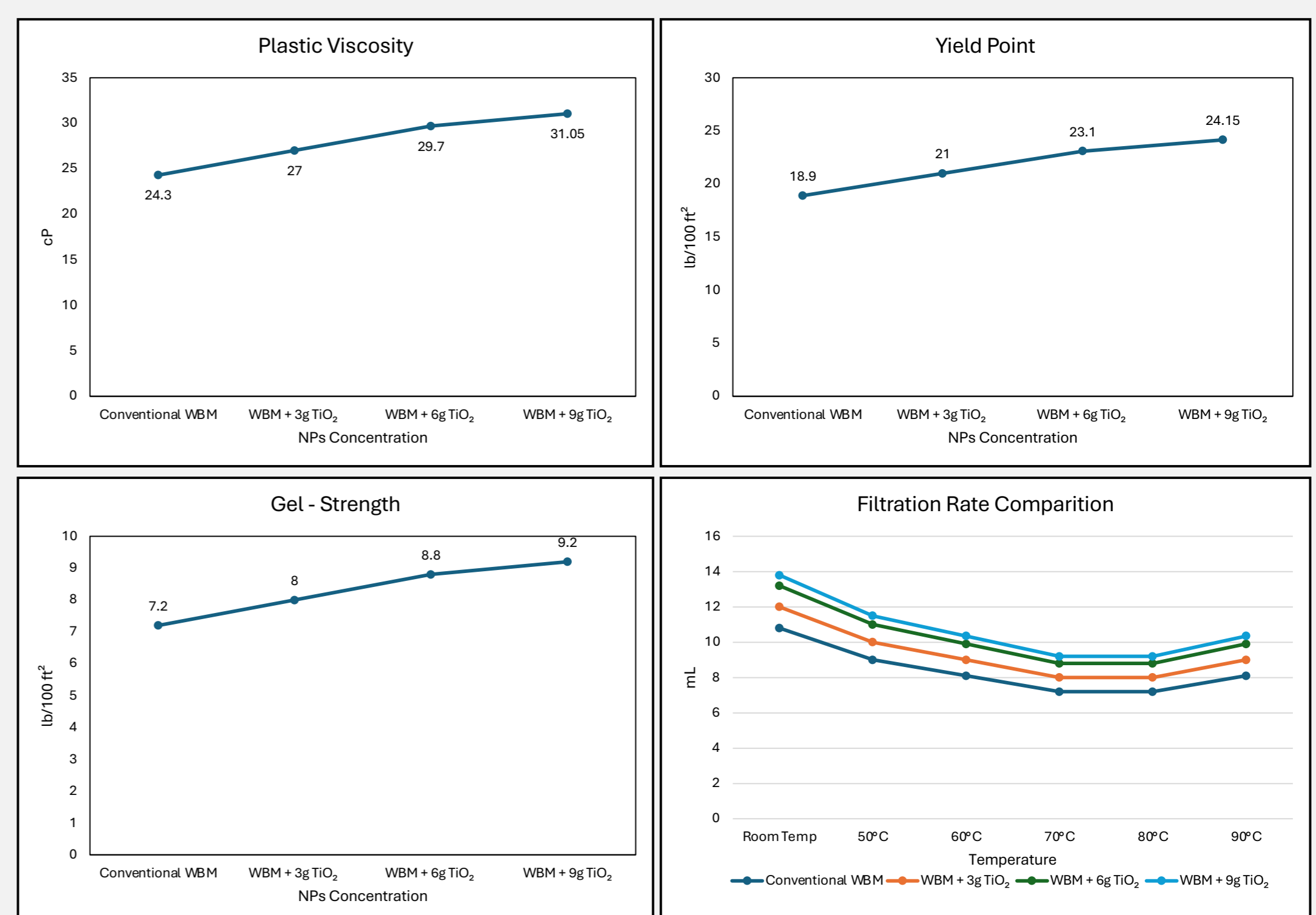


Fig. 2. Preliminary result TiO<sub>2</sub> nanoparticles

## References

- Hoelscher, K.P., De Stefano, G., Riley, M. and Young, S., 2012, June. Application of nanotechnology in drilling fluids. In *SPE international oilfield nanotechnology conference and exhibition*. OnePetro.
- Rafati, R., Smith, S.R., Haddad, A.S., Novara, R. and Hamidi, H., 2018. Effect of nanoparticles on the modifications of drilling fluids properties: A review of recent advances. *Journal of Petroleum Science and Engineering*, 161, pp.61-76.