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The effect of hydroxyapatite nanoparticles on wettability and brine-oil interfacial tension as enhance oil recovery mechanisms

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ABSTRACT

A novel concept of utilizing nanoparticles (NPs) to boost oil recovery and reduce entrapped oil in hydrocarbon reservoirs is being explored. The use of nanofluids (NFs) flooding to change wettability and reduce interfacial tension (IFT) between oil and water has been shown to be highly effective in experiments. Preparation and modification methods influence the performance of NPs. The application of hydroxyapatite NPs (HAP) in EOR has yet to be investigated. HAP was synthesized in this study using the co-precipitation method and in-situ surface functionalization with Sodium Dodecyl Sulphate SDS to visualize it effect on IFT reduction and wettability alteration under different salinity and temperature settings. To confirm the synthesis of HAP, zeta potential (ZP), Fourier transform infrared spectroscopy (FTIR), Particle size analysis (PSA), Transmission electron microscopy (TEM), and Energy dispersive X–ray (EDX) spectra were used respectively. According to the results, HAP was produced, and the particles were finely distributed and stable in aqueous solution. When the pH was altered from 1 to 13, the particles' surface charge rose from -5mV to −27mV, showing long-term stability in EOR processes. At salinity range from 5000 ppm to 30,000 ppm, and under temperature range from 25°C to 80°C, the HAP NFs changed the wettability of sandstone core from oil–wet at 111.7° to water–wet at 9.0°. In addition, at 0.1 wt% HAP concentration, the IFT was lowered to 3 mN/m. As a result, the HAP NF proved very effective in reducing IFT and altering wettability under both low and high salinity environments, and it is thus suggested for EOR operations.

1. Introduction

Crude oil is one of the most important existing fuel sources, accounting for more than 33% of total global energy consumption (Gielen et al., 2019). Indeed, it is expected that global energy demand will increase by 50% over the next 30 years, compared to its current level (Yarima et al., 2022). Due to the current scenario, it is more important than ever to enhance oil output. Primary oil recovery technologies have increased oil production by allowing crude oil to migrate towards the production well without being stimulated by external factors (Nikolova and Gutierrez, 2020). In a greenfield development approach with good reservoir characteristics, 20–40% of hydrocarbon (H–C) recovery is achieved through primary and supplementary procedures, while 60–70% of oil remains in the reservoir (Babadagli, 2007; Nwidee et al., 2016). and can only be recovered through enhanced oil recovery (EOR), a tertiary oil recovery technology (Negi et al., 2021).

EOR entails integrating cutting-edge technologies including chemical, gas, microbial improved oil recovery, and thermal energy to further improve H–C recovery. (Yernazarova et al., 2016; Nwidee et al., 2016; Nikolova and Gutierrez, 2020). Through rock-fluid contact, EOR causes a reduction in interfacial tension (IFT) between displacing and displaced fluids, wettability changes, and improved drive water viscosity and

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