ABSTRACT:

Comparative Analysis of Metal Oxide Nanofluids for Interfacial Tension Reduction in Enhanced Oil Recovery

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Oil reservoir formation damage remains a major challenge during secondary and tertiary recovery, often reducing permeability and limiting production. Enhanced oil recovery (EOR) techniques aim to overcome these constraints by improving displacement efficiency, but conventional chemical methods suffer from degradation, high dosage requirements, and elevated operational costs. Nanotechnology offers a promising alternative by modifying subsurface porous media, improving fluid–fluid and fluid–rock interactions, and enhancing phase separation through surface-active, highly reactive nanomaterials. This study highlights the influence of metal oxide nanoparticles on interfacial tension (IFT) reduction and their implications for EOR performance. Metal Oxides such as SiO, Al2O3, ZnO, CuO, and Fe3O4 have demonstrated significant potential for IFT reduction owing to their high surface area, tunable surface chemistry, and strong interfacial activity. The comparative analyses reported in this study indicate that metal oxide nanofluids can effectively reduce oil to water interfacial tension, improve oil mobilization, and enhance displacement efficiency under a wide range of reservoir conditions. Thus, incorporating metal oxide nanofluids in enhanced oil recovery offers a promising approach to improving oil recovery efficiency. Also, the ability of the metal oxide nanofluids to overcome limitations associated with conventional chemical methods highlights their potential as an advance technology for enhanced performance in challenging reservoir environments.
Keywords: Metal Oxides, Nanofluid, Enhance Oil Recovery, and Interfacial Tension

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