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Full Length Article

Impact of a novel biosynthesized nanocomposite (SiO_2@Montmorilant@Xanthan) on wettability shift and interfacial tension: Applications for enhanced oil recovery

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Abstract

Nanoparticles are used in various nano-energy applications such as wettability shift of hydrophobic surfaces to hydrophilic surfaces in oil-brine-mineral systems and interfacial tension (IFT) reduction for enhanced oil recovery. This is possible due to their small size (1–100nm) and chemical and physical properties. Mechanistically, they can interact with a fluid in the pore space and provide favourable conditions for wettability shift, IFT and oil viscosity reduction, and thus improve oil recovery. However, literature is scarce in terms of providing comprehensive information about the behaviour of nanocomposites (NCs) and associated formulations.

In this paper, we present biosynthesis, characterization, and application of a novel nanocomposite (SiO_2@Montmorilant@Xanthan) which is used with various concentrations (100, 250, 500, 1000, 1500, and 2000ppm) as dispersing agents in porous media. The NC was characterized using X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA), Fourier Transform Infrared Spectroscopy (FTIR), and Energy Dispersive Spectroscopy (EDS). The effects of different concentrations of the nano-suspensions on zeta potential, pH, conductivity, IFT, and wettability are investigated. Core flooding tests were done on sandstone and carbonate reservoir rocks to measure the secondary and tertiary recovery potential by injecting seawater and optimum NC concentrations, respectively.

Zeta potential and conductivity experiments demonstrated that 250ppm NCs can optimally reduce the IFT from 36 mN/m to 15.42 mN/m (56% reduction). The similar optimum concentration has shifted the wettability of examined carbonate rocks from 150° to 33° leading to an 11.72% increase in tertiary oil recovery. Whereas, the optimum concentration of NCs for sandstone rocks was 1000ppm; which, has optimally altered the wettability from 140° to 34°, and has increased the tertiary oil recovery by 15.79%. This reduction in IFT, the reversal of wettability, and an increase in tertiary oil recovery can improve significantly the design of effective enhanced oil recovery schemes for petroleum reservoirs.