A review study of metal oxide nanoparticles utilization in wettability alteration mechanism

ABSTRACT

Wettability is the property of rock which vital in controlling the location, flow, and distribution of fluids within a reservoir. The increases in the water-wetness will improve both sweep and displacement efficiency, consequently releasing the trapped oil within the pore space and throat of the rock. The water-wetness will lead to a favorable mobility ratio by changing the water and oil relative permeability and reducing the capillary force by decreasing the interfacial tension (IFT) of oil-water within a reservoir. On the other hand, the vast application of nanotechnology also provides the metal oxide nanoparticles as a wettability modifier, although still limited compared to silicon dioxide (SiO2) nanoparticles. Hence, in this review study, the effects of several metal oxide nanofluids: aluminium oxide (Al2O3), cerium oxide (CeO2), cuprum oxide (CuO), iron oxide (Fe2O3), magnesium oxide (MgO), nickel oxide (NiO), titanium dioxide (TiO2), and zirconium dioxide (ZrO2) during wettability alteration of the oil-wet rocks towards water-wet were analyzed and compared with the SiO2. The procedures for artificially modifying the wettability in laboratory experiments are also investigated, including porous media preservation and experimental conditions. The fundamentals of wettability alteration by a nanofluid, which are cleaning and coating mechanisms are presented too. Key factors such as the concentration of nanoparticle, particle size, brine salinity, and the presence or absence of surfactant were also discussed in detail. Meanwhile, the effectiveness of reducing the oil viscosity and increasing the brine viscosity showed that an extra mechanism could be achieved by utilizing the metal oxide nanoparticles, conversely, it was not achieved by the SiO2.