A study of nanofluid stability in low-salinity water to enhance oil recovery: An extended physicochemical approach

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Abstract

We examined the stability of SiO2 and Al2O3 NPs in both deionized (DI) water and low-salinity water (LSW). Stability was evaluated by measuring absorbance, hydrodynamic diameter, and zeta potential. NP stability was also manipulated by dispersion techniques and surfactant addition. To shape our experiments and explain results, we relied on an extended version of Derjaguin, Landau, Verwey, and Overbeek theory that accounts for hydrophobic and steric interactions. We attribute the observed stability of the examined NPs in DI to their highly negative zeta potential, which maintained absorbance and hydrodynamic diameter and produced a high energy barrier (EB). In LSW, SiO2 was stable because of its hydrophilicity, which maintained the EB, while Al2O3, which is naturally hydrophobic, strongly aggregated when a decrease in zeta potential decreased the EB. After applying various dispersion methods to Al2O3, including ultrasonication, surfactant addition, heat agitation, and pH control, we observed that the best stability occurred at pH 2 with cationic and nonionic surfactant. Although Al2O3 did not show an EB under any conditions, stability nevertheless occurred after surfactant addition, which we attribute to the steric interaction and manipulation of the primary minima. In sum, our physiochemical analysis produced stable nanofluids with potential LSW flooding applications.

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