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Chemical Enhanced Oil Recovery and Nanotechnology: Effects of Silica-Based Nanofluids on Low-Salinity Water Flooding and Enhanced Oil Recovery Processes in Oil-Wet and Water-Wet Reservoirs

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Advances in the field of nanoscience and nanotechnology have resulted in the development of engineered nanoparticles, with unique physico-chemical properties, and their applications to all the sectors of industry, including the petroleum industry. This presentation will discuss several advances and applications of silica-based nanofluids in chemical enhanced oil recovery (EOR) processes related to interfacial phenomena in multiphase systems and physics of multiphase flow in porous media, and in particular the oil recovery characteristics resulting from nanofluids based low-salinity water flooding and chemical EOR processes. Laboratory experiments were carried out using homogeneous sandpack columns simulating oil-wet and water-wet reservoirs. To simulate oil-wet reservoirs, the sandpack columns were saturated with a light crude oil (West Texas Intermediate) at first. While in the case of the simulated water-wet reservoirs, these reservoirs were made by saturating the sandpack columns initially with a 1.0 wt% brine (NaCl) and then followed by an injection of the light crude oil. The subsequent oil-saturated (oil-wet system) and oil-brine mixture (water-wet system) within the sandpack columns were then subject to water flooding (non-sequenced recovery) or EOR processes (sequenced recovery) utilizing brine and/or surfactant as controls as well as low (0.01 wt%) and high (0.1 wt%) silica-based nanofluids. When compared with the high concentration of silica-based nanofluid, the low silica-based nanofluid concentration produced low fractional and cumulative oil recovery results in the water flooding process of oil recovery for both oil-wet and water-wet reservoir systems; however, the low silica-based nanofluid concentration was found to be the most effective with EOR process for both oil-wet and water-wet reservoir systems. Our findings permit to choose optimal concentrations of silica nanoparticles to be employed for either water flooding or EOR processes in order to increase the oil extraction efficiency.