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Protected polyacrylamide nanostructure used for enhanced oil recovery: Stability behaviors and flooding tests

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The utilization of traditional polymers like polyacrylamide (PAM) in polymer enhance oil recovery (EOR) has revealed several challenges, such as a high surface absorption and a high sensitivity to the reservoir's salinity, as well as its thermal, mechanical, and bacterial properties. In this study, a novel core-shell nanostructure of polyacrylamide/polystyrene as protected polyacrylamide nanostructure (PPN) was designed and prepared for smart modification of the mobility ratio to overcome the aforementioned problems by two step-one pot inverse emulsion polymerization of aqueous acrylamide solution in cyclohexane in the presence of Span 20-Span 80 mixture and also styrene monomer to synthesize high molecular weight polyacrylamide with a protective nanolayer. A wide range of analytical techniques—such as IR, NMR, DSC, SEM, DLS, and SAXS—were used to examine the PPN structure, which confirmed a core-shell nanostructure with average core and shell diameters of 61 and 12 nm, respectively. Combined with rheology and release ability of the protected system at high temperature, salinity, and mechanical conditions as harsh environment by dissolution experiments, it was found that the protected polyacrylamide nanostructures show a time-dependent release behavior after contacting polymers to hydrophobic phase. The results of mechanical- and temperature-dependent viscosities in presence of high total dissolved salinity (178,082 mg/L including divalent cations) illustrated viscosity of PPN samples increase with increased temperature and undergo a slightly reduction (2.37 %) with increased mechanical mixing. Besides, the adsorption behavior of PPN samples against temperature indicated that PPN samples adsorb weakly on silicate formations at all temperatures, regarding polymer adsorption on sand surface can change the flow properties of the porous media and reduce the water permeability. The micromodel and core flooding results revealed that both flooding processes by PAM and PPN solutions had generally comparable and higher macroscopic areal sweep efficiency as well as recovery compared to traditional water flooding, while the PPN flooding process needs less amount of polymer.

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