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Water permeability reduction associated with injection of oil-water emulsions and microcapsule suspensions in Bentheimer sandstone

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In recent years, water alternate emulsion injection (WAE) has been explored as a potential enhanced oil recovery method. Emulsion drops may block the pore throats diverting the aqueous phase towards oil-containing pores. The efficiency of the method strongly depends on the drop size distribution and interfacial properties of the emulsion. Emulsions are thermodynamically unstable systems and their characteristics can be affected by various reservoir conditions such as temperature, salinity, and surfactant adsorption on the rock walls.
The alternative explored in this work is the use of a dispersion of microcapsules with a biopolymer (gellan gum) thin shell as an alternative to emulsions. Microcapsules, which can also block throats in the porous medium and produce the same positive damage effect as emulsions, are less susceptible to reservoir conditions since their shell acts as a physicochemical barrier against coalescence and drop breakup during flow through the pore space. Moreover, the mechanical properties of the microcapsule shell can be adjusted by changing the polymer structure, leading to different flow resistance.
To compare the mobility reduction caused by the dispersed phase of an o-w emulsion and a microcapsule suspension with the same diameter distribution, we performed experiments using a miniaturized Bentheimer core, which allowed faster parametric analysis of the effect of different parameters on the flow behavior. The pressure difference was monitored during the injection at constant flow rate of slugs of the water, followed by a slug of the dispersion (o-w emulsion or microcapsule suspension), followed by a second slug of water. The ratio of the water permeability between the first and second water slug was evaluated as a function of drop size distribution and shell properties. The results reveal the optimum microcapsule properties to achieve a desired mobility reduction.

Participation

In-Person

References

Oil-water emulsion; microcapsule suspension; permeability reduction;alternate emulsion injection (WAE); enhanced oil recovery (EOR); core flooding; Bentheimer Sandstone;

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