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Impact of Solubilized and Dispersed Crude Oil on Foam in a Porous Medium

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Dispersed and solubilized oil can impact bulk foam stability differently. Though aromatic components are more soluble in water than straight-chain aliphatic components, solubilized aromatics do not necessarily impact bulk foam stability, whereas straight-chain aliphatic components can have a detrimental impact (Lee et al., "Stability of Aqueous Foams in the Presence of Oil: On the Importance of Dispersed vs Solubilized Oil", Ind. Eng. Chem. Res., 52,pp. 66−72, 2013). However, to our knowledge there is no research on the impact of solubilized oil on foam in porous media.

The impact of the crude oil, as a separate oleic phase, was studied by co-injection of crude oil, surfactant solution and gas in coreflood, on steady-state mobility, captured by the pressure drop across the core. To investigate if the behaviour of steady-state foam with dispersed crude oil can be explained by the solubilized oil components, we perform foam-flooding experiments with surfactant solution previously equilibrated with crude oil. Furthermore, we conduct foam-flooding experiments with solubilized hexane in surfactant solution, to determine if the straight-chain aliphatic components can explain the behaviour of the solubilized crude oil on steady-state foam mobility as it impacts bulk foam in the literature.

The crude oil , as a separate oleic phase, reduces the pressure gradient across the core by a factor of twenty compared to the case without oil. Nonetheless, this pressure gradient was about a factor three higher than we observed by co-injecting crude oil, water without surfactant, and gas, which indicates that some weak foam and emulsion was generated by co-injecting surfactant, crude oil, and gas. In contrast, with solubilized crude oil and with solubilized hexane, the pressure gradient is in the same order of magnitude for co-injection gas and surfactant with and without solubilized oil. These results indicate that solubilized crude oil cannot explain the impact of the crude oil as a separate oleic phase on foam mobility in our case. Furthermore, the impact of solubilized crude oil on steady-state foam mobility cannot be explained as the effect of a solubilized straight-chain aliphatic component such as hexane.

The major result of our work is that the impact of solubilized crude oil on foam does not explain the detrimental impact of crude oil in a separate oleic phase on foam in a porous media. Another result is that though co-injected water, gas and crude oil might not generate strong foam, it can result in somewhat higher pressure gradients with surfactant in the aqueous phase than without surfactant. This is possibly caused by smaller oil droplets in presence of surfactant and a weak foam.