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Capillary-number Insights into Mobilization of Oil in Porous Media by Foam Injection

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The mobilization of oil in porous media is a function of capillary number (Nca), i.e. the ratio of viscous to capillary forces. With foam injection, Nca increases considerably, a result of the combined effects of an increase in pressure gradient (∇p) due to gas-mobility reduction by foam and reduction in oil/water interfacial tension (IFT) by foaming surfactant. However, the relative importance of ∇p and IFT in published foam coreflood studies remains unclear. Our goal is to understand the dominant driving force for oil mobilization by foam in laboratory corefloods and provide insights into the extrapolation of laboratory results to field applications. We present a critical review of foam-oil displacement data reported in the literature, based on the correlation between remaining oil saturation (Sor) and Nca (i.e., the capillary desaturation curve (CDC)) available for various formation types. In this, we update the results of Heins et al. (2014).
Most coreflood studies of foam-oil displacements do not report the IFT. For the purpose of our study, we investigate the correlation between Sor and ∇p in their data and place the data on a standard CDC correlation plot (Lake et al., 2014) based on the value of Sor. If oil is displaced by high ∇p created by foam in the coreflood, as often reported in laboratory corefloods, such high ∇p cannot be seen in geological formations, considering the difficulty in injectivity and risk of fracturing. Then, upon lower ∇p values feasible in field, we relate the reduced Nca to Sor expected in field application using the CDC plot. We also examine the oil relative permeability implied in published studies. The high ∇p reported in foam corefloods often corresponds to very low oil relative permeabilities, meaning very slow oil recovery at the much lower ∇p in oil reservoirs. Thus, oil mobilization by high ∇p in foam corefloods as observed in laboratory cannot be directly extrapolated to field applications. Care is needed in extrapolating laboratory coreflood results directly to field application.
Foam can substantially improve sweep efficiency, and thereby increase oil recovery in field application. That advantage is independent of the question of reduced residual oil saturation with foam.

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References

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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