Foam Formation and Flow Diversion in Surfactant-Alternating-Gas Injection in Porous Media Micromodels

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Foam has the potential to significantly improve sweep efficiency in oil recovery, gas storage, and acidification processes. It can be used to solve problems caused by a thief zone or gravity override and in the remediation of contaminated sites. When foam is created in situ, it fills high permeability areas and diverts displacing fluid towards trapped oil, lowering the relative permeability of gas and resulting in a more stable displacement front. The efficiency of these processes largely depends on the generation and stability of the foam films (lamellae) residing in the pores. The mobility of the injected gas is reduced when foam is formed; this reduction is attributed to the reduction of the gas phase relative permeability. The liquid films formed create resistance against the gas flow, impeding its free motion inside the porous media.

Surfactant-alternating-gas injection, also known as SAG, is an enhanced oil recovery method in which alternated slugs of surfactant solution and gas are injected into a reservoir. During SAG injection, foam is formed in the reservoir as the surfactant solution is drained by gas. SAG has several advantages over other methods, in addition to foam formation: it cannot completely block the porous medium, avoiding excessive injectivity reduction; it also helps to reduce corrosion in injection facilities by reducing contact between gas and water.

The goal of this research is to understand foam formation during gas injection in a microfluidic device completely saturated with oil. It focuses on its implications for oil displacement during SAG injection, considering different surfactant concentrations.

Image processing was used to visualize pore-scale displacement and correlate the evolution of foam formation during gas injection with pressure behavior for different flow conditions using a microfluidic setup consisting of a glass micromodel, a syringe pump, a pressure transducer, and a stereo microscope.

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