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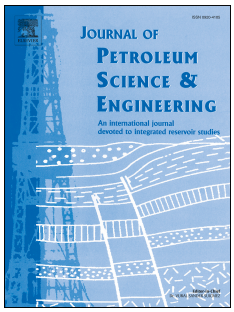

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SAG Foam Flooding in Carbonate Rocks

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Abstract

Foam is used in gas-injection EOR processes to reduce the mobility of gas, resulting in greater volumetric sweep. SAG (Surfactant Alternating Gas) is a preferred method of injection as it results in greater injectivity in the field, but designing a successful process requires knowledge of foaming performance at very high foam qualities (gas fractional flows).

Here the use of foam in low-permeability (~1 mD) Indiana Limestone cores for SAG foam applications is studied. Coreflood experiments were performed for a range of foam qualities at high pressure (100 bar), elevated temperature (55°C), high salinity (200,000 ppm) and in the presence of crude oil. The effectiveness of the foam was studied by differential pressure measurements along the core. Foam was still able to form under these stringent conditions, but it was a relatively weak foam (i.e. its ability to reduce gas mobility is modest). For one surfactant formulation, further analysis of the experimental results show that the foam would be able to maintain mobility control over the displaced phase, thus providing a stable displacement front, and that it can be used in a SAG foam process in these formations. For a second formulation the non-monotonic nature of the fractional-flow data requires further investigation before scale-up to the field.

In addition, further coreflood experiments were carried out using heterogeneous, vuggy Edwards White cores with even lower permeability (~0.5 mD). These experiments were performed to determine whether foaming is possible in heterogeneous media and especially to investigate the effects of disconnected vugs on the foaming performance. CT scans were taken during the period of foam injection to determine saturation profiles within the core. Foam was able to form inside these cores, but inside the vugs segregation was observed with liquid pockets visible in the bottom of the vugs and gas in the remainder. This segregation was only a local effect though, confined to the vug itself, and foam was able to persist in the rest of the core.