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Investigation of factors affecting the performance of surfactant and polymer floods in sandstone cores aided by X-ray CT imaging

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Traditional oil recovery methods typically extract around 30% of oil within a reservoir; as such, the development and understanding of newer recovery techniques is becoming more instrumental as focus in production shifts away from exploration and into the maximisation of output from already accessible reservoirs. Among these techniques, surfactant/polymer methods have the capability of increasing recovery up to 70% by both liberating trapped oil, in decreasing the residual oil saturation, and improving the displacement efficiency, in decreasing the mobility ratio. Despite its theoretical efficacy, cost and difficulties with forecasting field scale behaviours are often limiting factors in industrial application. Given the large number, and associated variability between explored cases, of key rock and fluid parameters influencing the displacement process, a traditional workflow firstly involves characterisation tests to determine key fluid properties and corefloods to evaluate the ultimate recovery performance. Within this workflow, the coreflood outlet analysis is critical in allowing for almost all key performance indicators to be inferred; however, given this limited viewpoint, it can be often challenging to decouple, and associate, the observed behaviours in the outlet analysis with the actual behaviour in-situ of the rock cores.
To this aim, direct visualisation of the core flooding phenomena can help elucidate the various contributing factors to the displacement process and help build associated fundamental understanding. Among the available techniques, X-ray computed tomography allows for the visualisation of phase flow, yielding insights into the formation and propagation of the oil bank –characteristic feature of surfactant and polymer floods.

In this work we present results from a series of surfactant-polymer floods performed in Bentheimer cores imaged via X-ray CT where saturation profiles –ranging from one to three dimensional –are extracted. Within these experiments, core aspect ratios and surfactant choice, hence performance, were systematically varied in order to gain appreciation for their respective effects on the fluid phases'flow and oil bank dynamics. Despite similarities in their successful performance by an oil cut and oil recovery viewpoint, direct imaging of the experiments reveals important differences. In examining the internal saturation profiles, we note disparities both in the degree of self-similarity and in the presence of late-stage tailing at the profiles'rear; hinting at differences in both the velocity and the efficacy of the displacement respectively. Through the three-dimensional imaging, other differing effects between experimental cases, such as gravity effects and oil bank dynamics, can also be visualised and quantified. Overall, the length of the core appears to have a strong influence on the 'idealness'of the surfactant and polymer displacement process; despite this, the surfactant choice itself, and its associated performance, can help mask some of the non-idealness –meaning an accurate understanding of the surfactant performance within the core might be limited when examining performance based solely on outlet sampling parameters.

Participation

In-Person

References

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