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Novel Application of Foam and Air Flooding in Glass-Silicon-Glass Micromodels

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Abstract

Low oil price scenarios, high production rates and the ever increasing desire for cost-effective resources dictates the oil industry to carefully evaluate the appropriate enhanced oil recovery (EOR) methods to be chosen. Air flooding is a relatively economical method to enhance oil recovery of post-primary-production fields. It is well documented that standard air flooding as a secondary production method yields poor areal sweep efficiency. One reason for this is the viscous fingering generated due to the high viscosity difference between the displacing phase (air) and the displaced phase (oil). Lately, a more advanced alternative - foam injection - has gained the interest of the oil industry. By injecting air and a foaming agent into an oil reservoir, foam is formed in-situ. This foam will stabilize the displacing phase by reducing the viscous fingering formation, which results in a better mobility ratio and thus a higher areal sweep efficiency.

This work focuses on the visualization and evaluation of water, air, and foam flooding. To obtain a better understanding of the processes taking place in a reservoir, a novel approach was used namely, Glass-Silicon-Glass (GSG) micromodels. The micromodels resemble reservoir rock properties e.g. porosity and permeability characteristics. The experimental set-up consists of a cabinet dryer with a camera mounted on top. The GSG model is placed inside the cabinet and PTFE Teflon® tubings and stainless steel pipes are used as connection lines. The fluids are injected with a syringe pump, while the pressure is monitored via a computer. By using a 25 Watt lamp and the camera, it is possible to visualize the flooding process. To achieve more comparable results, a black oil was used as the displaced fluid. Brine flooding is used as a benchmark to which results can be compared to.

The workflow presented in this work allowed the observation of swept areas as well as flow path behavior. The preliminary results suggest that foam injection, compared to air flooding, improves not only the areal sweep efficiency but also the microscopic oil displacement, which is suggested by recent literature released about this topic.

The advantages of this novel method are manifold; it is a fast and economical addition to EOR screening processes and only small volumes of fluids are necessary to get qualitative results.