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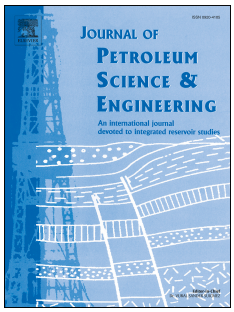

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Can Water-Alternating-Solvent Injection be an Option for Efficient Heavy-Oil Recovery?: An Experimental Analysis for Different Reservoir Conditions

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Abstract

We performed a set of experiments on vertically situated sandpack models. Different slug sizes of water and solvent (heptane used in the experiments) were tested for 2,000 cp heavy-oil. As a benchmark, tests were also performed for 14 cp light oil for comparative analysis. In addition to the technical feasibility, an economic analysis was performed considering the amount of solvent injected and oil and solvent recovered. Experiments were repeated for oil-wet systems. For both light and heavy oils, starting the process with the solvent was feasible in the short run technically and economically. If the process starts with water, excess amount of it occupies the largest pores and hinders solvent-oil interaction for mixing and oil displacement. This was true especially if the rock is oil-wet and oil is heavy, which yielded faster recovery and higher ultimate recovery than the water-wet case. The time for switching to solvent injection is more critical in the heavy-oil case as it is more sensitive to the amount of existing water in the system. As oil becomes heavier and if the rock is water-wet, starting the process with waterflooding is not suggested. In this case, more solvent needs to be injected in the first cycle compared to oil-wet systems. Due to partial miscibility and more gravity stable nature, solvent retrieval and sweep with water can be more effective in case of heavy-oil compared to light oil (fully miscible case) and, as a result, can be even more profitable. This is highly critical in exploitation of heavy-oil reservoirs if thermal options are limited and greenhouse gas emission is a concern.

Key words: Heavy-oil recovery optimization, solvent injection, WAG design, injection sequence and slug size, wettability.

[1] This paper was written while the first author was residing at Xi'an Shiyou University as a guest professor in 2017.

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