Bouquet, S., Douarche, F., Roggero, F., & Leray, S. (2019). Characterization of Viscous Fingering and Channeling for the Assessment of Polymer-Based Heavy Oil Displacements. *Transport in Porous Media, 131.* https://doi.org/10.1007/s11242-019-01370-3

Abstract

The ability to determine a predictive stability criterion is of great practical importance for designing stable polymer-based displacements. Where one usually resorts to a limited number of core-scale experiments or coarse-scale reservoir simulations, the first ones are potentially impacted by length scale issues, while the second ones possibly smooth out sharp displacing fronts and physical instability due to numerical diffusion. This paper proposes a new hydrodynamical stability criterion based on the previous linear stability analysis results. This criterion is tested for 2D polymer oil displacement by performing high viscosity contrasts, high-resolution numerical experiments at pilot scale. We investigate mesh resolution issues and several perturbation ideas. Different factors are considered such as mobility ratios, polymer adsorption and degradation and heterogeneities. The analysis is based on a combination of reservoir simulation and image processing techniques. We show the development of viscous fingering in homogeneous porous media is driven by the shock mobility ratio defined as the ratio of the total fluids upstream mobility over the total fluids downstream mobility. This stability criterion proves to predict both the polymer upstream and polymer-free downstream saturation fronts stability, typical of a polymer displacement, whether polymer adsorbs on the rock or degradates, or not. The observed fingers dynamical behavior is in line with previous works addressing single-phase miscible flow or immiscible oil displacement in porous media: fingers transversally merge while growing in the flow direction. Time evolution of fingers spreading and number is linear. Investigation on porous media of variable heterogeneity distributions shows how viscous fingering couples with heterogeneity and leads to even more marked, distorted and unstable flow patterns. In those cases, flow patterns are not solely driven by the porous medium heterogeneity. The more unstable the flow is, the more sensitive it is to heterogeneity. In-depth fingers analysis shows a very specific time evolution behavior, quite different from viscous fingering in homogeneous media. Such a flow pattern is related to production data such as water and polymer breakthrough times and/or oil recovery profiles as a function of time, which can be used in turn to interpret displacement stability and porous medium heterogeneity features