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Contribution ID: **696** Type: **Poster (+) Presentation**

A Semi-Analytical Solution for Modeling of Early-Time and Late-Time Countercurrent Spontaneous Imbibition in Porous Media

Thursday, 3 June 2021 14:40 (1 hour)

Countercurrent spontaneous imbibition (SI) is an important flow mechanism to recover oil in water- and mixed-wet porous media by means of capillary pressure. Experimental imbibition tests conducted in conventional core samples and numerical simulations show that oil recovery as a function of time occurs in a characteristic S-shaped form, which describes the infinite acting and the boundary-dominated regime. Although scaling time groups have been proposed to model SI in porous media, they fail to properly scale the results onto a single curve. Thus, the use of conventional approaches to estimate oil recovery such as an exponential model can result in wrong estimates of oil recovery.
Here, we present a new semi-analytical approach to model 1D countercurrent SI for oil-water systems through a general solution in Laplace transform of the mass-conservation equation. The infinite acting regime is modeled by a universal, early-time function that enables the accurate scaling of oil recovery onto a single curve. The early-time function considers the infinite acting behavior extends after the fluid reaches the no-flow boundary (March et al. 2016). The boundary-dominated regime is modeled by including a time-dependent diffusion coefficient into the general solution, which acts as a correction factor during the filling behavior. The Laplace transform solution is numerically inverted using the Gaver-Stehfest method. The novelty of the model is that it enables the accurate estimation of fluid imbibition under the boundary-dominated regime, a flow condition critical to evaluate the true potential of SI driven by capillarity for oil recovery in porous media. We verified the model against numerical simulations under a wide range of flow conditions relevant in water-oil systems. We show that fluid imbibition during the dominated-boundary regime is primarily driven by the diffusion coefficient and mainly affected by the viscosity ratio and the capillary pressure.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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Track Classification: (MS6-A) Physics of multi-phase flow in diverse porous media