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Flow-direction dependence of upscaled capillary pressure-saturation curve

Monday, 30 May 2022 14:25 (15 minutes)

Immiscible two-phase flow is widely present in natural and synthetic processes. The flow behaviour of two fluids is governed by constitutive relations, relative permeability and capillary pressure. These empirical relations are often influenced by the dynamic of the process and the characteristics of porous media such as heterogeneity. The effect of the non-equilibrium condition on the capillary pressure-saturation behaviour has been investigated and shown that the dynamic capillary pressure is different from the one measure under the equilibrium condition. Moreover, recent studies showed that the presence of micro-heterogeneity in porous media changed the trend and the extent of the capillary pressure-saturation compared to the background porous medium. Although, the magnitude and the trend of the capillary pressure-saturation curves remained almost unchanged irrespective of the direction of the fluid flow in these studies.
The present work investigates the effect of heterogeneity interface on saturation distribution and capillary pressure-saturation behaviour in a micromodel study. The micro model is made up of two sections called fine and coarse sections. Microfluidic experiments and optical imaging and analyses were used to calculate capillary pressure and saturation of fluids. Drainage experiments were conducted at four different flow rates with a wide range of capillary numbers in both directions (i.e. fine to coarse and coarse to fine). The saturation of each phase was measured using image analysis. Moreover, the capillary pressure at the pore scale was calculated by estimating the curvature of each fluid-fluid interface. Then using the fluid-fluid interfacial surface area, the averaged capillary pressure in the coarse section, fine section and the entire micromodel, was calculated.
Results show that the averaged dynamic capillary pressure-saturation curve with the presence of a heterogeneity interface does not follow the monotonic shape of the conventional capillary pressure curve, measured under equilibrium conditions. Moreover, the results demonstrate a non-monotonic relationship between the remaining wetting phase saturation and the capillary number. It is mainly due to the competition between the capillary and viscous forces during the transition from capillary fingering to viscous fingering regime. The results reveal that considering the flow direction with respect to the heterogeneity interface, can lead to a better prediction of the upscaled capillary pressure-saturation relation and the remaining wetting phase saturation.

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

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