Wettability Impact on Two-Phase Flow Dynamics

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Multiphase flow in porous media is of essential importance in industrial applications including geological storage of CO$_2$, enhanced oil recovery, groundwater remediation and nuclear waste storage. Wettability which is characterized by the equilibrium contact angle ($\theta$) between the fluid-fluid interface and a solid surface, has a significant impact on the efficiency and dynamics of immiscible displacement in multiphase flow.

This study presents a pore-scale simulation of two-phase flow in a realistic rock model of Tuscaloosa sandstone under strong-, intermediate- and weak-wet conditions. These visualizations display the displacement pattern of the invaded fluid, which has a ramified pattern under the strong drainage conditions ($\theta$). However, the coroner flow mechanism prevails under imbibition condition (small $\theta$) in which filling of smaller pore throats is favored over large pores. As the wettability of a porous medium changes to an intermediate-wet condition, complication in fluid physics arises, as a mixed population of concave and convex interfaces appear in the displacement front.

The present study remarkably contributes to assessment of sweep efficiency and storage capacity of CO$_2$ storage projects and provides information on the behavior of these multiphase systems in contact with rock formations having various wetting properties.

References: