PORE-SCALE INVESTIGATION OF UNSTABLE VISCOUS AND CAPILLARY FLUID DISPLACEMENT USING SMOOTHED PARTICLE HYDRODYNAMICS

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A clear understanding of immiscible fluid displacement at the pore-scale is important to predict the continuum-scale processes that occur during CO2 sequestration in subsurface. Unstable immiscible displacement in porous media at the pore-scale has been a subject of extensive experimental research in the past and the displacement patterns have been well characterized. However, these characterizations are limited to a relatively narrow range of viscosity ratios (M) and Capillary numbers (Ca) due to technical challenges. In real CO2 sequestration scenarios these quantities may vary in a much wider range. In the present work we use a Smoothed Particle Hydrodynamics (SPH) model to study immiscible flow. The model is validated using experimental results of Zhang et al. (2011) (C. Zhang, M.Oostrom, T. W. Wietsma, J. W. Grate, and M. G. Warne. Influence of Viscous and Capillary Forces on Immiscible Fluid Displacement: Pore-Scale Experimental Study in a Water-Wet Micromodel Demonstrating Viscous and Capillary Fingering). Zhang et al. (2011) conducted a series of displacement experiments to study the impacts of viscous and capillary forces on displacement stability and fluid saturation distributions in a homogeneous water-wet pore network micro-model. Experiments were conducted for M and Ca, which were varied by four orders of magnitude. We use the SPH model to study the immiscible displacement for a much wider range of M and Ca.