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Exploring the Impact of Heterogeneity and Flow Rate on Mixing and Displacement of Miscible Phases in Porous Media

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Miscible phase flow in porous media plays a significant role in many natural and industrial processes, such as CO₂ sequestration, aquifer salinization, and soil pollution. In these processes, a less dense and less viscous invading phase mixes with a more dense and more viscous defending phase at the interface between the two phases. The resulting mixture at the interface has an intermediate density and viscosity based on the mixing ratio of the phases. The invasion pattern is determined by the rate of mixing and displacement between the phases, which is influenced by the miscibility ratio, viscosity, and geometry of the phases. Most previous research on miscible multiphase flow has been conducted using 2D Hele-Shaw cells, in which a resident phase is displaced by an invading miscible phase introduced at the center of a circular plate. However, these studies do not account for the complexity of porous media structure at the pore scale, where the uneven advancement of the invading phase due to capillary or viscous forces is dominated by the heterogeneity of the porous structure. In this research, we will address the gap between the pore scale and volume scale by examining how the inner structure of the porous medium, or heterogeneity, leads to various mixing patterns for different inlet pressures and heterogeneity levels. We will use a low viscosity fluid invading and mixing with a high viscosity fluid in a 2D porous media at various flow rates and heterogeneity levels to investigate the impact on fingering patterns and displacement to mixing patterns. Our results will show that these variations in displacement to mixing have a unique signature at the Darcy scale as measured by flux measurements, demonstrating that the pore scale phenomenon for miscible phase flow in porous media can propagate to the Darcy scale.

Participation

In-Person

References

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