UNDERSTANDING THE EVOLUTION OF MISCIBLE VISCOUS FINGERING PATTERNS

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Viscous fingering, the hydrodynamic instability that sets in when a low viscosity fluid displaces a higher viscosity fluid, creates complex patterns in porous media flows. Fundamental facets of the displacement process, such as volumetric sweep and mixing efficiency, depend strongly on the type of pattern created by the uneven front of the less viscous fluid. Although viscous fingering has been studied for many years, the effect of parameters such as viscosity ratio and displacement rate on the fingering patterns, and its subsequent impact on mixing, remain poorly understood.

This work focuses on understanding the evolution of miscible fingering both experimentally and computationally. We carried out experimental work in a radial Hele-Shaw cell – as an analog to porous media flow – to map out the evolution of fingering patterns. Differences in fingering patterns are characterized via attributes such as interface length and average finger width. Our experimental results indicate a nontrivial (nonmonotonic) dependence of finger width on i njection rate (see Figure). We numerically simulate viscous fingering in a radial geometry and compare growth in interfacial area and finger width to linear stability analysis and our experimental results.