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Lifecycle of miscible viscous fingering: onset to shutdown JAPINDER S. NIJJER, DUNCAN R. HEWITT, JEROME A. NEUFELD, Univ of Cambridge — When a viscous fluid is injected into a porous medium or Hele-Shaw cell that is initially saturated with a more viscous fluid, the flow can be unstable to viscous fingering. We investigate the long-time dynamics of miscible viscous fingering in a homogeneous, planar, two-dimensional porous medium using high-resolution numerical simulations. At late times, we identify a new flow regime which consists of a pair of counter-propagating fingers that diffuse and slow, leaving a linearly well-mixed interior. We derive an analytic solution for this regime, and show that, in contrast to previous suggestions, the flow always evolves to this regime irrespective of the viscosity ratio and Peclet number. As a consequence, we find the instability can only ever generate a finite amount of advective mixing. We also describe the full life-cycle of miscible viscous fingering, which can be partitioned into three regimes: an early-time linearly unstable regime, an intermediate-time non-linear regime, and a late-time exchange-flow regime. We identify, using linear stability theory, a critical Peclet number below which the flow is always stable, and derive a model for the evolution of the transversely averaged concentration in the intermediate-time regime, which extends previous empirical models.

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