Numerial Simulation of Interfacial Instabilities on Miscible Rotating Hele-Shaw Flows with the Effects of Coriolis Force

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ABSTRACT

The Hele-Shaw flows driven by centrifugal force have been the subject of recent studies due to their potential applications of in the technology of spin coating. In the common practices of spin coating process, a liquid drop is initially deposited on the top of rotating target substrate, and spreads outward by the centrifugal force. Since the coating film is extremely thin, the process bears similarities to a rotating Hele-Shaw flow. The rotational effects to the fingering instability differ from the radial flows in many ways. Instabilities in radial flows are mainly due to the viscosity contrast, and decay as radial distance increases. Fingerings are triggered if the displacing fluid is less viscous and more vigorous near the origin. However, in the rotational Hele-Shaw cell, the centrifugal force is generated by the density difference, and proportional to the radial distance. A stronger unstable mechanism is expected if the heavier fluid, usually more viscous, is the driving fluid and more pronounced away from the center. Numerical simulations of interfacial stabilities for miscible interfaces of confined annulus in a rotating Hele-Shaw cell have been presented by means of highly accurate numerical schemes. The influences of Coriolis forces, rotating speed, viscosity contrast, Korteweg stresses and injection are simulated systematically. The fingering patterns are detailed demonstrated by images of concentration, vorticity fields and streamlines systematically to depict the influences of various parameters.

Keywords : Fingering Instabilities, Hele-Shaw Cell, Coriolis forces, Korteweg stresses

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