

Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Sensitivity of Saffman-Taylor fingers to channel-depth variations

ANDRES FRANCO-GOMEZ, Manchester Centre for Nonlinear Dynamics and School of Physics and Astronomy, University of Manchester, ALICE THOMPSON, Department of Mathematics, Imperial College London, ANDREW HAZEL, Manchester Centre for Nonlinear Dynamics and School of Mathematics, University of Manchester, ANNE JUEL, Manchester Centre for Nonlinear Dynamics and School of Physics and Astronomy, University of Manchester — We probe the sensitivity of Saffman–Taylor fingers to small controlled variations in channel depth by investigating the effect of a centred, rectangular occlusion on finger propagation in a Hele-Shaw channel. This geometry supports symmetric, asymmetric and oscillatory propagation states. A previously developed depth-averaged model is in quantitative agreement with laboratory experiments once the aspect ratio (width/height) of the tube’s cross-section reaches a value of 40. We find that the multiplicity of solutions at a finite occlusion height arises through interactions of the single stable and multiple unstable solutions already present in the absence of the occlusion: the classic Saffman–Taylor viscous fingering problem. The sequence of interactions that occurs with increasing occlusion height are invariable for all aspect ratios investigated, but the occlusion height required for each interaction decreases with increasing aspect ratio. Thus, the system becomes more sensitive as the aspect ratio increases, in the sense that multiple solutions are provoked for smaller relative depth changes. We estimate that the required depth-changes become of the same order as the typical roughness of the experimental system (1 micron) for aspect ratios beyond 155.

Andres Franco-Gomez
Manchester Centre for Nonlinear Dynamics and
School of Physics and Astronomy, University of Manchester

Date submitted: 22 Jul 2015

Electronic form version 1.4