Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Viscous potential flow analysis of radial fingering in a Hele-Shaw cell DANIEL D. JOSEPH, Department of Aerospace Engineering and Mechanics, University of Minnesota and Department of Mechanical and Aerospace Engineering, UC Irvine, HYUNGJUN KIM, Department of Aerospace Engineering, KAIST, 373-1 Guseong-dong, Yuseong-gu, Daejeon, 305-701 South Korea, TOSHIO FUNADA, Department of Digital Engineering, Numazu National College of Technology, Numazu, Shizuoka, 410-8501, Japan — The problem of radial fingering in two-phase gas/liquid flow in a Hele-Shaw cell under injection of gas is studied here. The fingers arise as an instability of a time dependent flow which is rigorously resolved in the linearized approximation for the first time. One consequence of the unsteady basic flow is continuous nucleation of new finger as the radius $R(t)$ of the unperturbed interface increases. Another consequence is that the evolution of the perturbed interface $f(R(t))$ is not governed by the local (in time) value of the unperturbed interface $R(t)$ but depends globally on all past values of $R(t)$ up to the present. The problem is analyzed as a viscous potential flow VPF in which the potential flow analysis of Paterson (1981) [J. Fluid Mech. 113, 513] and others is augmented to account for the effects of viscosity on the normal stress at the gas/liquid interface. The unstable cases in which gas is injected into liquid or liquid is withdrawn from gas lead to fingers. Here we show that the viscous normal stress should not be neglected.

Juan C. Padrino
Department of Aerospace Engineering and Mechanics, University of Minnesota

Date submitted: 06 Aug 2008 Electronic form version 1.4