Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Propagation velocities of chemical reaction fronts advected by Poiseuille flow BOYD EDWARDS, West Virginia University — Ascending chemical wave fronts place a reacted fluid mixture below a more-dense unreacted fluid mixture, and are therefore potentially unstable to buoyancy-driven convection. Indeed, ascending fronts bounded by parallel vertical no-slip plates are unstable to buoyancy-driven convection above a critical gap width. Imposed finite-amplitude Poiseuille flows distort the shapes of such reaction fronts and alter their velocities of propagation. We have investigated these effects using the Navier-Stokes equations and the appropriate cubic reaction-diffusion-advection equation. Analytical solutions of this equation resolve the chemical concentration across the gap for narrow gaps, wide gaps, and small-amplitude flow. Numerical solutions supply a general description for fluid flow in the direction of propagation of the chemical reaction front, and for flow in the opposite direction. In contrast with previous assumptions, the propagation velocity is found to exceed the sum of the velocity of a planar front in a static fluid and the average flow velocity. General velocity results preclude the need for the reaction-diffusion-advection equation in future studies of nonlinear fingering.

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Date submitted: 01 Dec 2004 Electronic form version 1.4