Center for Fluid Mechanics, Division of Applied Mathematics
Fluids and Thermal Systems Group, School of Engineering
Joint Seminar Series

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Laboratory Measurements of Large-Scale Flows in Carbon Sequestration

The long-term fate of supercritical (sc) CO_2 injected into deep geologic saline aquifers is critical to the success of carbon sequestration, an important option for reducing the emissions of this most prevalent greenhouse gas. Less dense than the native brine, scCO_2 floats to the top of the aquifer where it is trapped as a metastable pool by a geologic feature such as a low permeability cap rock. Dissolution into the underlying brine creates a CO_2-brine mixture that is denser than the native brine, eliminating buoyancy and removing the threat of scCO_2 escaping back to the atmosphere. If molecular diffusion were the only dissolution mechanism, the CO_2 waste stream from a typical large coal-fired electrical power plant may take upwards of 10,000 years to no longer pose a threat, however, a convective instability of the dense diffusion boundary layer between the scCO_2 and the brine can dramatically increase the dissolution rates, shortening the lifetime of the scCO_2 waste pool to perhaps 100 years. We have performed bench top, similitude-scaled 2D and 3D experiments of this process that explore the transient diffusive behavior and the quasi-steady convective behavior. We present results for the time-dependent and steady-state dimensionless mixing rates which are crucial to estimating the lifetime of scCO_2 waste pools. In addition, we will comment on experimental evidence of two potentially new secondary instabilities that are important to a fundamental understanding of the CO_2-brine mixing rate. The results of these experiments provide important data for benchmarking difficult, large-scale simulations of CO_2 sequestration sites.

TUESDAY – OCTOBER 18, 2011
4:00 PM
Barus & Holley, Room 190