

Characterization of the Convective Dissolution of CO₂ in Water at a Temperature of 308 K and Pressures up to 10 MPa

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To reduce greenhouse gas emissions while the global energy demand increases, carbon sequestration solutions have been proposed. Among them, the sequestration of carbon dioxide (CO₂) in deep saline aquifers is known to be a long-term viable solution. It consists in pumping supercritical CO₂ into deep sub-surface brine aquifers where, after dissolution, CO₂ is trapped by mineral precipitation. Besides mass diffusion, instabilities, in form of viscous fingers, drive the kinetics of dissolution. Thereby, a comprehensive analysis of the growth and dissipation of the instabilities at relevant pressures is needed for optimizing the process.

In the present contribution, measurements performed with the shadowgraph method demonstrate the effect of varying pressure on the convective dissolution of CO₂ in pure water. All measurements have been carried out in a cylindrical cell allowing a three-dimensional visualization of the instabilities. The experimental setup is oriented horizontally or vertically to study the progression of the finger-like plumes in the bulk or at the interface. In addition, the setup oriented vertically enables the analysis of long-ranged concentration non-equilibrium fluctuations to determine the Fick diffusion coefficient after the relaxation of the instabilities. The effect of pressure will be discussed on space-time maps of the instabilities and, more in general, on the convective dissolution process.