

Convective Dissolution of CO₂ in Saline Aquifers

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The aim of geological CO₂ storage is the permanent removal of the injected CO₂ from the atmosphere. The buoyancy of the injected supercritical CO₂ and the possibility of leakage along fractures faults and old wells may lead to leakage of CO₂ back into the atmosphere over time. CO₂ dissolved into the brine increases its density and is assumed to trap CO₂ underground and prevent leakage. The rate at which CO₂ dissolves into the brine is a key constraint on the duration of possible leakage. We present numerical simulations and bench top experiments in beadpacks with analog fluids. Both show that the dissolution rate, R , of the CO₂ is directly proportional to $R=aAUC$, where a is a constant of proportionality, A is the area of the interface, C is the solubility, and U the Darcy buoyancy velocity of the porous medium. The buoyancy velocity, $U=K\Delta\rho g/\mu$, is a function of the permeability, K , the viscosity of the brine, μ , the density difference between saturated and unsaturated brine, $\Delta\rho$, and the gravitational acceleration, g . These results are valid in large regional aquifer where the background saturation of dissolved CO₂ does not build up. We therefore expect that CO₂ dissolved at a constant rate in large regional aquifers. The dissolution rate will be largest in high permeability aquifers and may contribute significantly to the safety of geological CO₂ storage. However, currently numerical simulators do not have the necessary numerical resolution to resolve the convective motion in the brine and may lead to misleading prediction of the time necessary to dissolve all injected CO₂.