

An Experiment study on dynamic displacement and non-equilibrium dissolution for CO₂ in porous media

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A clear understanding of the displacement and dissolution processes in porous media is of importance for CO₂ trapping mechanism during geological storage. The porous media were filled with quartz glass beads. CO₂ and water injection with different flow rates in porous media were investigated using MRI. The intensity of MRI images decreased with CO₂ injection and increased with water injection in the longitudinal sections at various times. Flow patterns in the drainage, changed with different flow rates. However, water imbibition proceeded as the uniform displacement front even with the fast flow rates. The residual CO₂ saturation after imbibition was sensitive to the capillary number and initial CO₂ saturation. As capillary numbers increased, viscous forces dominated the flow resulting in a decreasing in CO₂ phase trapping. At high initial saturation range, the residual saturation decreased with initial CO₂ saturation. For post imbibition, CO₂ dissolution dominated the mass transfer reflecting the transition from capillary trapping to solubility trapping. The concentration of supercritical CO₂ (ScCO₂) decreased sharply during imbibition and slightly during post imbibition. In contrast, lots of gaseous CO₂ dissolved into water during post imbibition. The dissolution rate for ScCO₂ was around the order of magnitudes 10^{-6} - 10^{-7} Kg/m³.s. And the CO₂ saturation during post imbibition decreased. The study visualization measured dynamic drainage and imbibition processes and investigated the influence of dissolution to trapping characteristics which is useful for CO₂ geological storage.

Keywords: capillary trapping, dissolution, CO₂ saturation, geological storage, flow pattern