An Experiment study on dynamic displacement and non-equilibrium dissolution for CO_2 in porous media

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A clear understanding of the displacement and dissolution processes in porous media is of importance for CO_2 trapping mechanism during geological storage. The porous media were filled with quartz glass beads. CO_2 and water injection with different flow rates in porous media were investigated using MRI. The intensity of MRI images decreased with CO_2 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 CO_2 saturation after imbibition was sensitive to the capillary number and initial CO_2 saturation. As capillary numbers increased, viscous forces dominated the flow resulting in a decreasing in CO_2 phase trapping. At high initial saturation range, the residual saturation decreased with initial CO_2 saturation. For post imbibition, CO_2 dissolution dominated the mass transfer reflecting the transition from capillary trapping to solubility trapping. The concentration of supercritical CO_2 (ScCO2) decreased sharply during imbibition and slightly during post imbibition. In contrast, lots of gaseous CO_2 dissolved into water during post imbibition. The dissolution rate for $ScCO_2$ was around the order of magnitudes 10^{-6} - 10^{-7} Kg/m^3.s.And the CO_2 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 CO_2 geological storage.

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

