AAPG HEDBERG CONFERENCE
"Geological Carbon Sequestration: Prediction and Verification"
August 16-19, 2009 – Vancouver, BC, Canada

The Effect of Trapping Hysteresis on Permanent Storage of CO_2 in Deep Saline Aquifers

Morteza Akbarabadi and Mohammad Piri

Department of Chemical and Petroleum Engineering, University of Wyoming, Laramie, Wyoming

We present the results of an experimental study about the effect of hysteresis on capillary trapping of CO_2 in two-phase CO2/brine systems. A state-of-the-art two- and three-phase core-flooding facility has recently been established. The facility includes a medical CT scanner that can be rotated to horizontal and vertical orientations, a core-flooding system with eleven Quizix cylinders and three in-line viscometers. We perform several unsteady-state drainage and imbibition CO_2/brine experiments in two different sandstone rock samples, i.e., Berea and Nugget. The samples were 15 cm long and 3.8 cm in diameter. The experiments were carried out with gaseous and supercritical CO_2 in order to investigate the effect wettability on residual CO_2 saturation. The CT scanner is used to measure in-situ saturations. During the experiments the fluids were recirculated to maintain thermodynamic equilibrium between the phases. Special core-flooding techniques had to be employed to minimize large variations in back pressure particularly at high CO_2 flow rates. This minimized the variations in the pressure of the system and consequently in the equilibrium between the phases. All the experiments were carried out in vertical orientation, i.e., through vertically-placed rock samples. The samples were first saturated with brine and then flooded with CO_2 at different maximum flow rates. In each experiment injection of CO_2 was continued until constant pressure drop and saturation distribution along the core were reached. The "irreducible" brine saturation was then measured using the CT scanner. The drainage process was followed by a low flow rate (0.5 cc/min) imbibition until residual CO_2 saturation was achieved. The variation of residual CO_2 saturation with initial brine saturation was investigated. Different initial brine saturations were created by performing drainage experiments at different CO_2 flow rates. The ratio of trapped CO_2 saturation to the initial CO_2 saturation was found to be much higher for low initial CO_2 saturation than those at high initial CO_2 saturations.