MODEL FOR CO2 LEAKAGE THROUGH A FAULT WITH MULTIPHASE AND NON-ISOTHERMAL EFFECTS

Chuanhe Lu, Lawrence Livermore National Laboratory, 925-423-2307, lu25@llnl.gov

1. Chuanhe Lu, Lawrence Livermore National Laboratory
2. Yunwei Sun, Lawrence Livermore National Laboratory
3. Yue Hao, Lawrence Livermore National Laboratory
4. Joshua White, Lawrence Livermore National Laboratory
5. Laura Chiaramonte, Lawrence Livermore National Laboratory

The potential for CO2 leakage through a permeable fault is a key concern for carbon storage project. CO2 is normally injected under supercritical conditions. CO2 leakage occurs through a fault connected to the storage reservoir, a phase change happens because of the decrease in temperature and pressure as the CO2 migrates upward. T he larger change of CO2 density during this phase transition will make the temperature decrease, the so called Joule-Thomson effect. Th ese changes will affect the CO2 viscosity, and thus finally the CO2 leakage rate. In this work, we will present a computational model for the behavior of a leaking fault connecting a saline storage reservoir and a groundwater aquifer. The model includes transitions between super- and sub-critical conditions, considers the nonlinear CO2 enthalpy functions given by Span and Wagner (1996) and the viscosity function given by Fenghour and Wakeham(1998). The model is set up w ith variable pressure and CO2 saturation conditions in the reservoir. The model results show that the CO2 leakage rate initially increases when the CO2 transports upward driven by both buoyancy and overpressure during the period of pressure buildup in reservoir. When the overpressure in reservoir disappears, CO2 leakage is only driven by buoyancy and the leakage rate decreases. The effect of non- isothermal condition is more pronounced during the first stage, when flux rates are largest. This fault model is then used within a UQ sampling framework in order to rigorously quantify the sensitivity of the output response to the input model parameters. The results show that the fault permeability is the most sensitive factor for CO2 leakage rate. For the chosen ranges of input parameters, the CO2 leakage rate falls in the range 0.001 to 0.005 kg/s/m2, broadly consistent with natural analog observations. (LLNL-ABS-501671)