# DEVELOPMENT, VERIFICATION AND APPLICATION OF A COUPLED MULTIPHASE FLOW AND REACTIVE TRANSPORT SIMULATOR FOR SIMULATION OF CO2 STORAGE IN SALINE AQUIFERS

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The storage of CO2 in deep saline aquifers is due to the large available capacities and the common occurrence of these formations one of the major options for carbon dioxide sequestration. The injected CO2 will move in the subsurface as non-aqueous phase driven by pressure gradients due to injection and buoyancy and will dissolve in the formation brine. Due to the thus lowered pH geochemical reactions within the formation brine and with the minerals of the formation rock are stimulated, which may affect porosity and permeability, providing a feedback on the multiphase flow. Simulation of these processes requires a coupled multi-process simulator. Therefore, the coupled simulator OpenGeoSys was coupled to Eclipse, as a standard, efficient multiphase flow code, and to ChemApp, a Gibb's free energy code for thermodynamic equilibrium calculations, which is well adapted to the high pressure and temperature conditions encountered under reservoir conditions.
Coupling is performed via an operator-splitting technique, where ECLIPSE is used to simulate the multiphase flow behaviour of CO2 and the formation brine. Pressure, saturation and phase flow velocities are passed to OpenGeoSys, where transport of dissolved geochemical species in the formation brine is calculated. Because ECLIPSE uses a Finite Difference Method and OpenGeoSys a Finite Element Method, a variable transformation is required for this step. Kinetically controlled mineral dissolution or precipitation reactions are simulated following a Lasaga-type rate law. Brine speciation and equilibrium geochemical reactions are simulated using the thermodynamic code ChemApp. Porosity changes are accounted for and a feed back to the flow simulation is established.
The coupled OpenGeoSys software has been successfully applied to several benchmarks for validating the coupling concept and accuracy. A close comparison of simulation results from the coupled software with OpenGeoSys simulations alone allows to highlight differences stemming from the underlying numerical methods.
The software has been applied to simulate CO2 injection into a realistic site in the north German basin. The main focus of the simulation is the evaluation of the long term geochemical changes induced and their feedback on the multiphase flow field.
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