COUPLING OF TWO-PHASE CARBON DIOXIDE FLOW WITH HEAT TRANSPORT: IMPLEMENTATION OF CONSTITUTIVE RELATIONSHIPS AND PARAMETER STUDIES

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This contribution presents numerical simulation of carbon dioxide (CO_2) capture and storage (CCS) and enhanced oil or gas recovery (EOR, EGR) applications. A small scale model domain focuses on the vicinity of the injection well, where the injected CO_2 displaces the residing fluid. This residing fluid can be either natural gas (in gaseous or supercritical state) or saline water. By reason that injected carbon dioxide has a different, mostly lower temperature than the surrounding reservoir, the storage process is considered to be non-isothermal. Assuming that injected and residing fluids are immiscible, the numerical model solves a multiphase flow governing equation based on the balance of mass, momentum and energy. The independent variables are the pressure of the wetting fluid, the saturation of the non-wetting fluid, and the temperature.

The governing equations are expanded to include the changing of fluid densities with respect to pressure and temperature in compressibility of fluid. International standard equations of state (EOS) are used to couple the two-phase flow process with heat transport. Furthermore, highly precise constitutive correlations determine the effect of varying pressure and temperature conditions to the fluid mobility properties and heat conductivity.

A benchmark example demonstrates the ability of the numerical model and the constitutive correlations to accomplish the influence of variable fluid properties on the simulation results. This test case shows complex connections of the reservoir conditions with the fluid mobility and compression in the immediate vicinity of the injection well during the injection process.

In a sensitivity analysis, effects of reservoir parameters such as depth, temperature gradient, and permeability are investigated. The presented results show that the use of accurate fluid property correlations is essential for feasible prediction of pressure and temperature development, storage capacity, and expansion of the CO_2 plume in numerical simulations of geological carbon dioxide storage.