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Vertical Mixing of CO2 and CH4 with Gravity Effects

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Numerical simulations of mixing of carbon dioxide (CO2) and methane (CH4) in a gravitationally stable configuration have been carried out using the multicomponent flow and transport simulator TOUGH2. The configuration is relevant to carbon sequestration in depleted natural gas reservoirs, where injected CO2 will migrate quickly to low levels of the reservoir by buoyancy flow due to its large density. Once a gravitationally stable configuration is attained, mixing will continue on a longer time scale by molecular diffusion. However, diffusive mixing of real gas components CO2 and CH4 can give rise to pressure gradients that can induce pressurization and flow that may affect the mixing process. Understanding this coupled response of diffusion and flow to concentration gradients is important for the prediction of mixing times in stratified gas reservoirs used for carbon sequestration. We have implemented the Dusty Gas Model (DGM) as an alternative to the standard Advective Diffusive Model (ADM) in our multiphase flow simulator TOUGH2. A new equation of state module (EOS7C) that handles water, brine, CO2, gas tracer, and CH4 was developed in which gas properties for mixtures in the system water, CO2, and CH4 are calculated using the Peng-Robinson real gas mixture model. Comparisons of vertical mixing results for low permeability and high permeability systems using the DGM and ADM will be presented.

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