XVIII International Conference on Water Resources
CMWR 2010
J. Carrera (Ed)
CIMNE, Barcelona 2010

STREAMLINE-BASED SIMULATIONS OF VERTICALLY AVERAGED CO_2 MIGRATION

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Summary. When injected into deep saline aquifers, CO_2 is less dense and much less viscous than the resident brine. It is expected that after the injection period, CO_2 will migrate over several kilometers in the horizontal direction, but only tens of meters in the vertical direction limited by the vertical boundaries of the aquifer. Because of this large aspect ratio, it is reasonable to approximate CO_2 migration using vertically averaged models. The resulting two-dimensional vertically averaged saturation equation includes a parabolic term due to changes in capillary pressure and a hyperbolic term consisting of an advective component due to pressure gradients and a gravitational component due to buoyancy forces.

Streamline methods represent an attractive alternative to solve the vertically averaged saturation equation because of their superior accuracy and speed compared to standard finite difference simulators. The main obstacle for the use of streamline methods is that in standard streamline formulations parabolic terms are handled using an operator splitting approach, which requires mapping saturations at each time step. The mapping introduces numerical errors that are difficult to quantify and make streamlines simulations less attractive for this kind of problems.

We present a new solution technique tailored for the post-injection phase, where gravitational forces dominate. We solve the gravitational term of the saturation equation along gravity lines and the parabolic term using a meshless numerical approximation. The proposed method avoids mapping errors because it does not require interpolating saturations to a background grid to solve the pressure term. We apply the proposed scheme to simulate the long-term migration of an initial CO_2 plume in a heterogeneous sloping aquifer.