Role of partial miscibility on pressure buildup due to constant rate injection of CO2 into closed and open brine aquifers

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Abstract:

This work extends an existing analytical solution for pressure buildup because of CO2 injection in brine aquifers by incorporating effects associated with partial miscibility. These include evaporation of water into the CO2 rich phase and dissolution of CO2 into brine and salt precipitation. The resulting equations are closed-form, including the locations of the associated leading and trailing shock fronts. Derivation of the analytical solution involves making a number of simplifying assumptions including: vertical pressure equilibrium, negligible capillary pressure, and constant fluid properties. The analytical solution is compared to results from TOUGH2 and found to accurately approximate the extent of the dry-out zone around the well, the resulting permeability enhancement due to residual brine evaporation, the volumetric saturation of precipitated salt, and the vertically averaged pressure distribution in both space and time for the four scenarios studied. While brine evaporation is found to have a considerable effect on pressure, the effect of CO2 dissolution is found to be small. The resulting equations remain simple to evaluate in spreadsheet software and represent a significant improvement on current methods for estimating pressure-limited CO2 storage capacity.

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