

Sensitivity analysis of salt precipitation and CO₂-brine displacement in saline aquifers

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Abstract:

Carbon dioxide sequestration in deep saline aquifers is a means of reducing anthropogenic atmospheric emissions of CO₂. Among various mechanisms, CO₂ can be trapped in saline aquifers by dissolution in the formation water. Vaporization of water occurs along with the dissolution of CO₂. Vaporization can cause salt precipitation, which reduces porosity and impairs permeability of the aquifer in the vicinity of the wellbore, and can lead to reduction in injectivity. In an earlier work, we developed an analytical model to predict the precipitated salt saturation and CO₂ displacement around the wellbore. In this study we analyse the effect of different parameters on the salt precipitation and CO₂-brine displacement. The parameters include: aquifer pressure, temperature, salinity, relative permeability functions, and volume change upon mixing.

The results indicate that increasing the salinity, increases the CO₂ spread due to reduced vaporization and dissolution. Furthermore, it is found that the amount of salt precipitation increases and the maximum plume size decreases with pressure increase. The CO₂ plume expands by increasing the temperature. However, the effect of temperature on the salt precipitation depends on the pressure.

Increasing relative permeability of the aqueous phase (or decreasing the relative permeability of the gaseous phase) causes both the amount of precipitated salt saturation and the extent of the CO₂ plume to decrease. It is also found that the effect of volume change upon mixing may be negligible at higher pressures.

For the range of parameters studied, both the solid salt saturation and the plume extent are very sensitive to the relative permeability of the aqueous phase. While the plume size is also very sensitive to the pressure, the salt precipitation is most affected by the brine salinity.

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