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Sensitivity Analysis of Salt Precipitation and CO2-brine Displacement in Saline Aquifers

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Carbon dioxide sequestration in deep saline aquifers is a means of reducing anthropogenic atmospheric emissions of CO_2. Among various mechanisms, CO_2 can be trapped in saline aquifers by dissolution in the formation water. Vaporization of water occurs along with the dissolution of CO_2. Vaporization can cause salt precipitation, which reduces porosity and impairs permeability of the reservoir 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 amount of salt precipitation, and also CO_2 displacement around the wellbore. In this study we analyse the effect of different parameters on the salt precipitation and CO_2 flow in the vicinity of the wellbore. The parameters include: aquifer pressure, temperature, salinity, relative permeability functions, and volume change upon mixing.

The effect of pressure and temperature on advancement of CO_2 in the aquifer depends on the condition under which the CO_2 is injected (sub-critical or super-critical). However, the pressure increase always causes the salt precipitation to decrease. The increase in brine salinity causes the amount of salt precipitation to increase, while reducing the amount of dissolved CO_2 in the aqueous phase. The effect of the relative permeability is studied using Corey's and van Genuchten models.

Water expands when transferred from aqueous phase into the gaseous phase. The opposite occurs for CO_2 when transfers from gaseous phase into the aqueous phase. It was found that advancement of dry CO_2 in the aquifer is faster when the volume change is neglected.

By comparing the results obtained from the analytical model to those obtained by numerical models, it is shown that capillary force may increase the salt precipitation significantly. The gravity can also increase the salt precipitation, but its effect can be small particularly in the wellbore vicinity where the viscous force is large.