

Impact of flow cycling on geochemical reactions in a porous saline aquifer

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Porous saline aquifers are being considered as potential reservoirs for compressed energy storage. In these systems, a gas, such as CO₂, is injected during periods of excess energy production and extracted to drive a turbine during periods of excess demands. However, the injection of reactive gases in saline aquifers can result in mineral dissolution and precipitation reactions. The rate and extent of these reactions and impacts on formation properties are not well understood. Constant injection of CO₂ into saline aquifers for CO₂ sequestration has shown to constantly acidify the formation brine resulting in the dissolution of carbonate and aluminosilicate minerals. Geochemical reactions during the cyclic flow conditions corresponding to energy storage systems, however, have not been considered. In this study, reactive transport simulations are utilized to assess the potential geochemical reactions and changes in porosity that occur during injection and extraction flow conditions for energy storage in saline aquifer using CO₂ as the gaseous phase. Simulation results are compared with simulations that consider the injection-only flow regime of CO₂ for geologic storage. The cyclic flow regime results in noticeably smaller overall dissolution as the rate and extent of dissolution are limited after the first injection cycle. In the injection-only flow conditions, the continuous undersaturation of the reactive fluid with respect to formation minerals results in larger extents of dissolution and higher dissolution rates. Porosity for the injection-only flow regime increased uniformly from 24.84% to 33.6% throughout the simulation domain while it increased non-uniformly for the cyclic flow conditions to 31.1% and 25.8% closest and furthest from the injection well respectively.