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Salinity gradients and salt precipitation due to hydrogen injection in saline aquifers and reservoirs

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As a strategy to match renewable energy supply and demand, surplus energy can be converted into hydrogen gas and stored in the pore space of geological subsurface formations such as saline aquifers and depleted gas reservoirs. Although similar operations with natural gas and CO2 are well studied, H2 has unique chemical and physical properties which, combined with cyclic injection and withdrawal, may cause complex phenomena that affect the efficiency and safety of storage operations. In this study, we investigate the risk of H2 injectivity impairment due to salt precipitation in the pores, driven by the interplay between the evaporation of water from the brine (originally present in the reservoir) into the injected gas, salt diffusion, and capillary fluid flow. To do so, we investigate the pore-scale salt concentration distribution and resulting precipitation patterns during gas injection in sandstone using micro-CT imaging. We present the first of such dry-out experiments performed with hydrogen gas under reservoir pressure and temperature, supplemented with N2 experiments to evaluate the influence of the original salt concentration and flow rate on the salinity gradient during drying, as well as on the resulting salt precipitation. In order to explain and predict the associated permeability impairment, we set up a pore network model with pore structure modification due to precipitated salt in individual pores, measured during the experiment. Our experimental results indicate that salt precipitation can cause up to a 30% reduction in permeability, which was also supported by numerical model outputs. The results of this study provide useful information on the impact of salt precipitation, and other geochemical and microbiological effects driven by concentration gradients on storage efficiency.

Participation

In-Person

References

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