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Effect of rock heterogeneity on pore-scale fluid displacement in a layered sandstone for underground hydrogen storage

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A safe and efficient hydrogen storage mechanism will be crucial for the successful transition towards a green hydrogen economy. Underground storage of hydrogen can be a viable option for short to long-term storage to meet the fluctuations in energy demand. However, there is limited understanding of the pore-scale displacement and trapping mechanisms for hydrogen-brine systems, especially in heterogeneous rocks at reservoir conditions. Our recent experimental study [1] allowed us to understand the trapping of hydrogen within the pore space of a homogeneous sandstone rock and showed dissolution of hydrogen in the resident brine after injection and production of hydrogen at subsurface conditions. In this work, we build on these findings and use X-ray micro-tomography to study the pore-scale fluid displacement processes during cyclic injection of hydrogen in a layered sandstone rock sample. We investigate how the presence of a thin and low permeability layer between two high permeability zones in the rock sample affects fluid displacement processes and hydrogen trapping. The results indicate that hydrogen preferentially occupies the higher permeability zones, and the residual hydrogen saturation increases in subsequent cycles. The findings from this experiment contribute towards the selection of the most suitable subsurface formations for underground hydrogen storage. Extending our research to perform time-resolved synchrotron X-ray imaging experiments will provide additional insights into the dynamics of pore-scale processes in layered reservoirs during underground hydrogen storage.

Participation

In-Person

References

[1] Jangda et al., 'Pore-scale visualization of hydrogen storage in a sandstone at subsurface pressure and temperature conditions: Trapping, dissolution and wettability', Journal of Colloid and Interface Science, vol. 629, pp. 316–325, Jan. 2023, doi: 10.1016/j.jcis.2022.09.082.

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