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Impact of Relative Permeability Hysteresis on Underground Hydrogen Storage

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The relative permeabilities of multiphase fluid systems depend on saturation history as has been shown by experimental, numerical, and field studies. Such hysteresis is especially relevant in underground hydrogen storage (UHS). UHS projects involve temporary storage of hydrogen in the porous subsurface on a seasonal timescale. The injection and production of hydrogen over the span of several seasons necessitates accurate description of saturation history in the reservoir to estimate the overall efficiency of the storage operations and losses due to trapping.

Here, we concentrate on hydrogen injection and production into a heterogeneous semi-synthetic benchmark model of a saline aquifer [1] using TOUGH 3 [2]. We conduct reservoir simulations of UHS accounting for experimental hydrogen-water relative permeabilities from literature [3] which show obvious hysteretic behaviour. The goal is to elucidate the effect of inclusion of hysteretic vs non-hysteretic relative permeability-saturation constitutive relations for multiple storage cycles of UHS. Key markers such as quantity of hydrogen extracted in each cycle and evolution of gas-saturation distribution in the reservoir illustrate the importance of accurately accounting for hysteresis in the simulation of UHS.

Participation

In-Person

References

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Primary authors: Ms KUMBHAT, Diya Sunil (Research Associate, Helmut Schmidt University, Hamburg); Prof. EBIGBO, Anozie (Chair of Hydromechanics, Helmut Schmidt University, Hamburg)

Presenter: Ms KUMBHAT, Diya Sunil (Research Associate, Helmut Schmidt University, Hamburg)

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