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Comparative study of hydrogen and CO2 performance in subsurface using sharp-interface modelling

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The increasing need for hydrogen storage on a large scale has motivated new ideas on different methods of underground storage. Saline aquifers may offer a practical option for hydrogen storage due to their geographic availability and large capacity. However, reservoir engineering aspects of the injection and withdrawal of hydrogen in aquifers are yet to be understood. While 3D reservoir simulations offer rigorous but they are computationally demanding. Alternatively, sharp-interface models can be implemented to still get an accurate description of fluid flow in the porous medium and have less complexity compared to widely-used 3D simulators.
Sharp-interface models are based on the vertical equilibrium concept that considers the presence of a sharp interface between two phases due to the significant density difference between brine and gas and can be applied to reservoirs with a high aspect ratio that makes the vertical fluid flow negligible compared to horizontal flow. The sharp-interface model is widely utilized to study CO2 injection in saline aquifers, so it can also be valid for hydrogen and brine systems, as hydrogen is much lighter than CO2.
In this study, the sharp-interface model from MRST-co2lab is utilized to simulate hydrogen storage in the Johansen formation. The Johansen saline aquifer is one of the large-scale CO2 storage prospects that also have the criteria of the vertical equilibrium approach. This study aims to understand how the difference in densities and viscosities between CO2 and H2 impacts the performance of storage and withdrawal efficiency. For this purpose, CO2 and H2 are injected and withdrawn for four cycles under similar operational conditions and reservoir properties. As CO2 has a higher density and viscosity, its concentration would be higher in areas close to the wellbore, but the hydrogen spreads widely throughout the reservoir. Additionally, the storage ability of H2 is lower than CO2 due to its higher gravity override, though its withdrawal ability is higher than CO2.

Participation

In-Person

References

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