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Underground hydrogen storage in deep aquifers with CO2 as a cushion gas

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Hydrogen is regarded as a key element of the energy transition, provided it is generated from renewables and/or decarbonized energies. Since this production is estimated to be intermittent as that of renewable electricity, safe storage of large quantities of H2 needs to be considered. Currently, hydrogen storages are operated in salt caverns. However, deep saline aquifers offer medium to very large storage capacities, as well as a wide geographic distribution. Therefore, this work aims to improve the evaluation of the performance and safety of the storage of hydrogen in deep aquifers, in combination with CO2 as a cushion gas (CG).
One of the encountered challenges in this topic is to understand the degree and extent of the mixing zone between hydrogen and the CG, or the spreading of the front between these fluids. This understanding serves to minimize and control the mixing process considering that the extent of this zone impacts directly the recovery ratio and the purity of hydrogen produced. Therefore, an accurate description of the fluid mixture between the different components and their behavior within the reservoir is needed during the numerical simulation. The relevant multi-compositional multi-phase flow requires a robust equation of state that is efficient over a wide range of temperatures and pressures and particularly around the storage conditions of the reservoir. Here, we study the different possible thermodynamic models (the research is oriented to cubic Equation-of-State (EoS) and the GERG-2008 equation) and their ability to predict the behavior of compounds of interest separately as well as the possibly resulted mixture.
Through this task and based on the experimental data collected for this system, the phase diagram of the mixture was examined with the attempt to delineate the optimum reservoir conditions, i.e., pressure, temperature and architecture that would rather curtail the mixing phenomena and promotes for the recovery of a hydrogen-rich gas (< 5% CO2). Under the proposed reservoir configurations, different scenarios are evaluated to suggest the suitable injection configuration that could possibly limit the occurrence of miscible or immiscible viscous fingering and could control the stability of the front between the fluids to curtail mixing.

Participation

In-Person

References

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