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Dispersion Measurements for Underground Hydrogen Storage over Sequestered CO2

Underground hydrogen storage (UHS) and geological CO2 sequestration are two important technologies supporting the global energy transition. While each has been widely studied independently, their integration—specifically, the use of stored CO2 as a cushion gas for hydrogen storage—offers both economic and environmental advantages. Using CO2 as the cushion gas can reduce operating costs, make use of already sequestered CO2, and potentially improve storage efficiency. However, implementing such a strategy requires accurate reservoir-scale modelling of hydrogen injection and withdrawal over a pre-existing CO2 layer. A major source of uncertainty in these models is mixing between hydrogen and CO2, which can significantly impact hydrogen purity during withdrawal. Reliable reservoir simulations therefore require experimentally-derived dispersion coefficients (KL) for the H2–CO2 system under reservoir-relevant conditions of pressure, temperature, and flow velocity. Despite its importance, such data has been notably lacking in the literature.

We addresses this critical data gap by presenting the first systematic measurements of dispersion between hydrogen and CO2 in a sandstone core under both gaseous and supercritical CO2 conditions. Using a newly developed continuous-flow core-flooding method combined with benchtop 1H NMR detection, we quantify dispersion behavior during both hydrogen injection and withdrawal, and demonstrate the influence of viscous fingering. These findings fill a key knowledge gap for UHS reservoir modelling and demonstrate that H2–CO2 dispersion in sandstones can be reliably predicted using standard porous-media parameters when coupled with accurate mutual-diffusion models.

Country

Australia

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References

Kobeissi, S., Ling, N. N., Yang, K., May, E. F., & Johns, M. L. (2024). Dispersion of hydrogen in different potential cushion gases. International Journal of Hydrogen Energy, 60, 940-948.

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