Viscous-Dominated Flow Experiments for Hydrogen Storage in Saline Aquifers

Abstract

Underground hydrogen storage (UHS) is a potential long-term solution for net-zero energy storage. There have been numerous simulations studies on the feasibility of UHS in porous media such as saline aquifers, but very few experimental studies to complement them. This seminar will examine core-scale experiments for UHS, and how observations from these studies compare with numerical simulation studies.

An analog fluid system of nitrogen (N_2) and viscosified brine, and a vertically oriented sandstone core are used to simulate hydrogen (H_2) and brine in a saline aquifer at storage conditions. UHS is simulated through cycles consisting of gas injection, shut-in, and production while subjected to x-ray computed tomography (CT). We present the results in 1D, 2D, and 3D visualizations. The effect of permeability heterogeneity is shown through core-scale simulations based on our experimental results.

Bio

Jimin Zhou is a 5th year PhD candidate working with Prof. Anthony R. Kovscek in the Department of Energy Science & Engineering at Stanford University. His research is focused on underground hydrogen storage in porous media. Jimin's work looks at two main points: (1) comparing multiphase Darcy flow theory with core-scale experiments in the context of hydrogen storage, and (2) examining the thermodynamic stability of hydrogen-containing gas mixtures at storage conditions. He has received the Chevron Fellowship in Energy (2022), the Henry J. Ramey, Jr. Fellowship (2024), and was named a Siebel Scholar for the class of 2026.

Research related papers

- Zhou, J.D., Kovscek, A.R. 2025. Viscous-Dominated Flow Experiments for Hydrogen Storage in Saline Aquifers. Presented at the SPE Western Regional Meeting, Garden Grove, CA. SPE-224189-MS
- Zhou, J.D., Kovscek, A.R. 2024. Hydrogen Storage in Saline Aquifers: Experimental Observations of Viscous-Dominated Flow. Presented at the SPE Western Regional Meeting, Palo Alto, CA. SPE-218944-MS
- Okoroafor, E.R., Sampaio, L., Gasanzade, F., Perez Claro, Y., Zhou, J.D., Saltzer, S.D., Bauer, S., Kovscek, A.R. 2023. Intercomparison of numerical simulation models for hydrogen storage in porous media using different codes. *Energy Conversion and Management* **292** pp. 117409.