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CT Gas Tracer Study of Gas Trapping and Diffusion in Foam in Porous Media

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Foam improves sweep efficiency in gas-injection processes to sequester CO_2 in, and to produce hydrocarbons from, porous geological formations (Bellow, 2023, Rossen et al., 2022). Gas trapping plays a key role in foam's ability to reduce gas mobility in porous media. We describe a study of gas trapping and diffusion in a sandstone core using nitrogen (N_2) foam and krypton (Kr) as a gas-phase tracer.

Surfactant solution and nitrogen were injected, with gas fraction 0.6, superficial velocity 2 ft/day (3.5 x 10-6 m/s), into a 17-cm-long, 4-cm-wide Berea core oriented horizontally in a CT scanner. At steady-state, foam apparent viscosity was 0.4 Pa s (400 cp), and gas saturation was uniform across the core cross-section. Then injection continued with 0.6 gas fraction, but with half the N_2 replaced by Kr gas. Krypton can be distinguished in the CT scanner from N_2 at the pressure of these experiments (4 MPa). Kr can therefore serve as a tracer in high-pressure foam-flow experiments in cores in place of the more-expensive xenon used by Nguyen et al. (2009). With image filters, it was possible to determine Kr fraction in the gas from the image with a resolution of about 2 mm.

CT images show that the advance of Kr was almost entirely in a thin zone at the top of the horizontal core, with trapped, immobile foam below. (See graphical abstract, where Kr is shown in red.) This is likely the result of segregation of gas and surfactant solution in the core endplate. Similar, though less-severe, segregation originating in the endplate was observed in the foam CT experiments in Kil et al. (2011). Slowly Kr diffused down from the flowing foam at the top of the core, in a similar fashion to diffusion of gas through trapped foam in the coreflood experiments in Kil et al. Our resolution was not sufficient to resolve individual flowing-gas paths in our experiments as in Kil et al., however. A model fit to the CT data indicates that flowing fraction of gas in the core was roughly 0.06, and the Kr diffusion coefficient through trapped gas was 3 to 4 x 10-8 m2/s.

In addition to measuring the flowing gas fraction and diffusion rate of gas through trapped foam, these results highlight the usefulness of Kr as a possible gas-phase tracer in high-pressure foam experiments in porous media. They also highlight the need to account for possible nonuniform injection from the core endplate in multiphase displacements in core samples.

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References

** Bello, A., et al., "Foam EOR as an Optimization Technique for Gas EOR: A Comprehensive Review of Laboratory and Field Implementations,"Energies, 16(2): (2023)972. https://doi.org/10.3390/en16020972 ** Kil, R. A., Nguyen, Q. P., and Rossen, W. R., "Determining Trapped Gas in Foam From CT Images," SPE Journal 16, 24-34 (2011). https://doi.org/10.2118/124157-PA ** Nguyen, Q. P., et al., "Determination of Gas Trapping With Foam Using X-Ray CT and Effluent Analysis," SPE Journal 14, 222-236 (2009). https://doi.org/10.2118/94764-PA ** Rossen, W. R., et al., "Potential and Challenges of Foam-Assisted CO2 Sequestration," SPE paper 209371, presented at the SPE Improved Oil Recovery Conference, Tulsa, OK, 25-29 April 2022. https://doi.org/10.2118/209371-MS

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