Contribution ID: **445** Type: **Oral Presentation**

Impact of nanoparticles and gas composition on bubble density and coarsening rate of confined CO2-foam under high-pressure high-temperature conditions

Wednesday, 24 May 2023 12:00 (15 minutes)

The use of foam technology is a potential solution to control gas mobility in highly heterogeneous reservoirs. However, achieving stable CO2-foams under reservoir conditions can be challenging since the high solubility in water of supercritical CO2 enhances coarsening and coalescence of confined bubbles. Coarsening is characterized by the evolution of foam structure due to gas diffusion between bubbles, changing the average bubble size and foam texture. When foam texture coarsens, gas mobility control is impaired, and it can also affect foam rheology (Nonnekes et al., 2015). While most studies have focused on the dynamics of foam texture, which results from the balance between foam generation and destruction, few works have tried to evaluate foam coarsening for confined foams. In this presentation we will show the main results from a micromodel experiment where CO2-foam coarsening was reduced by using nanoparticles and/or a CO2/N2 gas mixture. A zwitterionic surfactant was used as base foaming agent, and different foams containing CO2 were injected into a micromodel at high pressure (10.3 MPa) and high temperature (60 ℃). Pressure drop, foam texture (bubble density), bubble growth regime, and flow characteristic were quantitatively assessed and related to gas mobility reduction obtained by gas trapping during the co-injection of gas and foaming fluids at 50% foam quality. Image analysis was performed without stopping the foam experiment or using a dye for image analysis, and used to calculate bubble density and size distribution of the foam confined in dead-end pores areas of the micromodel. The results showed that the CO2-foam stabilized only by surfactant showed poor behavior in porous media, while an improvement in both foam texture (bubble density at the inlet of the micromodel) and gas trapping was obtained using the nanofluid (Lopes et al., 2021). A larger decrease in gas mobility was obtained with CO2/N2 gas mixture, achieving the highest increase in pressure drop, which was attributed to the large number of trapped bubbles (2x higher than with nanofluid). This result suggested that using a gas mixture would be suitable to control gas mobility in high-permeability channels and to block thief zones. The coarsening rates (change in trapped bubble area with time) were reduced in both cases, indicating that the initial foam texture determined the resistance to flow (Façanha et al., 2022). The attempt to combine both strategies for reducing coarsening showed that nanoparticles decreased the pressure drop of the foam generated with the N2/CO2 mixture. Hence, injectivity concerns that might arise when injecting a gas mixture with a surfactant solution could be overcome by adding nanoparticles to the aqueous phase. The results of this work suggest that a minimum pressure gradient for strong foam generation can be achieved by simply tackling the foam destruction mechanisms rather than changing injection conditions, showing the complexity of foam injection projects. Therefore, investigating the mechanisms of foam destruction at pore scale is fundamental for tailoring CO2-foam properties for field applications.

Participation

In-Person

References

Façanha, J.M.F., Lopes, L.F., Fritis, G., Godoy, P., Weber dos Santos, R., Chapiro, G., Perez-Gramatges, A., 2022. Bubble-growth regime for confined foams: Comparison between N2–CO2/foam and CO2/foam stabilized by silica nanoparticles. J. Pet. Sci. Eng. 218, 111006. https://doi.org/https://doi.org/10.1016/j.petrol.2022.111006

Lopes, L.F., Façanha, J.M.F., Maqueira, L., Ribeiro, F.R.T., Pérez-Gramatges, A., 2021. Coarsening reduction strategies to stabilize CO2-foam formed with a zwitterionic surfactant in porous media. J. Pet. Sci. Eng. 207, 109141. https://doi.org/10.1016/j.petrol.2021.109141

Nonnekes, L.E., Cox, S.J., Rossen, W.R., 2015. Effect of Gas Diffusion on Mobility of Foam for Enhanced Oil Recovery. Transp. Porous Media 106, 669–689. https://doi.org/10.1007/s11242-014-0419-z

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

Brazil

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary author: Prof. PÉREZ-GRAMATGES, Aurora (Pontifical Catholic University of Rio de Janeiro)

Co-authors: DA FONSECA FAÇANHA, Juliana Maria (Shell Bazil Technology); FREITAS LOPES, Leandro (Pontifical Catholic University of Rio de Janeiro); CHAPIRO, Grigori (Universidade Federal de Juiz de Fora); Prof. WEBER DOS SANTOS, RODRIGO (Federal University of Juiz de Fora); RIBEIRO, Felipe (Pontifical Catholic University of Rio de Janeiro); GODOY, Pablo (Pontifical Catholic University of Rio de Janeiro); MAQUEIRA, Luis (Pontifical Catholic University of Rio de Janeiro); FRITIS, Giulia (Federal University of Juiz de Fora)

Presenter: Prof. PÉREZ-GRAMATGES, Aurora (Pontifical Catholic University of Rio de Janeiro)

Session Classification: MS11

Track Classification: (MS11) Microfluidics and nanofluidics in porous systems