Contribution ID: **79**

Type: **Oral Presentation**

Nanofluidics: a window into pore-scale fundamentals of CO2 injection in shale

Tuesday, 23 May 2023 14:30 (15 minutes)

Shale resources are massive, controversial, and provide an increasing share of global energy with a broad group of stakeholders in academia, industry, and government. CO2 injection is promising for enhancing shale resource recovery due to its high mobility in tight porous media and strong extraction capacity for hydrocarbons. Meanwhile, the injected CO2 can be sequestered in the reservoir to achieve the carbon neutralization goal. The shale reservoir is featured by its nanometer pores. Due to the unique nanoscale confinement effect, the interactions among CO2, reservoir fluids, and minerals in shale differ from that in conventional reservoirs.

In this presentation, we would like to introduce our recent nanofluidic and theoretical work in investigating nanometer pore-scale CO2 injection fundamentals. Emergent topics include nanoconfined CO2-oil miscibility and CO2-induced salt precipitations. The nanofluidic experiments indicate deviations from classical theory predictions, due to the multiscale nature of the shale matrix. The miscibility between CO2 and oil at the nanoscale is found to shift from the bulk value and varies with pore structures. The salt precipitation and dissolution rate during the CO2 injection is slowed by orders of magnitude from theoretical predictions. In addition, the nanofluidic device has also been applied to characterize the phase behaviors of gas condensate at the nanoscale. The upper dew point is measured to deviate from the bulk value significantly, and is affected by pore size distributions. We see massive opportunities in leveraging nanofluidic devices to evaluate relevant fluid phases and transport fundamentals of CO2 injection in shale. The experimental findings can provide solid support for theoretical modeling and simulation.

Participation

In-Person

References

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Session Classification: MS11

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