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Storage and recovery of multi-component mixtures in single shale pores

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Natural gas production from shale formations has received extensive attention in recent years. While great progress has been made in understanding the adsorption and transport of single-component gas (usually CH_4) inside shales'nanopores, the adsorption and transport of multicomponent shale gas under more realistic reservoir conditions (e.g., considering CH_4/C_2H_6 mixture) only begun to be studied. In this work, we use molecular simulations to compute the storage of CH_4/C_2H_6 mixtures in single nanopores and their subsequent recovery. We show that, surface adsorption contributes greatly to the storage of CH_4 and C_2H_6 inside the pores, and C_2H_6 is enriched over CH_4. The enrichment of C_2H_6 is enhanced as the pore is narrowed, but is weakened as the pressure increases. These effects are captured by the ideal adsorbed solution (IAS) theory, but the theory overestimates the adsorption of both gases. We show that the recovery of gas mixtures inside the nanopores toward a gas bath approximately follows the diffusive scaling law. The ratio of the production rate of C_2H_6 and CH_4 is close to their initial mole ratio inside the pore despite that the mobility of pure C_2H_6 is much smaller than that of pure CH_4 inside the pores. By using scale analysis and by computing the Onsager coefficients for the transport of binary CH_4/C_2H_6 mixtures inside the nanopores, we show that the strong coupling between the transport of C_2H_6 and CH_4 is responsible for the effective recovery of C_2H_6 from the nanopores.

References

H. Wu, Y. He, and R. Qiao, "Recovery of multicomponent shale gas from single nanopores", Energy & Fuels, 31, 7932, 2017

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Primary authors: Mr WU, Haiyi (Virginia Tech); Prof. QIAO, Rui (Virginia Tech)

Presenter: Prof. QIAO, Rui (Virginia Tech)

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