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Dynamic pore-network modeling of compositional flow and nanoconfined phase behavior in shale rocks

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The phase behavior of fluids becomes abnormal in shale formations due to the presence of extensive nanoscale pore spaces. Prior research has demonstrated that this so-called nanoconfined phase behavior—driven by the presence of significant capillary pressure and interaction between hydrocarbons and the pore wall (i.e., competitive adsorption)—is a function of the pore size and geometry. However, it remains unknow how the pore-size and -geometry dependent nanoconfined phase behavior manifests in complex multiscale nanopore structures representative of shale rocks. The interplay between the nanoconfined phase behavior and compositional gas-condensate flow adds further complexity. Here, we develop a novel dynamic pore-network model that couples nanoconfined phase behavior and compositional gas-condensate flow. The new modeling framework is comprised of 1) a phase-equilibrium model that accounts for the pore-size and -geometry dependent nanoconfinement effects and 2) a fully implicit dynamic pore-network modeling framework that couples the individual-pore nanoconfined phase-equilibrium formulation with the two-phase compositional flow. This new framework for the first time allows us to investigate the interactions between nanoconfined phase behaviors and compositional flow dynamics in complex multiscale pore structures representative of shale rocks, which we will illustrate by a series of numerical experiments on complex nanopore networks with pores varying in size and geometry.

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Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Unsure

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