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Oil/water two-phase slip flow in a random pore network of shale

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In contrast to the conventional reservoirs, shale reservoirs embody micro-pores developed from inorganic minerals and nano-pores developed from organic matters, which can both exert an important influence on two-phase flow properties. Through a bimodal pore-size distribution (PSD) in whole shale system verified by nitrogen absorption tests may be assumed as the Gaussian mixtures, the random pore-network model for shale is developed with a classification algorithm that decouples the different distributions of inorganic pores and organic pores. Corresponding throats can be generated and distinguished appropriately.
As for shale system, traditional Hagen-Poiseuille flow equation may not be applicable on account of the slip effect in nanopores and pore geometry in the whole system. Here, computational fluid dynamic (CFD) method is utilized to modify bulk/corner phase flow equations in various geometric pores (circular, square, equilateral triangle) for two-phase slip flow. Developing new flow equations, we can estimate the flow characteristics such as capillary pressure and relative permeability relationships in a shale network through the quasi-static simulation technique. Our study confirms the slip effect would significantly affect oil/water two-phase flow in shale. And then, we employ this multiscale network model to further study the influence of shale pore structure on oil/water two-phase flow properties.
Through coupling the multiscale pore-network model and oil/water two-phase slip flow for shale reservoirs, we believe this work can furnish a great importance to the further research associated with flow mechanism in shale.

References

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