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Nano-scale wetting film impact on multiphase transport properties in porous media

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The multiphase distribution and transport properties in porous media are strongly influenced by capillary pressure and rock-fluid interactions. The influence of nano-scale wetting film caused by the disjoining pressure on the multiphase transport properties is not fully considered in the current pore scale modeling methods and it is unclear how the nano-scale wetting film influences the transport behavior. In this study, we propose a multiphase pore network transport model that considers both capillary pressure and disjoining pressure (the latter arising only in fluid films on solid surfaces). The thickness of nano-scale wetting film under multiphase conditions in irregular pores is calculated based on the force balance between capillary pressure and disjoining pressure resulting from van der Waals force, electric double-layer interactions and structural force. The gas displacing water process is simulated in a water-wet 3D unstructured pore network extracted from 3D reconstructed digitized shale image. The influence of nano-scale wetting film on essential transport parameters including relative permeability, capillary pressure curve and resistivity index is analyzed and its variation is elucidated for different porous media length scale. Notably, the nano-scale wetting film enhances the wetting phase relative permeability and electrical conductivity in nano-scale porous media, and the effect is way less important on micron-scale. Furthermore, we found that the nano-scale wetting film causes more wetting fluid retention after displacement in nanoporous media, which possibly explains the low flowback rate after hydraulic fracturing in shale and ultra-tight sandstones.

Time Block Preference

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

References

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