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Calculation of CO2-oil minimum miscibility pressure for tight reservoirs considering adsorption effect

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CO2 miscible injection holds tremendous potential for enhancing tight oil recovery, where achieving the minimum miscibility pressure (MMP) is crucial. The adsorption of CO2 and oil in nanopores affects the CO2-oil MMP in tight reservoirs, necessitating the precise calculations of nanoscale MMP and a comprehensive understanding of influencing factors. In this work, we employed a modified Peng-Robinson equation of state (PR-EOS) for nanoscale MMP calculations, incorporating adsorption layers and effective molar volume to describe molecular adsorption. Additionally, our improved method accounted for capillarity and critical point shift. The accuracy of this approach is validated against molecular simulations and nanofluidic experiments, with a maximum deviation of 4.61%. We observed that in nanopores, achieving miscibility demands less CO2 than in bulk. The CO2-oil MMP reduces as pore size decreasing, influenced by adsorption, capillarity and critical point shift. At 5 nm, the MMP is 11.12 MPa, 27.8% lower than the bulk value (15.4 MPa). Adsorption intensifies this reduction by curtailing free molecules and effective pore radius, and becomes more pronounced for lighter hydrocarbon mixtures. However, the nanoscale CO2-oil MMP is equal to the bulk value when rp ≥ 350 nm. Furthermore, a maximum MMP and the corresponding transition temperature exist for each pore size, and increase as pore size increasing. This method provides a valuable tool for optimizing CO2 miscible injection and carbon storage in challenging nanoscale-pore reservoirs.

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