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A Robust three-phase equilibrium calculation framework for dimethyl ether (DME)-H2O-CO2-Hydrocarbon systems

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CO2 flooding is a strategic measure to enhance oil recovery (EOR) while mitigating CO2 emissions. In recent years, dimethyl ether (DME) has emerged as a promising solvent used in EOR practices. Its potential application in CO2 flooding attracts considerable interest. However, accurate modeling of the phase behavior of the DME-H2O-CO2-Hydrocarbon system remains a challenge, which leads to the lack of a reliable reservoir simulator required by the industrial production simulation.

In this study, the phase behavior of the DME-CO2-H2O is systematically studied after the intensive literature collection and review. We developed a robust and efficient multiphase equilibrium calculation framework for the DME-H2O-CO2-Hydrocarbon systems. The Peng-Robinson EOS with the Huron-Vidal mixing rule is used as our thermodynamic model. We have implemented a combined successive substitution-Newton-trust region iterative algorithm to guarantee convergence in the stability analysis and multiphase flash calculations. Besides, the initial phase equilibrium constants (K-values) strategy is revealed to correctly detect the phase status for one-phase and two-phase stability analyses. We present the performance of our model with two characterized fluid systems from the literature. For each case, the fluid consists of 30% oil and 70% H2O, and the mixture of the different ratios of CO2 and DME is injected into the fluid. Our model works accurately and robustly for these cases, and we do not find a single mistake or convergent problem for more than tens of millions of tested points.

Our model and the developed algorithms can robustly and accurately predict the multiphase behavior of the DME-H2O-CO2-Hydrocarbon systems. To the best of our knowledge, our algorithm is the first one to meet the restricted standard for multiphase equilibrium calculations in the compositional simulation of injecting the mixture of CO2 and DME into a reservoir. Our developed method will provide the key contribution to the development of the compositional simulation for the DME-H2O-CO2-Hydrocarbon systems.

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References

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