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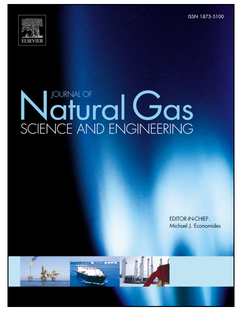

Data-driven comparison between solid model and PC-SAFT for modeling asphaltene precipitation

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Abstract

Selecting an appropriate equation of state (EOS) to model asphaltene precipitation in compositional wellbore and reservoir simulators is still unclear in the literature. Recent studies have shown that the PC-SAFT model is more appropriate for modeling asphaltene precipitation compared to the commonly used solid model. The main objective of this paper is to compare the solid and PC-SAFT models in both static and dynamic asphaltene modeling. Through fluid characterization, the capabilities of both models are compared to reproduce precipitation experimental data.

The results show that both solid and PC-SAFT models are capable of predicting the amount of asphaltene precipitation with high accuracy. Although the matching process using the PC-SAFT model is much easier, the properly tuned solid model is also able to reproduce the experimental data with the same quality as the PC-SAFT model. The simulation results show that the PC-SAFT model is superior to the solid model in terms of the extrapolation accuracy when the experimental data are not available for the simulation conditions (i.e., variation in temperature, pressure, and fluid composition in the reservoir/wellbore). However, both models are applicable for interpolation when the experimental data cover the entire range of the simulation condition. The wellbore simulations show that although the trend of asphaltene deposition is similar for both models, the solid model using Peng-Robinson EOS overestimates the amount of asphaltene precipitation and deposition in the wellbore compared to the PC-SAFT model. On the other hand, the simulation procedure using the PC-SAFT model takes much more computational time as this model uses an iterative solution to obtain the density roots and the phase equilibrium calculation.

Introduction

Asphaltene deposition is known to be one of the major problems in the oil industry. Asphaltene precipitation and deposition from the reservoir fluid cause serious formation damage problems (i.e., pore throat plugging and wettability alteration) in the near wellbore region where maximum pressure drop occurs (Darabi 2014). Furthermore, asphaltene precipitation and deposition can occur in the wellbore and result in partial or total plugging. These factors affect the project economics by lowering the production rate and requiring frequent remediation jobs. Additionally, miscible gas flooding with CO_2, N_2, and natural gas might reduce the asphaltene solubility in the crude oil and enhance the probability of asphaltene precipitation and deposition in the reservoir and wellbore (Gonzalez et al. 2005).

By classic definition, asphaltene is the heaviest and most polarizable component of the crude oil. Asphaltene is characterized as insoluble in paraffins such as n-pentane and soluble in aromatic solvents such as benzene (Srivastava and Huang 1997). The carbon number of asphaltene macromolecules is in the range of 40 to 80 with a typical H/C ratio of 1.1 to 1.2. The typical range of asphaltene density is around 1.12 to 1.2 g/cm^3 (Gonzalez et al. 2005). Hence, the crude oil with more asphaltene content has higher viscosity and density.

Creek (2005) reported that removal and reduction of asphaltene deposits cost about 0.5 and 3 million US dollars for onshore and offshore fields, respectively, and the loss of production may rise up to 1.2 million US dollars per day assuming the oil price of $30 per barrel. Therefore, prevention of asphaltene precipitation and deposition is more favorable in terms of easiness and