A wax crystallization model from DSC experiments

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Wax deposition in pipeline during operations represents a concern in petroleum production. Different models have been developed during years to describe this phenomenon and molecular diffusion is typically considered as the most important mechanism [1]. However, in addition to the molecular diffusion, other mechanisms were considered important to study wax deposition and gelification [2]. In this work, a preliminary mathematical model is presented for crystals segregation/dissolution in a model mixture which mimics the behaviour of waxy oils. The mathematical model is based on a multi-scale approach [3], which takes into account microscopic phenomena, such as nucleation and growth of wax crystals, and macroscopic phenomena, such as diffusion and gelation. The multi-scale approach is able to discriminate among several mechanisms, such as thermal diffusion, segregation of waxes, diffusion of dissolved and segregated waxes and last but not least gelification. The idea underlying the system is to exploit simple experimental data, such those coming from DSC of a mixture, which are employed here to validate the mathematical model. Effects of supercooling in cooling experiments as well as phase change phenomenon in both heating and cooling experiments demonstrate that DSC plots never provide the real solubility curves and phase change inertia is needed to be included to avoid this discrepancy. The model represents a relatively simple procedure to predict the behaviour of a two component mixture during heating/cooling cycles. Based on its validity, the model could be extended to more complex systems, such as waxy crude oils, to reasonably make predictions on segregation dynamics, eventually leading to wax deposition on the wall of a pipeline.

References

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