Experimental Study and Modelling of Asphaltene Precipitation Caused by Gas Injection - DTU Orbit (24/08/2019)

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Amongst the different possible solid deposits occurring in the oil industry, asphaltenes might be the most studied and the less understood issue. The problems due to the heaviest and molar polar fraction of petroleum affect reservoirs, wells and even refinery processes, to name a few of their nuisances. The colloidal behaviour of asphaltenes in crude oil, the lack of knowledge about its structure, the complexity of the aggregation, flocculation, precipitation or deposition processes make this topic quite complex and interesting. During the Enhanced Oil Recovery (EOR) process, gases such as carbon dioxide or nitrogen may be injected in order to decrease the viscosity of the oil or to push it towards the well, whether it is miscible or not. For instance, 20,000 tons per day of CO₂ are currently delivered to oil fields for EOR projects. Total production due to CO₂ injection is a little less than 200,000 barrel/day. However, this injection clearly modifies the composition of the oil and its conditions. Therefore, asphaltenes have the tendency to flocculate and precipitate during such modifications. There is no predictive tool so far since models are descriptive at the best. The technical solutions are expensive (injection solvent, cleaning pipes). Thus, studying asphaltene precipitation during gas injection and trying to get more knowledge about asphaltene stability seemed relevant. In Chapter I, a brief review of asphaltene science is presented as well as the problems that petroleum industry has to cope with because of asphaltenes. In Chapter II, some input parameters used for the modelling of asphaltene phase behaviour are determined (namely the solubility parameter of crude oils and asphaltenes as well as the critical constants of asphaltenes). The effect of pressure is emphasized. In Chapter III, asphaltene stability in presence of carbon dioxide and methane is investigated for several crude oils over a wide range of pressures and temperatures with a novel high-pressure experimental set-up. The effects of pressure and temperature are identified. In Chapter IV, calorimetry is used to obtain more understanding about asphaltene precipitation. Experiments are performed with dead and live oils and compared to model systems. Two techniques were used for that matter: high-pressure scanning calorimetry and isothermal titration calorimetry. In Chapter V, a model taking into account aggregation and based on cubic equations is presented. It is tested with several crude oils and asphaltene solutions. Conclusions and future challenges are presented in Chapter VI. The additional information is gathered in Appendixes.

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