Comprehensive Crude Oil Wax Precipitation Study Using Differential Scanning Calorimetry

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Wax precipitation in crude oil is fundamental information for flow assurance studies. Wax appearance temperature, wax precipitation curves, and total wax content are key wax properties as input to wax deposition simulations and wax control strategy. There are different methods for wax appearance temperature and wax precipitation curves [1, 2]. Differential scanning calorimetry is one of the methods widely used [3, 4]. Total wax content is often obtained from method UOP 46 and its modifications [5, 6]. However, this method suffers from poor reproducibility. There can be quite different results from different labs, depending on slight differences in procedure. This has been investigated by detailed analysis of precipitated wax samples. Total wax content can also be obtained using Differential Scanning Calorimetry (DSC). This requires empirical correlations for the enthalpy of fusion [7, 8]. A new and robust DSC method for total wax content, by applying octane addition, is presented. The enthalpy of fusion is measured for the reference oil, and oil with octane additions. For all the samples, a nonlinear relationship between enthalpy of fusion and total wax content could be established, which in turn gives the total wax content of the reference oil. It is shown that the enthalpy of fusion for the wax components themselves in different crude oils could vary in a wide range between 100 and 200 J/g. Therefore, the empirical correlation [8] could both over- and underpredict total wax content, with quite large deviations found in several cases. Total wax content and WAT obtained with the new DSC method has been compared with data obtained from UOP 46 and Crossed Polar Microscopy, respectively. With the new DSC method, both wax appearance temperature, the entire wax precipitation curve, and total wax content can be obtained quickly with a very small volume of oil.