Kinetic growth of asphaltene aggregation in crude oil

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Near the onset of asphaltene instability, asphaltene aggregation in crude oil is a slow process. The rate of particle growth, the agglomeration of particles to form large aggregates, size distribution, and the morphology of aggregates may have significant impact on the tendency for precipitated asphaltenes to deposit on tubing wall surfaces as well as on sedimentation and accumulation during oil production. Previous studies that used light scattering to measure asphaltene particle size distribution need to assume a particle shape that may fail to discriminate aggregate morphology accurately. Usually dilute solutions of redispersed asphaltene dissolved in toluene have been used in light scattering measurements, which may not produce results that are representative of the precipitation mechanism in a natural crude environment. In this study, we have utilized high resolution digital photography to capture the continuous growth of precipitated asphaltene particles and aggregates from a crude oil destabilized by n-alkanes. A 0.02x0.2x50 mm glass capillary tube was used to provide a closed system to contain the oil/n-alkane mixtures studied microscopically. The tube was placed on a heat stage to maintain constant temperature and the photo micrographs were captured as a function of time. Recorded images were analyzed using open-source software (ImageJ) to evaluate changes of particle size distribution and morphology of aggregates as a function of time and temperature. Results from these statistical analyses will be compared for oils with completely different deposition tendencies to improve our understanding of complex deposition mechanisms. Calculated precipitation rate and agglomeration rate – a pair of competitive efforts in deposition process – also provide crucial inputs to a downhole asphaltene deposition simulator currently under development [1].

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Reference

[1] Vargas, F.M., Creek, J.L., Chapman, W.G., “On the Development of an Asphaltene Deposition Simulator” *Energy & Fuels*, February, 2010.