Effects of Resins on Aggregation and Stability of Asphaltenes

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Effects of the addition of resins on aggregation and stability of petroleum asphaltenes in hydrocarbon solutions were studied by dynamic light scattering. Average aggregate size as a function of the concentration of the precipitant (heptane) and upon the addition of resins was monitored in real time. It is shown that resins serve as inhibitors for asphaltene aggregation, shifting the onset of aggregation. However, the dependence of the onset on the concentration of resins has a tendency to saturate. The characteristic time of aggregation decreases exponentially upon increase of the precipitant concentration, while it grows linearly upon increase of the concentration of resins. A definition of the onset of asphaltene aggregation based on the time dependence of the aggregate-size growth is suggested. It is also shown for all the samples studied (with and without resins) that the aggregation is controlled by diffusion-limited kinetics. The size of the aggregates as a function of time follows a diffusion-limited-kinetics power law with an exponent $\alpha = 0.36 \pm 0.04$, which is related to the fractal dimension d_f of asphaltene clusters as $\alpha = 1/(1+d_f)$.