Characterization and Modeling of Asphaltenes: from Model to Processing Conditions

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Due to a high energy demand, the petroleum industry has to focus on low quality products such as heavy oils and distillation residua, to be transformed into valuable fractions. These products show difficulties to be converted during hydrotreating processes because of their asphaltene content, which are heavy molecules with peculiar aggregation properties. Small angle scattering techniques (X rays, neutrons and light) were used to characterize the system on a wide length scale (1 nm - 1 μm). Asphaltenes in model solvents were first investigated to refine the description of nanoaggregates made of core/shell discs, organized at a larger length scale into polydisperse fractal clusters. This colloidal approach was then adapted to study the asphaltenes in processing conditions. A nanofiltration process has been performed, and the structural study of the fractions made evidence that the system is a colloidal suspension of particles. The behavior through temperature elevation depends on the length scale of interest: while clusters are sensitive to temperature, nanoaggregates persist at 300°C. The hierarchical aggregation scheme enables predicting viscosity behaviors through temperature and concentration variations. These findings on structural organization and characteristic particle sizes near processing temperatures improve the knowledge required for heavy oil transport, hydroconversion process and catalyst design.