The Various Phases and Phase Transitions of Asphaltene in Natural Gas and Petroleum Systems

G.A. Mansoori
Department of Chemical Engineering
University of Illinois at Chicago
810 S. Clinton Street
Chicago, IL 60607-7000 USA

Asphaltene is a highly active non-hydrocarbon molecule which is often present, along with many variety of hydrocarbons and non-hydrocarbons, in natural gas and petroleum systems. While studies about the variations of the molecular structures of asphaltenes from natural sources is well documented, its behavior in oil systems is not well recognized. This has resulted in many misunderstandings when there has been attempts by engineers and scientist to model thermophysical properties of asphaltenic oils.

It is a proven fact that asphaltenes could exist in oil in various phases including in molecular form, in steric colloidal state, in micellar state, and in solid state. It is also known that asphaltenes are polar, polydisperse, surface active agents, and are of the category of associating compounds. Association, or aggregation of asphaltenes could be reversible, or irreversible, depending on the presence and relative amounts and kinds of other components of an oil system. Other variables which are known to affect asphaltene phase transitions are temperature, pressure, the nature of the oil container, conduit through which oil flows, oil thermal and electrical conductivities, oil viscosity, and oil flow regime.

In this talk the author will present and illustrate the basic cause and effects of phase transitions that asphaltene goes through in oil systems. The experimental techniques to detect the phase transitions of asphaltene will be discussed. Reaction kinetics, electrokinetics, transport, statistical mechanical, and thermodynamic models which can be utilized to predict and quantify the behavior of asphaltene in oils will be presented. Sample calculations for a number of cases for which experimental phase behavior data are available will be presented.