CHAPTER II
HISTORICAL BACKGROUND

2.1 Definition of Asphaltenes

Asphaltenes are usually referred to the most polar part of the heavy end of crude oil. Since the difficulty of isolating and characterizing asphaltene individually, asphaltenes are often defined as the fraction of crude oil that is insoluble in light normal alkanes (e.g., n-pentane or n-heptane), but soluble in aromatic solvents (e.g., toluene) (Mitchell and Speight, 1973 ; Burger and Li, 1981). Figure 2.1 shows the diagram of separation asphaltene from crude oil.

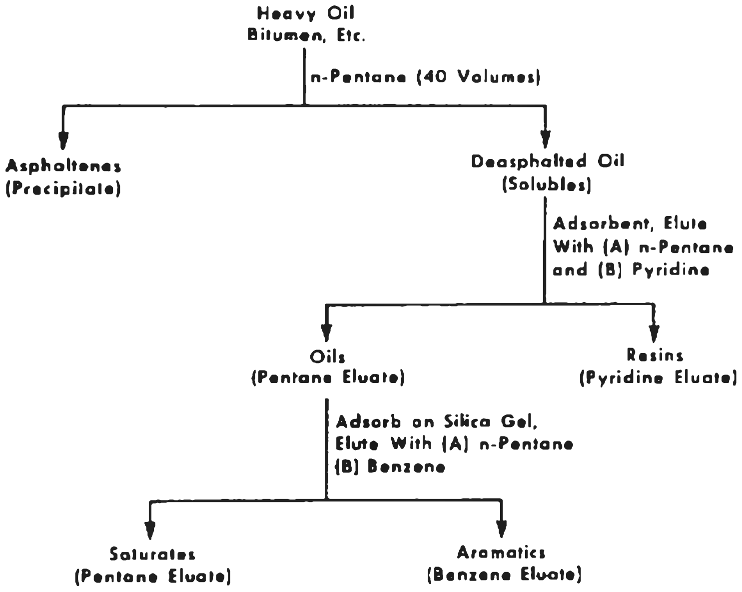

Figure 2.1 The separation of petroleum into four major fractions (Speight, 1991).

2.2 The Structure of Asphaltenes

Asphaltenes consist of condensed aromatic nuclei that carry alkyl and alicyclic systems connected by the heteroatom bridges (i.e., nitrogen, oxygen and sulfur) scattering throughout in various locations.

The presence of functional groups contributes strongly to the physical-chemical properties of asphaltenes. Sulfur is presented principally in condensed thiophenic structures (benzo-, dibenzo- and naphthobenzothiopene), but is also presented in aliphatic (sulfides and disulfides) and oxidized forms. The sulfides and disulfides are often presented as the bridges between hydrocarbon clusters in asphaltene molecule. Nitrogen-containing functional groups are both base (in the form of aliphatic and aromatic amines, particularly primary amines and pyridene derivatives) and neutral (as indoles, carbazoles, and amides as well as porphyrinic nitrogen) in nature. Oxygen is presented predominantly in the form of acidic functional groups (carboxylic acids and phenols) (Sheu and Mullins, 1995). Asphaltenes contain the trace metal (Ni, V, and Fe) in form of the organometallic compound which result in the asphaltene to be the heaviest part of crude oil.

Even though, the actual structure of asphaltenes depends on the source of oil from reservoir to reservoir, Figure 2.2 gives an idea of the structural complexity of the compounds comprising the asphaltene.

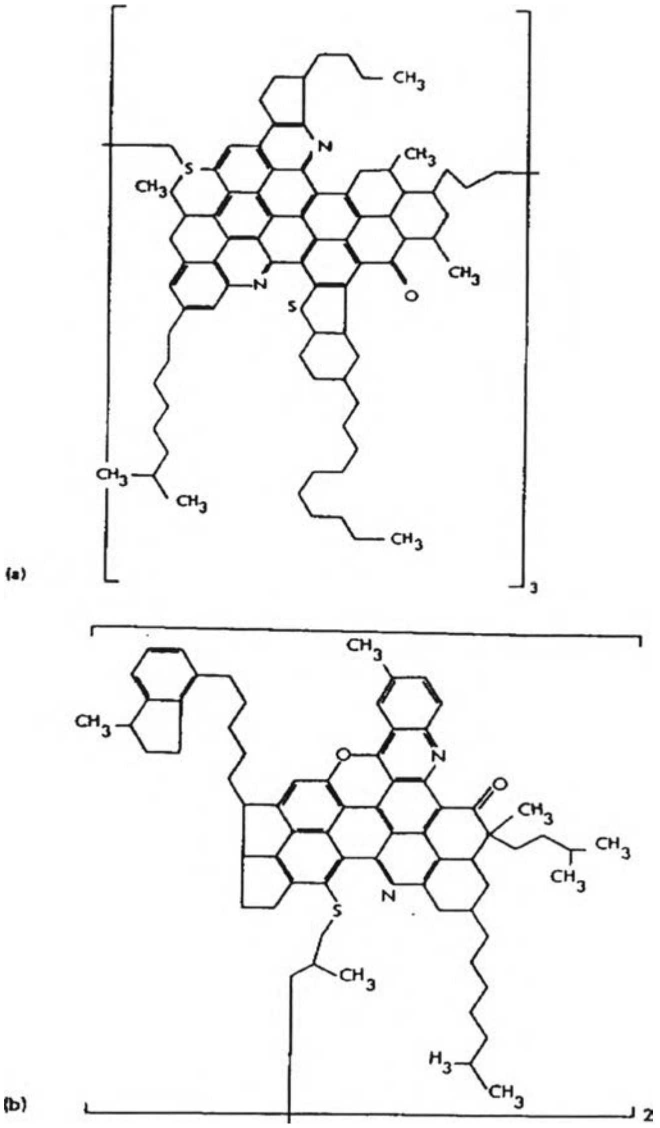

Figure 2.2 Hypothetical structures for asphaltenes (Speight, 1991).

2.3 Asphaltene Physical Model

From the hypothetical structure of asphaltenes, the poly-aromatics ring and heteroatoms of asphaltenes tend to associate through electron donor-acceptor and hydrogen bonding interaction as to bring about the formation of asphaltene micellar particles in crude oil (Yen, 1974; Burger and Li, 1981; Strausz, et al., 1992; Sheu and Mullins, 1995). Asphaltene micelles are presented as discrete or dispersed particles in the oily phase. Although the asphaltenes themselves are insoluble in gas-oil (saturates and aromatics), they can exist as fine or coarse dispersions, depending on the resin content. The resins are part of the oily medium which then have a polarity higher than those in gas-oil. This property enables the molecules of resin to be easily adsorbed onto the asphaltene micelles and to act as a peptizing agent of the colloid stabilizer by charge neutralization mechanism (Shue and Mullins, 1995) as shown in Figure 2.3.

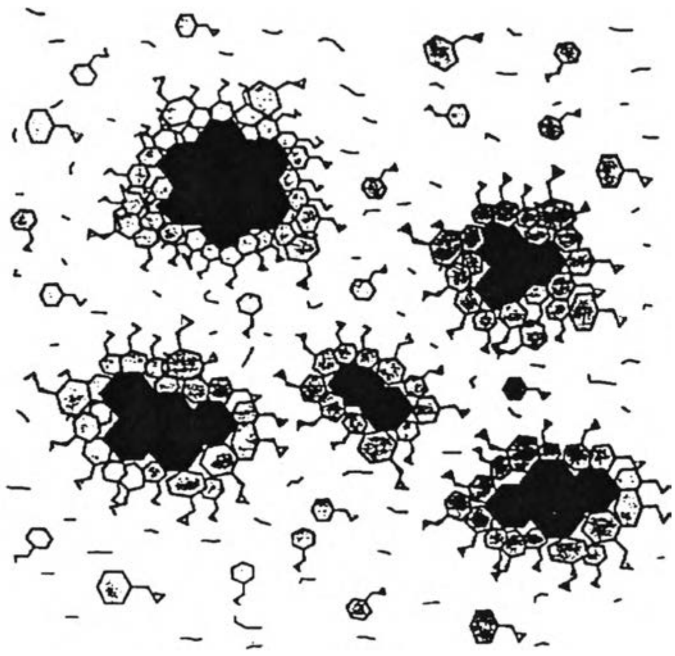

Figure 2.3 Peptization of asphaltenes with resins (Leontaritis, et. al, 1994).

Considering the stabilized nature of asphaltenes as colloidal particles peptized by resins, any action of chemical, electrical and mechanical nature that depeptize these particles will lead to flocculation and precipitation of asphaltene which are the serious problem in oil industry as mentioned earlier.