CHAPTER I
INTRODUCTION

Crude oils consist of a distribution of large molecules (MW~1000) with different chemical structures and molecular weights. In order of increasing polarity, the classes are saturates, aromatics, resins and asphaltenes (SARA). Asphaltenes are the fraction of oil that is soluble in aromatic solvents, such as toluene and insoluble in alkanes, such as pentane or heptane. Asphaltenes are of interest in many aspects of oil production because they tend to precipitate under producing conditions. However, since they are defined as a solubility class, which consists of a large variety of molecules, they are difficult to characterize (Yarranton and Masliyah, 1996).

It is generally accepted that asphaltenes are composed of a cluster of polyaromatics and/or conjugated polyene groups carrying aliphatic chains and a variety of hetero elements including sulfur, oxygen, nitrogen and metals such as vanadium and nickel (Speight, 1991). The extra element atoms (i.e. S, O, N and metals) account for a variety of polar groups on the asphaltene molecules (particles), such as aldehyde, carbonyl, carboxylic acid, amine, and amide. These asphaltene polar groups may perform acid-base interactions with each other and associate asphaltene molecules into micellar-like aggregates in crude oil (Chang and Fogler, 1996). The traditional theories of asphaltene stability in crude oil state that resin molecules, the lighter, neutral polar components of crude, surround the polar asphaltene particles (Speight, 1991). In order to stabilize them, the resin molecules orient themselves with their polar head groups toward the surface of the asphaltene particles, forming a steric layer around the asphaltene particles. Asphaltene particles are thus dispersed in crude oil with a highly polar core of asphaltene polyaromatics and a slightly polar shell of resins. Once resin molecules are removed from crude oil by the method of adsorption chromatography or others, the remaining crude oil can no longer resolubilize asphaltenes (Speight, 1991).

In production and refining processes, black solid deposits of asphaltene are commonly formed as a result of changes in temperature, pressure, and composition (Speight, 1991). Asphaltene precipitation is unwanted during production,

transportation and upgrading processes involving hydrogen addition such as hydrocracking and hydrotreating. For example, the precipitation of asphaltenes plugs porous formations resulting in lowering the oil production rate. The adsorption of asphaltenes to mineral surfaces changes the reservoir's wet ability from water-wet to oil-wet and therefore influences the efficiency of oil recovery (Leontaritis, 1989).

In order to solve these asphaltene problems, studies have been carried out on asphaltene precipitation and dissolution. Aromatic-based fluids (polyaromatics, naphthalene, xylenes, and toluene) are effective in cleaning asphaltene deposits in reservoirs (Leontaritis, 1989). However, recent environmental concerns about the toxicity of aromatic fluids have further prompted researchers to develop alternate fluid systems for asphaltene dissolution. In recent years, amphiphile-based alkane fluids have been proposed as viable, nontoxic alternatives to aromatic fluids for dissolving asphaltene deposits: alkyl-benzenesulfonic acid amphiphiles appear to be the most effective amphiphile stabilizers (Chang and Fogler, 1994 a and b).

Researchers are now interested in aromatic-based solvents, especially toluene, for investigating asphaltene solubility. Fused aromatic compounds such as naphthalene and phenanthrene are also of interest. Because studies on the solubility of asphaltenes using the solvent mixture of aromatic and aliphatic solvents will be very beneficial, this research focused on the characterization of asphaltenes, the solubility of asphaltenes in different aromatic/alkane solutions at different temperatures, the evaluation of the effectiveness of the aromatic/alkane solvents on asphaltene solubility, and the prediction of molecular weights of asphaltenes.

Eventually, it has been observed that the properties of asphaltenes can be changed due to the elapse time during oil production. Therefore, in this study, the effect of aging on solubility of asphaltenes was also investigated.