CHAPTER I
INTRODUCTION

Crude oils are complex mixtures which are usually divided into four major components; saturates, aromatics, resins, and asphaltenes (SARA). Asphaltenes are the heaviest and the most polar fraction of the crude oil that is soluble in aromatic solvents but insoluble in normal alkanes (Speight, 1999). Asphaltene deposition is considered to be one of the most problematic organic deposits. The precipitation and deposition of asphaltenes due to the change in composition, pressure, and temperature in the reservoir or any part of the production system are an undesirable situation that can damage reservoirs by blocking pore space, plug tubing and transportation facilities, and cause fouling in downstream equipment causing a reduction in capacity and productivity.

Due to the serious economic nature of these problems, numerous studies have been done on asphaltene precipitation in order to determine the conditions at which asphaltene precipitation occurs. Several methods have been utilized such as optical microscopy, spectroscopy, viscosity, electrical conductivity, thermal conductivity, etc. (Donaggio *et al.*, 2001). Although there are many methods to determine the asphaltene precipitation onset, there are only two common methods that can be used to predict the asphaltene instability at reservoir conditions from the experimental data at ambient or near ambient conditions. The first method is the measurement of refractive index (RI) (Wang and Buckley, 2001; Wang and Buckley, 2003). However, refractive index provides only an empirical approach to predict the asphaltene instability at reservoir conditions. Prediction beyond the experimental range requires accurate theoretical models. Another method is the automatic titration method with spectrometer. The automatic titration method with a spectrometer is the simplest and easiest way to detect the asphaltene precipitation onset at ambient or near ambient conditions because it is less time consuming and acquires data automatically. However, we need to be careful about interpreting the actual asphaltene precipitation onset point. Beer's law with a mathematical enhancement technique was used to determine the actual asphaltene precipitation onset point as demonstrated in this dissertation. The precipitation results were used with the solubility parameter concept to determine the stability of the crude oil.

The solubility parameter was first described by Hildebrand and Scott in 1950. A solubility parameter is a cohesion parameter which describes the interaction between molecules in condensed materials. The Hildebrand solubility parameter is one of the parameters that can be used to characterize the solubility of asphaltenes in crude oil and determine the precipitation onset point of asphaltenes. This solubility parameter concept can also be used to predict the asphaltene instability of the live oil at reservoir conditions.

In spite of much research, there still remains many questions about the effect of temperature, asphaltene precipitant (normal alkanes), and solvent (aromatics) on both the oil solubility parameter and onset solubility parameter and at what conditions asphaltenes will begin to precipitate out from the crude oil. Also in the oil recovery, using of miscible injection, carbon dioxide injection, and solvent injection has an effect on the asphaltene stability.

The objective of this research is to understand the effects of these factors and develop a theoretical model for determining and predicting the asphaltene instability at reservoir conditions or any process conditions using solubility parameter technique.