CHAPTER I
INTRODUCTION

The focus of this study is to develop a better understanding of the precipitation of asphaltenes from crude oils. The effects of precipitant concentration, type of n-alkane precipitant, blends of different n-alkanes, and precipitation time were studied.

Asphaltenes are a class of molecules in crude oils. Asphaltenes can be precipitated out of crude oils by adding n-alkanes like n-pentane or n-heptane. However, they dissolve in solvents like toluene or methylene chloride. They precipitate from crude oils because of changes in temperature, pressure and composition. Asphaltene precipitation can be induced during oil production through processes like enhanced oil recovery, CO_2 flooding, matrix acidization of oil formations, and reducing the oil bulk viscosity by blending with different crude oils (Wattana, 2004).

The oil industry faces many problems associated with asphaltenes precipitating in different phases of oil production, transportation, and processing. Precipitation of asphaltenes can lead to deposition on porous oil well formations, which may result in partial or complete plugging of these formations. Also, deposition of asphaltenes on pipelines, tubings and production facilities can happen while transporting crude oils causing reduction in oil production (Leontaritis, *et al.* 1988; Pina, *et al.*, 2006). Downstream, precipitated asphaltenes can cause storage capacity losses, equipment fouling and deactivation of catalysts in oil refining (Wattana, 2004).

Due to these critical industrial problems, a number of studies have been conducted for understanding the precipitation of asphaltenes from crude oils (Cimino, *et al.*, 1995; Escobedo and Mansoori, *et al.*, 1995; Buckley and Wang, 2002; Kraiwattanawong, *et al.*, 2007; Wattana, *et al.*, 2003; Wiehe, *et al.*, 2008). The oil industry has also widely used a standard procedure (ASTM D6703-07) which was developed by ASTM International (ASTM International, 2007). However, most of these studies assumed that asphaltene precipitation is instantaneous. These experimental measurements were run either instantaneously or on short time scales

ranging from a few hours to 24 hours, which lead to the assumption of near-instantaneous precipitation. Effects of time on precipitation are often neglected in these experiments. It is assumed that asphaltene precipitation is based primarily on the changes in temperature, pressure and concentration.

Recently, studies have highlighted the importance of the kinetics of asphaltene precipitation. Maqbool and Fogler (2008a) have shown the effects of time on the precipitation of asphaltenes from crude oils. At low precipitant concentrations, asphaltenes can precipitate out of crude oil after significantly long periods of time ranging from days to weeks and even years. These results challenge the theories proposed by earlier studies that precipitation of asphaltenes is instantaneous.

Maqbool and Fogler (2008a) studied K1 crude oil, which contains a high amount of asphaltenes. The precipitation onset time upon detection of asphaltene precipitates was determined using optical microscopy. Experiments were also performed to quantify the amount of precipitated asphaltenes that precipitate as a function of time by centrifuging samples of crude oil–heptane mixtures. Experimental results showed the kinetic behavior of the precipitation of asphaltenes from K1 crude oil.

In order to examine if the observed kinetic behavior is universal to crude oils, different crude oils were studied. This study conducted similar experiments using GM2 and N2 crude oil, which have a different oil composition and sourced from different oil field locations. Different types of n-alkane precipitants were also used in precipitating asphaltenes from GM2 and N2 crude oils. In addition, different n-alkane precipitants were blended in various volume ratios and were used to precipitate the asphaltenes. A geometric population balance model developed by Maqbool, Raha and Fogler (2008b) has been validated with the experimental results, which had successfully described the observed kinetic effects on asphaltene precipitation.