CHAPTER I

INTRODUCTION

Chlorobenzene and its derivatives are classified as hazardous substances. However, they are widely used in numerous applications including solvents in paints, raw materials in the manufacture of the phenol and aniline, insecticides for termites, degreasing agents for metals, and heat transfer medium (Martin et al., 1992). This class of compounds must commonly be removed from industrial wastewaters.

Froth flotation is a separation technique which can be used to remove oils (either dissolved or as oil droplets) from water (e.g. cleaning-up oily wastewaters) and is illustrated in Figure 1.1. In froth flotation, a surfactant is usually introduced into the wastewater to enhance the flotation of the oil. Air is introduced into the system through a sparger which produces fine bubbles. The surfactant tends to concentrate at the air/water interface with hydrophobic groups (water insoluble) in the air and the hydrophilic or head groups in the water. The oil attaches to the air bubbles as they rise through solution and is highly concentrated in the foam layer called froth at the top of the flotation cell which is basically skimmed off. Many factors are considered to have an effect on oil removal such as air flow rate, size of gas bubbles and oil droplet, zeta potential of oil droplets and bubbles, oil density, type and concentration of polyelectrolyte (Okada et al., 1988; VanHam et al.,

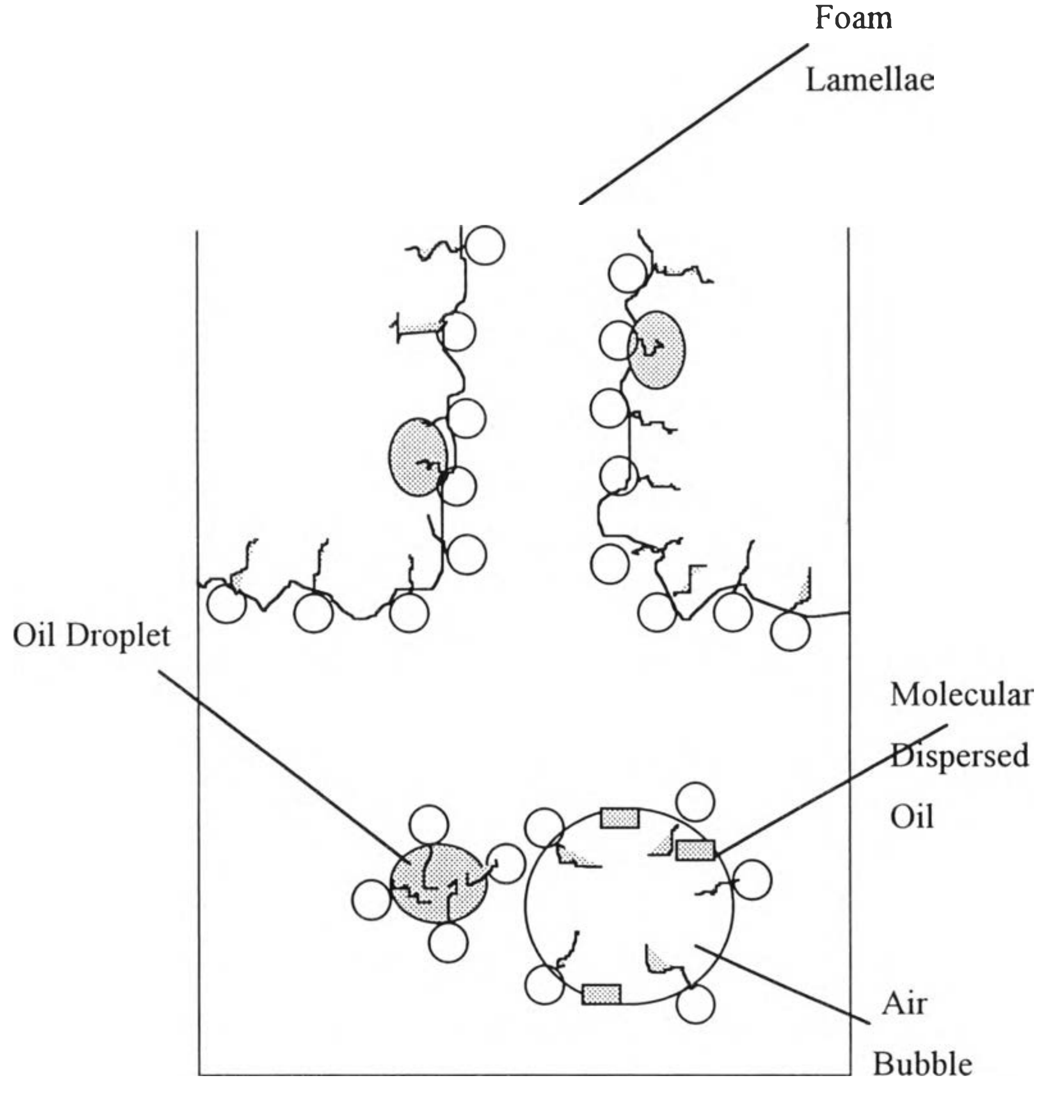

Figure 1.1 Schematic of froth flotation removal of oil from water (Wungrattanasoporn, 1995).

1983; Strickland, 1980; Sylvester and Byeeseda, 1980).

When water soluble surfactant is added to water under the proper conditions and above the critical micelle concentration (CMC), the surfactant forms aggregates called micelles which dissolve or solubilize oil and can result in an increase in oil solubility in the aqueous phase. This aqueous phase in equilibrium with excess oil is also known as a Winsor Type I microemulsion (Winsor, 1968). Under the proper conditions, as some variables (e.g., salinity, temperature) are changed, this oil/water/surfactant system can change from the two phase system composed of the type I microemulsion and excess oil into a three phase system as shown in Figure 1.2. These three phases consist of an excess oil phase, an excess water phase (both containing little surfactant) and a Winsor Type III microemulsion phase which containing high levels of both water and oil and most of the surfactant in the system (Puerto and Reed, 1983). Ultralow interfacial tensions (e.g. $< 10^{-4}$ mN/m) between the excess water and the microemulsion phase and between the excess oil and the microemulsion phase can be attained in this system (Barakat et al., 1983). The condition corresponding to equal volumes of oil and water being transferring from the excess phase to form the microemulsion approximately corresponds to minimum equal interfacial tensions between the microemulsion and the excess phases (Shiau, 1994). This is the condition which is desirable for trapped oil mobilization in enhanced oil recovery (Healy and Reed, 1977; Healy et al., 1975) and in oil contaminated soil remediation (Healy and Reed, 1974) using surfactants. As the adjustable variable is changed further, the system became two phase again, now with the surfactant predominately in the oil phase (Winsor Type II microemulsion) in equilibrium with an excess water phase as shown in Figure 1.2.

Winsor

Type I III II IV

Microemulsion

w w

w/m

m m

o o o/m

Variable changing (e.g. Temperature)

o = oil phase

w = water phase

m = microemulsion phase

Figure 1.2 Demonstration of microemulsion phase behavior for a model system (Winsor, 1968).

Altering variables in the froth flotation process using surfactants to remove oil droplets from water affects a number of separate and interacting phenomena; e.g., oil droplet size and hydrophilicily of droplet surface, air bubble size and nature of the air/ water interface, and froth characteristics and stability.

In a previous study, the effect of surfactant type on the efficiency of removal of a dissolved organic solute from water was investigated systematically (Wungratttanasopon, 1995). In the current study, was employed to remove oil from water which contained the froth flotation of oil greatly in excess of its saturation concentration, the effect of surfactant type and salinity (causing a Winsor Type I to Type III microemulsion transition) on flotation efficiency were investigated.