



## CHAPTER I INTRODUCTION

There has been a growing interest in utilizing surfactants in remediation processes to separate the volatile organic compounds (VOCs) from aqueous solution. Several of surfactant-based separation techniques are proposed such as micellar-enhanced ultrafiltration (Lipe *et al.*, 1996), liquid-liquid extraction (Hasegawa *et al.*, 1997), froth flotation (Yanatatsaneejit *et al.*, 2005a, b), etc. The advantage of these techniques is that it consumes low energy and the utilized surfactant is biodegradable, which is not harmful to the environment (Scamehorn and Harwell, 1989).

One of the effective surfactant-based separation techniques is cloud point extraction (CPE), which applies nonionic surfactant as a separating agent. As a nonionic surfactant solution is heated above the cloud point temperature, the solution turns cloudy and eventually separates into two phases—micellar rich phase or coacervate phase, and micellar dilute phase (Gullickson *et al.*, 1989). The coacervate phase can be utilized as a solvent for extraction. Generally, this technique has been applied for removal of organic compounds, biomaterials, and metals from aqueous media (Quina and Hinze, 1999; Hinze and Pramauro, 1993).

Recently, the CPE was scaled up in a rotating disc contactor (RTC), which effectively removed 85–95% of volatile aromatic contaminants from wastewater (Trakultamupatam *et al.*, 2004a, b). However, over 90% of the total surfactants was found in the coacervate phase. Since the surfactant cost is a key determination of the economic viability of the CPE process, it is important that the surfactants in the coacervate phase solution are recycled and reused.

Many processes have been used to remove VOCs from a surfactant solution; for instance, air or vacuum stripping, pervaporation, etc. (Cheng and Sabatini, 2007). In counter-current air stripping process, a direct contact between air and liquid streams causes a significant amount of foam, and then, leads to inoperable process (Lipe *et al.*, 1996). To avoid problem with foaming, the pervaporation process was suggested, however, surfactants form gel layer on the pervaporating membrane surface and consequently plug the membrane (Hitchens *et al.*, 2001; Jiang *et al.*,

1997; Vane and Alvarez, 2002). To overcome these problems, a co-current vacuum stripping using a packed column is considered to be the promising process to remove the VOCs from contaminated surfactant solution (Choori *et al.*, 1998). A study reported that although foaming was observed in the packed column, as high as 90% of TCE was successfully removed from contaminated anionic surfactant solution without flooding. Therefore, the co-current vacuum stripping in a packed column is interested for removal of the VOCs from concentrated coacervate solution and will be discussed in this study.

This work aims to study the performance of the co-current vacuum stripping using a packed column for VOC removal from coacervate nonionic surfactant solution obtained from CPE process. A background of this process is detailed in Chapter II. The materials and analytical techniques are described in Chapter III. The experimental results are shown in Chapters IV and V. Chapter IV discusses the effects of coacervate solution viscosity, the vapor-liquid equilibrium partitioning of VOC at 30°C, as well as the effects of feed flow rate, column pressure, and liquid distribution on the VOC stripping efficiency. Moreover, in Chapter V, the variation of the vapor-liquid equilibrium partitioning of VOC with temperature ranging from 30 to 50°C are investigated. In addition, the effects of surfactant concentration, operating temperature, and solute type on the VOC removal efficiency are also quantified. Finally, the overall conclusions and recommendations are summarized in Chapter VI.