CHAPTER 1

INTRODUCTION OF EMULSION LIQUID MEMBRANE

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1.1 INTRODUCTION

Liquid membrane extraction technology is a subgroup of membrane science where the membrane part is in liquid form. It consists of three phases where the liquid membrane phase would separate two immiscible aqueous phases which are external and internal. Liquid membrane process configuration can be categorised as either bulk liquid membrane (BLM), supported liquid membrane (SLM), or emulsion liquid membrane (ELM). This technology has attracted much more attention in recent years and various research has been attempted discussing and describing the liquid membrane process and its possible industrial applications.

Many disciplines utilise this promising process such as for wastewater treatment process, solute removal, and recovery in chemical industries, as well as for gas separation, product recovery in downstream bioprocess engineering, and many others. Among the three liquid membrane methods, ELM provides the highest surface area per volume external phase for solute transport. Moreover, this technology becomes especially appealing when dealing with highly diluted solutions that can be treated, resulting in concentrated solutes within the receiving/internal phase. A schematic diagram for the complete process of batch ELM is shown in

Figure 1.1. This process consists of three main parts such as water-in-oil (W/O) preparation, permeation/extraction process and treated external-emulsion settling, and finally, separation of liquid membrane and internal/recovery phase where the demulsification process is involved. Various methods can be used for the demulsification process which are chemical demulsifiers and physical methods. The physical method involves high voltage electrical field, magnification, ultrasonic vibration, centrifugal separation, heating, or the combination of any of them depending on the characteristic of the desired solute or product recovery. At this stage, the liquid membrane can be recycled for the next process of W/O emulsion preparation.

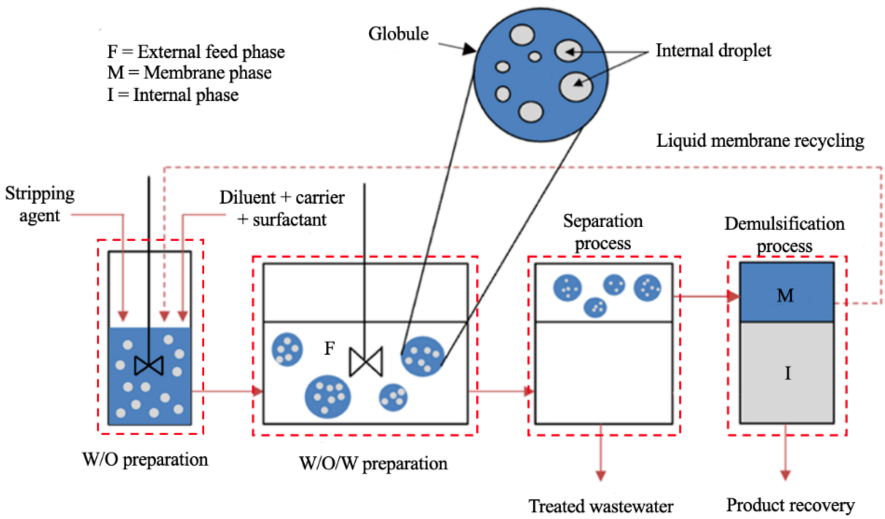

Figure 1.1 Schematic diagram of the ELM process

1.2 EMULSION LIQUID MEMBRANE

Outstanding double emulsions process or ELMs also known as surfactant liquid membrane consists of three main components: the internal phase (which serves as the receiving/stripping phase), the external phase (the feed phase to be treated), and the liquid membrane phase (where the extraction-stripping process occurs). A liquid membrane phase refers to the organic phase that serves as a barrier separating the internal encapsulated phase droplets within an emulsion from the external phase. Typically, it comprises of three essential components: an organic solvent/diluent, a surfactant acting as an emulsifying agent, and an extractant/carrier substance. The carrier functions to extract and form complexes with the solute from the external phase at the interface of the liquid membrane and external phase.

In order to perform the ELM process, the first step is the preparation of the primary W/O emulsions. This emulsion is produced by emulsifying the liquid membrane and stripping agent at a specific speed and time as shown in Figure 1.2(a). To extract the solute from the external phase, the W/O emulsion is then dispersed in the feed solution/external phase. The water-in-oil-in-water (W/O/W) emulsion globules are then formed as in Figure 1.2(b). During the extraction process, mass transfer of solute takes place between the external phase and the internal phase through the liquid membrane phase. The schematic diagram of the double W/O/W emulsion which includes phase I (membrane phase), phase II (internal phase), and phase III (external phase) is shown in Figure 1.3. The extraction takes place at the interface of phases I and III, forms a complex of carrier-solute which then diffuses in phase I, and finally, the stripping reaction occurs at the interfaces of phases I and II for the release of the solute into the internal phase.

The ELM process provides a very fast extraction and recovery process where it occurs simultaneously in one stage process. However, it typically faces a problem of emulsion stability. In this situation, the emulsion may break, and the inner droplet phase would leak into the external phase, and the separation performance is lost. This is due to the effect of interfacial shear between the external and membrane phases that causes the liquid membrane to thin and at a certain time or in some cases it may rupture.