CHAPTER 1

INTRODUCTION

1.1. Statement of the problem

Emulsion liquid membranes (ELM) process is basically composed of two major steps. In the first step, an emulsion is formed by mixing two immiscible phases with the support of a surfactant (emulsifier) by a high speed homogenizer. The second step is the dispersion of the prepared emulsion in another phase (external or feed phase). The feed phase contains solutes to be stripped. Eventually, the system can be inferred as either water in oil in water (W/O/W) or oil in water in oil (O/W/O). In the present study, we have investigated (W/O/W) ELM system. The solutes are present in the aqueous phase in (W/O/W) system.

The characteristics which contribute in making ELM promising and valuable are as follow:

- Relatively low energy consumption as compared to other separation processes
- Single stage operation (extraction and stripping take place in a single step)
- High surface area availability for solutes hence, fast extraction and stripping (Frankenfeld and Li, 1987)
- High efficiency (solute concentration from the feed phase can be removed up to a very low level) (Skelland and Meng, 1999)
- High selectivity (Frankenfeld and Li, 1987)

However, the wide use of ELM process is restrained because of the instability of emulsion caused by high shear stress during extraction, density difference between the membrane phase and the aqueous phase and swelling.

Breakage in emulsion either due to instability or swelling causes the diffusion of the internal phase towards the external phase which reduces the efficiency of the ELM process.

In the past years, several remedies were discovered such as adding more surfactants in the membrane phase, increasing the membrane viscosity and conversion of the ELM to non-Newtonian ELM by the addition of polymers. Nevertheless, each and every remedy has its own tradeoffs. All the techniques to improve stability were compromised with the final removal of solutes.

1.2. Research Objectives

ELM is comprised of solvent, surfactant, stabilizer and carrier. Each component has its own contribution to the preparation of a stable emulsion liquid membrane. The main objective of this study was to find a suitable role for an ionic liquid $[BMIM]^+[NTf_2]^-$ in the ELM process. In order to achieve this goal, a comprehensive and exhaustive literature survey is to be undertaken. The reasons behind choosing $[BMIM]^+[NTf_2]^-$ among all other ionic liquids are its hydrophobicity, lesser density and other important properties which are elaborated later in Section 4.1.

The effect of ionic liquid on the creaming/sedimentation rate of emulsion liquid membrane is another important objective of this study. One of the objectives is to develop a mathematical model for the stability of the ELM in terms of ionic liquid concentration and the initial rate of sedimentation. An attempt to explain the observed behavior has been made.

Subsequently, the prepared ELM is further applied to treat wastewater containing chromium and to extract chromium (Cr) ions from concentrated hydrochloride acid solutions. The effect of various parameters such as carrier concentration, surfactant concentration, treat ratio, ionic liquid concentration, pH of the feed phase, internal phase to membrane phase ratio, concentration of Cr and agitation speed on the percentage removal of Cr is investigated. Mathematical optimization of the process has been carried out using the Response Surface Methodology (RSM).