CHAPTER I
INTRODUCTION

Ethanol, a clean burning fuel, can be produced from biomass fermentation with the final ethanol concentration of about 10% (w/v). Before such a dilute aqueous solution can be used as an energy source, it must be concentrated by distillation process. In distillation, high energy is required together with a thermodynamic problem at azeotrope point (Ohshima, 2005). Ethanol boils at 78.4 °C, water boils at 100 °C, but the azeotrope boils at 78.1 °C, which is lower than either of its constituents. Therefore, at azeotrope, a mixture of the liquids boils without changes in proportion of the liquids, either in the liquid or the vapor phase. Complex processing steps involving addition of entrainers followed by extractive distillation are generally adopted to achieve absolute ethanol. This leads to high energy consumption and uneconomical operating costs. Moreover, selectivity of these processes is limited by the vapor–liquid equilibrium of the constituents. In the recent years, pervaporation (PV) is rapidly emerging as an economical and simple alternative to conventional energy-intensive technologies for separating azeotropic, close-boiling, isomeric or temperature-sensitive liquid mixtures (Dubey et al, 2005). Pervaporation of organic liquid mixtures, especially ethanol-water systems, has been widely investigated because of its low energy consumption and high separation characteristics (Gonzales-Velasco et al, 2002).

In pervaporation, liquids permeate through a membrane by a driving force that is provided by a pressure differential across the membrane. The overall process of permeation involves the adsorption of solvent molecules on to the surface of the membrane, diffusion of the liquid through the membrane, and desorption of the liquid molecules from the membrane on the downstream side where molecules emerge in the vapor phase (Ball et al, 2000).

For separations to be effective, membranes must possess both high permeabilities and high selectivities. Currently, these properties are often tested in synthetic membrane materials by a virtual trial-and-error process. If the synthesized

membrane lacks the desired properties, an entirely new material must be synthesized and tested.

Pervaporative dehydration of ethanol has been widely studied using membranes based on poly(vinyl alcohol), polyamides, polysulfonamides, poly(ethyleneimine) polysiloxanes, etc. Chitosan and its derivatives as well as sodium alginate have also been used for water–ethanol separations (Dubey et al, 2005).

The cellulose membrane formed by *Acetobacter* species is distinguished by a high degree of crystallinity and superior mechanical properties. Its unique structural features and properties facilitate diverse applications, ranging from wound-dressing, carrier for mammalian cell culture, immobilization of enzymes and other biomolecules, diaphragms in speakers for audio-communication and filter membrane (Dubey et al, 2002). The pellicle which is flat can be easily processed into a porous membrane possessing with good mechanical strength, whereas, plant cellulose is often interspersed with lignin, hemicellulose, and pectin leading to non-uniformity in porosity and unpredicatable permeability. Moreover, the porosity of membranes from bacterial cellulose can be suitably tailored by varying the physiological conditions of bacterial growth such as composition of the culture media, its pH, temperature, and oxygen tension as well as by chemical modifications.

Bacterial cellulose membrane has been examined for the pervaporation of binary ethanol-water mixtures (Dubey et al, 2002). It was found that for EtOH/H_2O binary system, the permeate flux was high but the selectivity was fairly low.

To improve the pervaporative performance of the bacterial cellulose membrane, in this study, the procedure for the membrane biosynthesis was modified by the supplement of alginate into the culture medium. Some chemical-physical, mechanical properties of the modified bacterial cellulose alginate membranes were then examined. Furthermore, dehydration of ethanol through the bacterial cellulose-alginate membrane by pervaporation was investigated.

Objectives

1.1.1 To develop and characterize bacterial cellulose-alginate membranes

1.1.2 To investigate the pervaporative performance of the developed membranes

Research Scopes

1.3.1 Set up the pervaporation unit

1.3.2 Develop bacterial cellulose-alginate membranes by biosynthesis

- Supplementation of alginate in the medium: 0, 0.5, 0.75, 1% (w/v)

1.3.3 Characterize the membranes by Scanning electron microscopy, Fourier Transform Infrared (FTIR) spectrometer, Universal testing machine, and Brunauer-Emmett-Teller (BET) surface area analyzer

1.3.4 By using the developed membranes, study the effect of operating condition on flux and selectivity

- The study for the effect of feed temperature was performed in the range of 30, 40, 50 and 60 °C.
- The study for the effect of feed concentration was performed in the range of 70, 80, 90, 95 %ethanol (v/v).
- The study for the effect of membrane thickness

1.4 Overview

This present work was organized as follows:

Chapter I presents an introduction of this study

Chapter II contains background theory of bacterial cellulose and pervaporation system

Chapter III is consisted of the literature review

Chapter IV states the details of the experimental procedures and techniques of this research

Chapter V reviews the experimental results of the characterization BC-alginate membrane and pervaporation.

Chapter VI contains the overall conclusion obtained from this research. Future work and recommendations are also stated.

Finally, the additional data of the experiments which had emerged from this study are included in appendixes at the end of this thesis.