CHAPTER I

INTRODUCTION

Sodium A zeolite (NaA) is very well-known for organic-water separation and catalysis (Kita *et al.*, 1995; Shah *et al.*, 2000). It can be synthesized in various forms, such as, plates, tubes, etc. A well-known form is in the form of tube that can be synthesized by coating NaA zeolite on the surface of tubular alumina (Al_2O_3) support, called "Tubular NaA zeolite membrane" (Huang *et al.*, 2004). The properties of the tubular NaA zeolite membranes are high thermal and chemical stability, high mechanical strength, and uniform pore size distribution [Nomura *et al.*, 1998; Ahn *et al.*, 2006).

NaA zeolite membrane can be synthesized by various methods, such as hydrothermal synthesis (Zhang *et al.*, 2004; Zah *et al.*, 2006; Motuzas *et al.*, 2006), microwave synthesis (Arafat *et al.*, 1993; Xu *et al.*, 2006 ; Chen *et al.*, 2006), and electrophoretic technique (Seike *et al.*, 2002). The obtained NaA zeolite crystals from hydrothermal techniques are rather randomly oriented. It was found that the orientation and crystal size of zeolite can be improved using secondary growth or called seeding technique (Li *et al.*, 2003). The electrophoresis technique provides high uniform crystal size and dense membrane (Huang *et al.*, 2007) while the microwave technique not only improve the duration of zeolite synthesis time, but also produce high performance of NaA zeolite membrane (Xu *et al.*, 2004; Li *et al.*, 2008). Moreover, NaA zeolite has pore size around 0.4 nm that is suitable to separate water from alcohol mixture because the kinetic diameter of water molecule is around 0.3 nm while that of alcohol, especially ethanol (around 0.42 nm), is larger than the pore size, causing water molecules to penetrate through the membrane and to separate out of the mixture.

The performance of NaA zeolite membrane can be evaluated in term of total water flux ($kg/m^2/h$) and separation factor (dimension less). The total water flux is calculated from the amount of water passed through the membrane to permeate side for a period of time, that is, the higher number of the total water flux means the high amount of the water amount passed through the membrane. The separation factor provides information on purity of the water passed through the membrane and purity of ethanol (alcohol) produced by this membrane.

Generally, to produce very high purity of ethanol (as high as 99.5%wt), azeotropic distillation is employed due to azeotrope formation between water and ethanol (around 94%wt of ethanol and 6%wt of water) which normal distillation cannot purify this composition. However, the azeotropic distillation is not only an energy-consuming process, but also is environmentally unfriendly, due to the toxicity of the entrainer used (Lelkes *et al.*, 1998; Lipnizki *et al.*, 1999). Pervaporation system (separation by membrane) was thus introduced to overcome those problems (Sommers *et al.*, 2002).

Sodium A zeolite (NaA) has been successfully synthesized by Wongkasemjit and cowokers using silatrane and alumatrane as precursors (Kuanchertchoo *et al.*, 2006) via microwave technique with moderate performance for water-ethanol separation in pervaporation system (Kuanchertchoo *et al.*, 2007). Thus, the aim of this work was to synthesize the NaA zeolite membranes via microwave (MW), autoclave (AC), and electrophoretic (EP) techniques, using silica and alumina as a precursors. The performance of those membranes was clarified by using pervaporation system for water-ethanol separation. In addition, the techno-economics of the pervaporation system using our homemade NaA zeolite membrane was studied to compare conventional distillation.