CHAPTER I
INTRODUCTION

Due to the substantial increase in the price of fuels and the global warming concern, the development of alternative renewable energy has been one of the main research focuses. Biomass is one of the renewable energy sources, which exists in different forms. One of these clean forms of renewable energy is biofuel that includes biodiesel, bioethanol, biomethanol, biogas, etc. These fuels are produced from agricultural and industrial wastes with a very low prime cost and also can add value to the agricultural products.. In Thailand, gasohol (bioethanol) becomes an attractive choice of fuel due to the lower price comparing with traditional petroleum based fuel. Gasohol, which is a mixture of gasoline and ethanol, has higher octane number and better antiknock properties than gasoline. Furthermore, it burns more slowly and dissipate less heat, its combustion process is complete resulting in reduced emission of some pollutants. Generally, ethanol used in gasohol is derived from the distillation process which is the common ethanol/water separation technology used in the petrochemical industry. Other separation techniques include liquid-liquid extraction, carbon absorption and air stripping. However, these techniques require high operating costs and in some cases have some limitations that make them unattractive for industrial applications. Therefore, other separation techniques are needed to be considered in order to reduce the gasohol production cost (Ameri *et al.*, 2008).

Pervaporation is an interesting candidate for ethanol/water separation. This technique utilizes the concept of partial vaporization of a liquid through a dense polymeric membrane. Several studies have been done in order to develop the new polymeric pervaporation membranes that can selectively interact with a specific component of feed mixture to maximize the separation performances in terms of separation factors, flux and stability. Moreover, the pervaporation technique can be used to separate close boiling, azeotropic or isometric mixtures which can then simplify the existing industrial processing (Hsueh *et al.*, 2005).

The separation technique using polymer membranes has received much attention due to the design flexibility in order to improve the selectivity and permeability. In addition, this method requires far less expenditure for maintenance and energy used comparing to the absorption process. Furthermore, polymeric membranes tend to be more economical than other type of membranes. Some polymeric membranes have already been used in industries. Polyimide has been used membrane for separation due to its good mechanical property and excellent thermal stability. However, polyimide suffers from high cost and poor processability.

Polybenzoxazine (PBZ) is a novel type of phenolic resin that provides high thermal stability, low shrinkage, no need of catalyst for polymerization, no by-product or volatile generation, excellent dimensional stability, and rich molecular design flexiblility. PBZ is a great material that can be used in a wide range of applications including parts of airplanes, electronic parts, etc (Agag *et al.*, 2006).

Polybenzoxazine precursors have been synthesized from various aromatic/aliphatic amine, mono/diphenol, and formaldehyde as shown in Figure 1.1 (Ning and Ishida 1994). One approach is to synthesize polybenzoxazine from low molecular weight monomers with monofunctional amine, phenol, and formaldehyde. However, polybenzoxazines obtained via this approach usually suffer from brittleness. Another method is to prepare polybenzoxazine from high molecular weight oligomers with diamine, bisphenol-A, and formaldehyde (Chernykh *et al.*, 2006). The properties of polybenzoxazines derived from this approach, especially brittleness, are greatly improved compared with cured film from the typical low molecular weight precursors. This will enable polybenzoxazine to be the candidate material for flexible membrane applications.

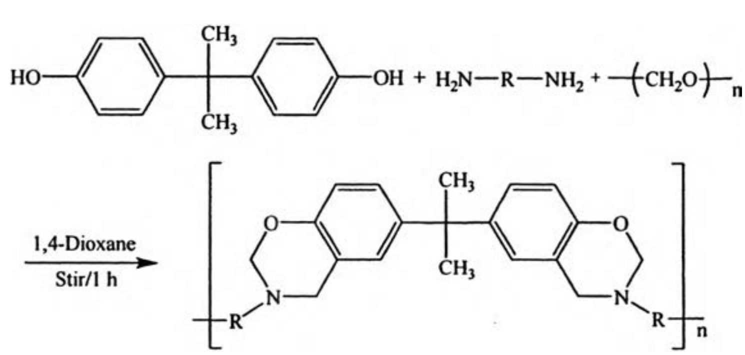

Figure 1.1 Preparation of polybenzoxazine precursors.

Generally, polybenzoxazines undergo thermally activated ring opening polymerization at temperature around 150°C or higher depends on types of reactants used.

The purpose of this work involves the investigation, optimization of processing parameters, and studying the characteristic properties of polybenzoxazine membrane for ethanol/water separation.