# CHAPTER I

# INTRODUCTION

Ethanol is a useful material that can be utilized in various applications such as solvent, cleaner fuel, and especially its versatility as a chemical intermediate for other chemicals production. Usually, ethanol is produced in an aqueous form either by synthetic methods or fermentation processes. Conventional ethanol fermentation systems have some disadvantages such as ethanol fermentation is usually operated in a batch system and ethanol concentration is low due to ethanol inhibition. Furthermore, microorganisms and other salts are not reused. Some ethanol fermentation processes have been proposed using microorganisms immobilized in a gel or on a support that enables us to operate continuously and to avoid ethanol inhibition. However, the concentration of ethanol is not high enough for further utilization (Nomura *et al.*, 2002). Separation processes to remove water from ethanol are then needed to increase ethanol concentration.

Conventional separation methods of water removal from ethanol including distillation processes are not applicable since at atmospheric pressure ethanol forms an azeotrope with water at an ethanol composition of 95 wt% and a temperature of 78.1°C (Al-Asheh *et al.*, 2004). For other separation methods, solvent extraction and membrane processes also have problems with a high selectivity for aqueous organics resulting in a low capacity or permeability. In contrast, commercial hydrophobic adsorbents offer a good selectivity and capacity for aqueous organics of the desired product. Hydrophobic adsorbents of separation processes are currently available and can be used to develop efficient large-scale separations (Farhadpour and Bono, 1996). One of methods used in reducing capital costs, operational costs, lower energy consumption, and avoid ethanol inhibition is based on the reactive separation concept, which has been proven to have conclusive advantages over conventional technologies in terms of their efficiency (Zadorsky *et al.*, 1989).

Successful recovery of low molecular weight aqueous organics depends largely on the availability of a hydrophobic solid capable of selective adsorption of the desired product. Well-known porous hydrophobic adsorbents include polymeric resins, activated carbon, silicalite, silanized silica and porous silicas, which have been thermally and chemically treated to remove the sites for hydrogen bonding and polar and acid-base interactions (Farhadpour and Bono, 1996).

In this study, hydrophobic adsorbents including silicalite, activated carbon, polymeric resin (XAD-2), and silica gels treated by chemicals were used to separate ethanol from water-ethanol mixture. Ethanol and water adsorption capacities were determined for each adsorbent using vapor phase adsorption method. Moreover, competitive adsorption between ethanol and water were performed to evaluate the adsorption isotherms and selectivity towards ethanol adsorption of each adsorbent. Additionally, ethanol adsorption capacities from breakthrough curve were evaluated.