CHAPTER I

INTRODUCTION

Global warming is the rise in the average temperature of Earth's atmosphere and oceans that it is caused by increasing concentrations of greenhouse gases. Among the greenhouse gases, carbon dioxide contributes more than 60% to global warming because of its huge emission amount. The International Panel on Climate Change predicts that, by the year 2100, the atmosphere may contain up to 570 ppm CO_2, causing a rise in the mean global temperature of around 1.9 °C and an increase in mean sea level of 3.8 m (Olajire, 2010). Continued uncontrolled greenhouse gas emissions may contribute to the melting of polar ice, rising sea levels, climate change and species extinction.

One of the methods to solve the problem is CO_2 capture and storage (CCS). There are three options for capture CO_2 from power plants, namely, pre-combustion capture, oxy-fuel combustion capture, and post-combustion capture, among which the post-combustion capture is the simplest and suitable for newly-built and existing coal-fired power plants without requiring substantial change (Yang et al., 2011). For post-combustion capture, amine absorption technique has been widely used in natural gas industry. However, it has some drawbacks such as high equipment corrosion rate, high energy consumption in regeneration, and a large absorber volume required. As a result, solid adsorption processes are suggested and studied to overcome those inherent problems in chemical absorption (Yu et al., 2012).

Activated carbon is a good adsorbent due to low-cost, high surface area, and its adsorption capacity. There is a wide range of activated carbon with a large variety of microporous and mesoporous structures. Activated carbon may be produced from many raw materials such as coal, coke pitch, wood or biomass sources. However, activated carbon seems to be interesting only for CO_2 removal at high pressure and low temperature. These limitations may not be suitable for low pressure CO_2 capture from flue gas treatment (Sayari et al., 2011). However, impregnation or grafting of amines has been proposed to enhance the originally limited adsorption capacity and to promote the mass transfer rate of CO_2 into adsorbents (Yu et al., 2012).

Ritmongkolpun (2013) investigated the use of PEI-impreganated activated carbon for CO_2 adsorption. He found that the amounts of PEI impregnated on activated carbon decreased with the increase in the molecular weight of PEI because the low molecular weight PEI has smaller molecular size than the others, which can easily diffuse and easily be impregnated on the activated carbon. Moreover, the large molecule PEI can block pore sizes of activated carbon causing low CO_2 adsorption capacity. It is, therefore, of interest to be able to identify potentially small polymer molecules to enhance the capacity and selectivity of the adsorbent.

Polybenzoxazine is a novel amine-functionalized adsorbents. Structure of polybenzoxazine is smaller than PEI, and it has amine groups that can react with CO_2 molecule. Hao et al. (2011) studied CO_2 capture using poly(benzoxazine-co-resol)-based porous carbon monoliths. Their results indicated that the poly(benzoxazine-co-resol)-based carbon sorbents perform well in CO_2 uptakes, selectivity, and regeneration among the commercial and state-of-the-art carbon sorbents reported to date. Moreover, polybenzoxazine has aromatic groups. Torrisi et al. (2009) found that CO_2 molecule has intermolecular interactions with functionalized aromatic molecules.

In this work, benzoxazine was synthesized from phenol, paraformaldehyde, and tetraethylenepentamine (TEPA). Activated carbon was then functionalized with benzoxazine via polymerization process of the benzoxazine monomer through ring-opening reaction of the benzoxazine ring to enhance capacity and selectivity of adsorbents. Effects of adsorption temperature, effects of polybenzoxazine loading, types of activated carbon, and regeneration of adsorbents were also investigated to find the optimum condition for CO_2 adsorption.