CHAPTER I
INTRODUCTION

One of the most problems in the world is global warming resulted from the emission of greenhouse gases especially carbon dioxide (CO_2). CO_2 contributed more than 60% to global warming because of its huge emission amount (Yu *et al.*, 2012). CO_2 emission is the most important environmental issues that cause global warming and it is necessary to use new high-performance technologies for reducing CO_2 into the atmosphere. From many sources of CO_2 caused by human, electric power stations utilizing fossil fuels (especially coal and heavy hydrocarbons), petroleum refineries, natural gas plants and certain chemical plants are the largest sources of CO_2 and deserve specific consideration (Meisen and Shuai, 1997).

CO_2 capture is one of the methods to reduce the amount of CO_2 released to the atmosphere. There are several techniques to capture CO_2 such as absorption, adsorption, cryogenic separation and selective diffusion through membranes. Adsorption process is the considered option for this study because it requires less energy, low costs and easy to handle in a wide range of temperature and pressure. Adsorption processes are based on intermolecular forces between gases and the surfaces of certain solid materials. They can be classified as physical adsorption (physisorption) and chemical adsorption (chemisorption). Surface area, pore size and functional group are important factors to determine the efficiency of the adsorbents. Various adsorbents, such as porous carbons, zeolites, metal oxide, amine-modified silicas, new classes of hybrid crystalline solids and polymeric supports have been widely investigated.

Many researchers have been studied to improve the CO_2 adsorption and selectivity by chemical modification on the surface of solid materials that have high surface area. Impregnation by certain functional groups such as amines have been proposed to enhance the originally limited adsorption capacity because the nitrogen active sites bonded on the adsorbent surface can capture CO_2 through the formation of carbamates and carbonates (Zelenek *et al.*, 2008) and it has been proposed to promote the mass transfer rate of CO_2 into porous, or mesoporous adsorbent (Yu *et al.*, 2012).

Polybenzoxazine is a novel type of phenolic resin that provides high thermal stability, low shrinkage, high porosity, more nitrogen functional group, low water adsorption, no by product or volatile generation, excellent dimensional stability, and rich molecular design flexibility (Nintawee *et al.*, 2011). Polybenzoxazine is a great material that can be used in a wide range of applications and it is a promising material as adsorbent for CO_2 capture. Polybenzoxazine is synthesized from phenol, formaldyhyde, and types of amines in a desired mole ratio.

Because of the polybenzoxazine's great characteristics and properties, it is of interest to use polybenzoxazine as the impregnated material on the adsorbent surface and as the porous adsorbent itself by carbonizing under nitrogen atmosphere and activating by CO_2. An excellent molecular design flexibility of polybenzoxazine will allow the properties of the treated materials to be controlled for CO_2 adsorption. The purpose of this work is to investigate the CO_2 adsorption capacity and its operating windows of polybenzoxazine-based adsorbent. As impregnating materials, polybenzoxazine synthesized from different amines were impregnated on the activated carbon surface to improve the CO_2 adsorption performance. Various impregnation loads were varied to determine a suitable impregnated amount on activated carbon surface. As carbonaceous adsorbent, different carbonizing conditions were determined to obtain adsorbent with suitable porosity with the aim to maintain nitrogen functional groups on the surface. A gravimetric method was employed to determine the CO_2 adsorption capacities. It was anticipated that the enhancing effect obtained from different amine structures will help identify a proper structure and proper surface properties of the adsorbent to improve the CO_2 adsorption performance.