CHAPTER 1

INTRODUCTION

1.1 Background Study

Carbon dioxide (CO₂) is one of the most important greenhouse gases that result from human activities such as industrial and domestic usage. Carbon dioxide (CO₂) emissions have a negative impact on global warming. Therefore, it is very important to remove carbon dioxide (CO₂) from the flue gas stream and the local industry as an effort to deal with issues of climate change in the future (Mansourizadeh and Ismail, 2011). In addition, human concerns regarding the level of carbon dioxide (CO₂) emissions to the atmosphere will affect the economy and demand for gas purification equipment will increase in the future (Rahbari Sisakht et al, 2012).

Figure 0-1: Emission estimates from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012
Based on Figure 1-1, line graph showed the total United State (U.S.) greenhouse gas emissions for 1990 to 2012. The total greenhouse gas emissions steadily increased from just over 6,000 million metric tons of carbon dioxide equivalents in 1990 to over 7,000 million around 2000. Between 2007 and 2009, the greenhouse gas emissions decline to about 6,600 million metric tons of carbon dioxide equivalents, followed by a slight rebound in 2010 and 2011 to around 6,800 million metric tons and a slight decline in 2012 to around 6,500 million metric tons. Hence, it can be summarized that carbon dioxide (CO\(_2\)) emissions in the United States increased by about 5% between 1990 and 2012.

Releasing of carbon dioxide to atmosphere can bring harm to the environment because the acid contents in carbon dioxide (CO\(_2\)) gas are hazardous. According to United State Environment Protection Agency (EPA), in 2012, greenhouse gas emissions totalled 6,526 million metric tons of carbon dioxide (CO\(_2\)). This problem caused temperature of the planet increase (global warming). Currently, the amount of carbon dioxide in the atmosphere is increasing at the rate of about one part per million per year (ppm). If this continues, some meteorologists expect that the temperature of the earth will increase by about 2.5 degrees celsius and it could be to cause glaciers to melt, which would cause coastal flooding. The changing climate impacts society and ecosystems, such as climate change can increase or decrease rainfall, influence agricultural growth, affect human health, cause changes to forests, animal habitats and other ecosystems.

Therefore, it is important to lower the negative impact of environment. Priority should be given to the technologies with enhanced carbon dioxide (CO\(_2\)) removal efficiency that can minimize the impacts. Membrane technology is one of the promising alternatives for carbon dioxide (CO\(_2\)) removal due to its favourable mass transfer performance (Mansourizadeh and Ismail, 2011).

Numerous studies have been conducted for CO\(_2\) removal by using the hollow fiber membrane, e.g. Nishikawa et al. (1995), Klaassen and Jansen (2001), Chen and Li (2005), Rongwong et al. (2009), Mansourizadeh et al. (2010), Khaisri et al. (2011), Mansourizadeh, A. (2012), Naim et al. (2013), and Rezaaei et al. (2015). For carbon dioxide (CO\(_2\)) absorption study, some of the microporous hydrophobic membrane was
used, which are polyethylene (PE), polypropylene (PP), polyvinylidene fluoride (PVDF) and polytetrafluoroethylene (PTFE). Although the physical and chemical properties of membranes is well understood, the improvement of the membrane structure must be always explored by the researchers to get the most effective membrane structure for efficient CO$_2$ removal. In this study, polyvinylidene fluoride (PVDF) was used because it is hydrophobic polymers dissolved in the some solvent, which can be used in phase-inversion process for the preparation of asymmetric membranes. This membrane showed in easy controlled membrane structure and morphology (Rezaei et al, 2014).

In recent years, several methods have been carry out for capturing of carbon dioxide (CO$_2$), such as chemical and physical absorption, solid adsorption, cryogenic distillation, and membrane separation (Naim and Ismail, 2013). Microporous hollow fiber membrane contactor system for carbon dioxide (CO$_2$) absorption is has attracted researchers’ attention to apply this in carbon dioxide (CO$_2$) absorption because gas and liquid can contact on the gas-liquid interface at the mouth of each membrane pore (Naim et al., 2013). Mansourizadeh, (2012) studied that the membrane was the most important element of the membrane contactor. Effective membrane required high hydrophobicity, high surface porosity, low mass transfer resistance and excellent resistance to get a better result performance.

Li and Chen (2005) reported that Qi and Cussler were the first to establish the idea of the hollow-fiber contactor using a microporous polypropylene (PP) hollow fiber membrane for absorption of carbon dioxide (CO$_2$) and aqueous sodium hydroxide solution was used as an absorbent.

In this study, a microporous PVDF membrane is one of the promising candidates for use in membrane contactors due to relatively high hydrophobicity, high chemical resistance and reasonable material cost (Rajabzadeh et al, 2009). PVDF is the only hydrophobic polymer that can be dissolved in common solvents to prepare asymmetric membranes via phase-inversion process (Mansourizadeh and Pouranfard, 2014). LiCl was used as an additive in PVDF/ Dimethylacetamide (DMAc) solution systems for the evolution of high performance hollow fiber membranes. The influence of LiCl concentration on the final membrane structure and the resulting of gas permeation,