CHAPTER I

INTRODUCTION

The rapid growth of population, industry and agriculture cause the rapid growth of green house gases (GHGs) emission, where CO_2 is a major contributor. The global CO_2 emission had increased by 40 % from 1990 to 2008 (20.9 to 29.4 Gt). Currently, the power sector is responsible for 41 % of the total CO_2 emissions, followed by transportation (23 %), industrial sector (10 %), and others. The CO_2 emission in the power sector is related to fuel combustion used to generate electricity or heat. The biggest fuel combustion in the year 2008 is from coal, about 43 %, while the contribution of oil and gas is 37 % and 20 %, respectively. Therefore, CO_2 capture process is primarily needed in power plants to capture CO_2 from flue gas. There are three main combustion technologies for fuel-combustion, including post-combustion, pre-combustion and oxyfuel-combustion. These three processes have different characteristics, yielding different conditions for CO_2 capture. In this study, the focus will be on post-combustion technology, which is widely used at traditional fossil-fuel-fired power stations to produce electricity. To capture CO_2 at low partial pressure (7-16 mol %) like post-combustion flue gas, chemical absorption is needed. Aqueous amines scrubbing technology such as monoethanolamine (MEA)-based process is currently considered the most feasible technology that can be used to capture CO_2 from post-combustion flue gas due to its maturity, stable operation, good reactivity, high absorption capacity and the low cost of MEA. However, the capture of CO_2 with MEA involves a chemical reaction with a large enthalpy of absorption (-88.91 kJ/mol CO_2). Consequently, a large amount of heat is required to release the captured CO_2 in the regeneration step. Retrofitting this unit of an existing power plant, would lower the energy output of the plant approximately by 25-40 %. Accordingly, the price of electricity would increase and would not satisfy to the target of the Department of Energy, of 90 % CO_2 removal from post-combustion flue gas and less than 35 % increase in the cost of electricity. Besides the energy penalty, the MEA-based process suffers a number of other drawbacks such as high volatility, tendency to degradation (above 120 °C), and equipment corrosion. These drawbacks cause a solvent loss and contamination to the environment. Among the emerging technologies to replace the conventional MEA-based process, ionic liquids (ILs) with properties of non-volatility, high thermal stability, and tunability of structure and properties, are considered potential solvent for green CO_2 capture technology with the benefit of cost reduction. Researches on ILs for CO_2 capture (measurement of CO_2 solubility in ILs) have been done in laboratories for almost ten years; a few process simulation using IL for CO_2 capture have also been done. However, only one process simulation of an IL-based scrubber comparing to an MEA-based process has appeared in the literature (Shiftlett *et al.*, 2010). To provide another option, one promising ionic liquid namely 1-Ethyl-3-methylimidazolium Acetate ([emim][Ac]) has been selected in this study due to its ability to capture CO_2 with lower energy consumption compared to MEA-based process. In this study, a commercial simulation program (Aspen Plus) is used to simulate the flow diagram of a new process design using IL ([emim][Ac]) and the conventional MEA-based scrubbing process for post combustion CO_2 capture based on the flue gas from a 180 MWe coal burning power plant. Then, the energy consumptions of both processes are compared. To ascertain the potential of economic benefits of the IL-based process, the investment cost is calculated and compared to the MEA-based process.