UNIVERSITI TEKNOLOGI MARA

SIMULATION: IMPROVING THE PERFORMANCE IN POST COMBUSTION CO_2 CAPTURE

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Thesis submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Engineering (Hons.) Chemical and Process

Faculty of Chemical Engineering

July 2018

ABSTRACT

This study was done to simulate by using Aspen HYSYS version 8.8 with Acid Gas Package for thermodynamic calculation for Post Combustion carbon dioxide capture (PCC). In order to tackle the main problems in PCC which are high operating cost and high energy consumption, this study was focused on the improvement that can be applied in this system where several parameters are varied in the simulation of PCC such as solvent used, number of absorber stages, stripper pressure and inlet stream flow rate. Cement flue gas was considered in this study since the carbon dioxide (CO_2) content of the cement flue gas is one of the highest emission than the other conventional power plants. The flue gas was coming from St. Mary's cement plant in Canada where the CO_2 content is 23.1 wt% and using solvent namely monoethanolamine (MEA) and diglycolamine (DGA). A parametric study was also carried out in order to identify the specific operating conditions and parameters for this absorption-desorption system. This modification and solvent used have reduce the energy consumption and increase the CO_2 absorption efficiency. About 87% of energy savings and 97% CO_2 capture were achieved by using 60 wt% of DGA and 40wt% of H_2O with the modifications used which is 20 stages of absorber, 5000 kg mole/h of inlet flue gas flow rate, 100,000 kg mole/h of inlet solvent flow rate and 2.6 bar of stripper pressure. This study deals with the detailed study on maximizing CO_2 absorption and removal efficiency while maintaining the minimal energy consumption for the absorbent regeneration section. As perspectives, these simulation results will be compared to the ones obtained by Hassan (2005) in which using Aspen PLUS model.

ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my degree and for completing this long and challenging journey successfully. My gratitude and thanks go to my supervisors Prof Madya Dr. Ruzitah Binti Mohd Salleh and Meor Muhammad Hafiz Bin Shah Buddin.

My appreciation goes to my colleagues and friends for helping me with this project.

Finally, this thesis is dedicated to both of my father and mother for the vision and determination to educate me. This piece of victory is dedicated to both of you. Alhamdulillah.

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CHAPTER ONE
INTRODUCTION

1.1 Research background

Carbon dioxide is a chemical compound which its chemical formula, CO_2 and consists of one carbon atom covalently double bonded to two oxygen atoms. It is an odorless and colorless gas at atmospheric temperatures and pressures which is relatively nontoxic and noncombustible. This gas is heavier than air since it has a density about 50% higher than dry air and may asphyxiate by the removal of air. CO_2 may form carbonic acid since it is soluble in water. At low concentrations the gas is odorless but it has a sharp and acidic odor at sufficiently high concentrations. CO_2 occurs naturally in Earth's atmosphere as a trace gas at a low concentration. It is in a gas phase in room temperature and is called dry ice, a white colored snow-like flakes or cubes in a form of solid. This CO_2 appears as colorless liquid if it is in a liquid state. The substance can decompose on heating above 2000^{o}C which can produce toxic carbon monoxide.

CO_2 was the first gas to be recognized from the ordinary air since CO_2 is a gas that involved in the cycles of plant, human and animal life. CO_2 is mostly released during respiration by exhalation from humans, animals, fungi and a few microscopic organisms. It is a final product in organisms that deliver energy from breaking down amino acids, fats and sugars with oxygen as the feature of their metabolism which is known as cellular respiration. At the point when plants store energy as sustenance, they use up the CO_2 from the atmosphere in term of photosynthesis. Also, it can be made from combustion, every time something organic is burnt or when a fire is ignited.

There are both natural and human sources of carbon dioxide emissions. Natural sources include volcanoes, hot springs and geysers and it is freed from carbonate rocks by dissolution in water and acids. Since the CO_2 is soluble in water, it occurs in rivers, lakes, ground water, ice caps, glaciers and seawater. It is returned to water via the gills of fish during respiration. It also can be found in the decomposition of petroleum and natural gas. Besides that, it is produced during the processes of decay of organic materials. Human sources come from activities like combustion, cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas. Moreover, it is an unwanted byproduct of many substantial oxidation processes in most of the industrial projects. The largest human source of CO_2 emission comes from the burning of fossil fuels.