SIMULATION OF PYROLYSIS AND GASIFICATION OF SUB-BITUMINOUS COAL USING ASPEN PLUS

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The things that I have learnt is on how to simulate a process using another Aspen product, which is Aspen Plus. Instead of using Aspen Hysys, Aspen Plus was used to run the simulation. I believe that being able to understand on how to use a two different programme will be beneficial in the future. My upmost gratitude goes to my supervisor, Dr. Noor Fitrah Abu Bakar who had always support and guide me through my research and many thanks to my previous supervisor, Miss Siti Norazian Ismail. Both of them had truly inspired me to be successful in this field and set great examples for me to keep learning from failures and never give up. I would also like to express my gratitude to all my colleagues who had make my degree years so exciting and memorable. My thankfulness to everybody who had contributed in completion of this course and research paper.

ABSTRACT

The purpose of this study is to simulate the process of pyrolysis and gasification of sub-bituminous coal. Simulation of this process was done in order to transform the coal into synthesis gas. This was done by using pyrolysis and gasification process. Gasification is a process where thermochemical reactions takes place. The coal was transformed by partial oxidation into synthetic gases. In the simulation by using Aspen Plus, the main syngas formed is carbon monoxide, hydrogen and carbon dioxide. These gas are used in electricity generation as a fuel to the turbines. In this project, the rigorous model that was used to simulate the pyrolysis and gasification process is R-Yield and R-Gibbs respectively. R-Gibbs model are used to determine the equilibrium composition of the expected products which involves various kinds of chemical reactions. R-Yield model was used to simulate the decomposition yield of the coal based from the ultimate analysis and proximate analysis obtained from references. The R-Yield model was simulated with the help of FORTRAN code which is needed to calculate the amount of yield. A study on the effect of the temperature of the gasifier and the air-fuel ratio on the amount of syngas produced was studied. The temperature was varied from 900ºC to 2000ºC and the air ration was varied from 9000kg/hr to 30000kg/hr. A solid-gas separator was used to simulate the separation of the ashes obtained from the pyrolysis process. The main concern of the process is the cleaning of the gas. The results obtained shows that the cyclone which was used for the solid-gas separation was successfully separated with an efficiency as high as 95%.. The efficiency of the cyclone mainly depends on the PSD (particle size distribution) of the coal.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Pyrolysis and gasification are used in industry in order to convert industrial fuel which may be a regular fossil fuels such as coal, biomass, crude oil and natural gas into a chemical or nuclear energy as heat or to be used for work. Gasification is a process which converts these fuels into syngas which is carbon monoxide, hydrogen and carbon dioxide. Syngas is an intermediate compounds which holds many uses, these production of syngas brings a lot of benefits towards the industry and has opened up a wide variety of research opportunities in renewable energy resources. The main usage of syngas is in the electrical generation which the generation of the electricity is from the power provided from the combustion of the syngas.

It is known that in the generation of electricity and the demand of energy, fossil fuels such as coal, gas and oil are the responsible source of energy being used as the fuel. Coal, compared to the other fuels are the largest source of energy for generation of electricity worldwide. Coal are largely used as a fuel due to its known reliability, affordability, abundance, known energy and safety. Energy produced from coal fired plants is cheaper and more affordable than other energy sources. Since coal is abundant, it is definitely cheap to produce power using this fuel. Moreover, it is not expensive to extract and mine from coal deposits. Consequently, its price remains low compared to other fuel and energy sources.