UNIVERSITI TEKNOLOGI MARA

THERMAL BEHAVIOUR STUDIES ON COAL-BIOMASS BLENDS DURING PYROLYSIS AND COMBUSTION VIA THERMOGRAVIMETRIC ANALYSIS

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ABSTRACT

Thermal behaviour of raw and demineralized Mukah Balingian coals, biomass and coal-biomass blends at different weight ratios (i.e. 90:10, 80:20, 70:30 and 50:50) during pyrolysis and combustion conditions was studied by using thermogravimetric analysis at different heating rates in the range of 5-60°C/min. The results thus far showed that the thermal events of the raw and demineralized biomass materials during pyrolysis and combustion were mainly contributed by the decomposition of hemicellulose and cellulose that evolved at lower temperature in the range of 295-333°C and 346-376°C, respectively. The raw and demineralized coal decompositions, however, revealed almost identical thermal events with the appearance of a single evolution peak that occurred at higher temperature regime in the range of 415-465°C. Apparently, no interaction was seen between the raw and demineralized coal-biomass blends during pyrolysis and combustion. However, by blending of 50 wt% coal and bio-coal, the DTG curves showed a single evolution peak indicating the comparable reactivity between the two fuels during combustion. Further, the reactivity of the demineralized coal and demineralized biomass materials increased with increasing in heating rates and were more reactive in comparison to the raw samples and these were proven by observing the profiles of char remaining after pyrolysis. The kinetic study of coal, biomass and their blends during pyrolysis was also been carried out to determine the activation energy and pre-exponential factors. The 50:50 blends of coal-rice husk and coal-rice straw with respect to the coal volatile matter released revealed the lowest activation energy of 201 and 217 kJ/mol, and pre-exponential factors of 7.46×10^{11} min^{-1} and 9.70×10^{12} min^{-1}, respectively. In addition, for the coal-sugarcane bagasse, the lowest activation energy was 211 kJ/mol with pre-exponential factors of 3.60×10^{12} min^{-1} for the blend ratio of 80:20. Likewise, the 80:20, 70:30 and 50:50 blends for the demineralized coal-rice husk, coal-rice straw and coal-sugarcane bagasse showed the lowest activation energies of 170, 173 and 163 kJ/mol and pre-exponential factors of 2.37×10^{9} min^{-1}, 5.82×10^{9}, and 1.77×10^{9} min^{-1}, respectively.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Biomass fuels are considered as an important resource for alternative fuels due to instability in the production of crude oils [1]. Moreover, the world crude oil reserves are estimated to last for another 20 to 30 years at the current rate of consumption [2]. Hence, finding an alternative fuel to substitute for crude oil has become an important agenda in order to sustain the current industrial growth.

An alternative choice of reducing the dependency on crude oil is by utilizing coal, since the world coal reserves are of abundance [2]. However, there are several disadvantages in the combustion of coal with problems associated with excessive CO_2 emission that can cause a global warming effect on the environment [3]. Hence, one option to reduce the CO_2 emission is by minimizing the combustion of coals by utilizing the co-firing of coal and biomass fuels (i.e. rice husk, rice straw and sugarcane bagasse).

Though combustion of biomass fuels alone emits less CO_2, the energy produced is less in comparison to that of fossil fuels. Hence, utilizing the co-firing of coal and biomass fuels would be an excellent choice for compromising between CO_2 emissions and the energy produced [3]. In addition, the coal reserves eventually deplete for over 215 years [2]. However, the biomass fuels that are of renewable resources can be reproduced regularly, thus attain the sustainable of the energy required.

In Malaysia, there are many projects such as the Small Renewable Energy Power Program (SREP) [4] was established to increase the usage of renewable energy for future power generation. However, the total energy demand from that source is quite slow and their research development is still ongoing. Therefore, co-firing techniques