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Experimental Investigations on the Characteristics of Biomass and Coal-biomass Fuel Briquettes

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Abstract. Combustion of coal, a fossil fuel, in power plant, is a major source of carbon dioxide emission, a greenhouse gas that causes global warming. Malaysia is one of the major exporters of palm oil and has 421 palm oil mills operating in 2010. Some of the residues from these mills like palm kernel shell and palm mesocarp fibre were converted into value-added products. An optimum biomass fuel briquette was obtained with palm kernel shell and palm mesocarp fibre as the major ingredients. Co-firing coal with biomass is a possible approach for power plant to curb the excessive emission of carbon dioxide. In this study, bio-briquette having 50% coal and 50% biomass which consisted of the ingredients of optimum biomass fuel briquette were studied in details. Comparison of the fuel properties, combustion characteristics and carbon dioxide emission between the optimum biomass fuel briquette and bio-briquette was made.

Introduction

It had been concluded in a previous research by Chin and Aris [1] that an optimum biomass fuel briquette originated from oil palm mill residues was the 60S:40F(p) briquette, where S means palm kernel shell (PKS), F for palm mesocarp fibre (PF) and p in parenthesis means paper as binder. Following that research, for a 10g fuel briquette with 10% binder material by weight, there are 54% PKS, 36% palm PF and 10% waste paper. The calorific value of that optimum biomass fuel briquette was found to be 18.63 kJ/g, compatible to a low rank coal. The fossil fuel, coal, that was used in power plants in Malaysia is usually having calorific value (CV) more than 20 kJ/g. Based on this scenario, a complete substitution of coal with the biomass fuel briquette is not a wise choice when CV is concerned. The Department of Energy (DOE) of the United States had mentioned that the reliance on fossil fuel, coal, as one of the major fuel resources for electricity will remain in the 21st century, despite all the environmental issues related to coal usage [2]. Carbon dioxide (CO_2), a major greenhouse gas (GHG) released from coal burning causes global warming. A study by Hassan et al. [3] revealed that the heat trapped in the atmosphere had increased to 1.4-5.8^{o}C in the 21st century from 0.6-2.5^{o}C in the last 50 years.

Burning biomass, however, does not increase the net amount of CO_2 in the atmosphere because the amount of CO_2 emitted during biomass burning is deemed equal to the amount of CO_2 assimilated into the plants during their growth [4]. Thus, co-firing CO_2-neutral biomass with coal is a possible means to lessen the global warming effect. Biomass generally had lower sulfur content when compared to coal and the alkaline ash produced at the end of the combustion process was capable of capturing some SO_2 produced in the combustion process [5]. Biomass combustion could lead to low NO_x emissions due to the higher volatility nature of biomass than coal [6]. Other minor pollutants like volatile organic compounds (VOC), polyaromatic hydrocarbons (PAH) and toxic organic compounds (TOC) could be reduced when coal was co-fired with biomass [7].

In this study, the simplest co-firing option of direct co-firing was considered. The 50% coal-50% biomass blend fuel briquette in this study was named bio-briquette. The 50% biomass had the same ingredients composition as the optimum 60S:40F(p) briquette. The fuel properties, combustion characteristics and carbon dioxide emission from combustion of the two types of briquettes – 60S:40F(p) briquette and bio-briquette were compared in this study.