UPGRADING OF BIOMASS BY PYROLYSIS AT LOW TEMPERATURE

MISS WORRADA NOOKUEA
ID: 51910413

A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING
IN ENERGY TECHNOLOGY AND MANAGEMENT

THE JOINT GRADUATE SCHOOL OF ENERGY AND ENVIRONMENT
AT KING MONGKUT'S UNIVERSITY OF TECHNOLOGY THONBURI

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Abstract

Renewable energy is becoming important as the fossil fuel reserve gradually depletes and the concerns over global climate change. Biomass is an important source of renewable energy which is derived from the living mechanism such as photosynthesis of plants. Due to the lower contents of sulfur and nitrogen in the biomass, its energy utilization also emits less environmental pollution and is less a health risk than fossil fuel. However, biomass utilization as a solid fuel still has many drawbacks and many undesirable properties. Pretreatment or upgrading of biomass before further utilization is one of the alternatives to improve their combustion properties. Pyrolysis at low temperature of raw biomass under inert atmosphere or torrefaction process is an attractive upgrading technique to remove moisture and increase the energy density. In this study, cassava rhizome, eucalyptus trunk, jatropha trunk and napier grass were torrefied at temperatures below 300°C in an inert atmosphere using drop tube and fixed bed reactor. Then, the torrefied biomass was subjected to various analyses to examine the effects of the pyrolysis on the fuel properties. It was found that the yields of solid products or treated biomass were decreased with increasing pyrolysis temperatures. The major gas product during the pyrolysis was H_2O. Considering both solid yield and heating value, slow pyrolysis gave the torrefied products a more significant increase in calorific values but lower decrease in solid yields compared to fast pyrolysis. The significant increase in the heating value of the treated biomass was brought about by the increase in carbon content in the treated biomass. The heating value of napier grass for example, increased as much as 20.7% and its energy density was increased to 1.21 when being torrefied by slow pyrolysis at 280°C. In addition, the char combustion rates of torrefied biomass were also increased from the rate of raw biomass.

Keywords: Biomass, Renewable energy, Pyrolysis, Slow pyrolysis, Fast pyrolysis, Torrefaction

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