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Comparison study of sugarcane leaves and corn stover as a potential energy source in pyrolysis process

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Abstract

Sugarcane (*Saccharum officinarum*) and corn (*Zea mays*, Linn.) is widely planted in Thailand. The pyrolysis process has been carried out in thermochemical processing of organic decomposition of biomass to increase the value of the biomass. The aim of this study was to research the probability of sugarcane leaves and corn stover for pyrolysis process. The proximate analysis results indicate that corn stover has a volatile content higher than sugarcane leaves. Sugarcane leaves have a higher ash content than corn stover. The heating value was obtained 14.47 and 20.91 MJ/kg for sugarcane leaves and corn stover, respectively. TGA results show 4 stages: dehydration, active pyrolysis passive pyrolysis and completed combustion stage. Furthermore, the thermal degradation of biomass could be considered an optimization of temperature for pyrolysis process.

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1. Introducion

Sugarcane (*Saccharum officinarum*) and corn (*Zea mays*, Linn.) is widely planted and used for industrial purposes in Thailand. Large amount of post-harvest residues are produced during harvesting of sugarcane, including

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sugarcane tops [1]. Another residue is corn stover which is the residue that is left on the soil surface after corn grain harvested. Both sugarcane Leaves and corn stover are an abundant, inexpensive and readily available source of lignocellulosic biomass [2] which are all useful raw materials for activated carbon [3]. Moreover, an agricultural waste could be a renewable energy. Currently, sugarcane leaves are used as raw materials in bioethanol product but the process require some chemical or biochemical for decomposing cellulose and hemicellulose to generate fermentable sugars. In contrast, pyrolysis process, is a thermochemical process which is able to recycle excess energy while producing lower pollutant as by-products [2]. Pyrolysis of biomass produces gas and liquid products and leaves a solid residue. The solid residue from pyrolysis process is biochar which could be used as fuel and activated carbon precursor. The liquid residue is bio-oil which consist of alcohol, aldehyde, ester and phenolic compound [4]. Moreover, the gas residue could be renewable energy as syngas. The objective of this work was to studies the thermal properties of agricultural waste for the energy conversions.

2. Materials and methods

2.1 Preparation of biomass

Sugarcane leaves and corn stover sample were collected from the northeastern of Thailand region. The samples were crushed using a blender and sieved with a 20, 32 and 35-mesh-screener (425-850 μm). The samples were dried in an oven to below 10 wt% moisture content at a temperature of 103 ± 2 ºC for 10 h.[5]

2.2 Analysis of biomass

2.2.1 The heating value of biomass analysis

The calorific value of sugarcane leaves and corn stover were found using a proximate analysis for moisture, ash and volatile matter, respectively by Bomb calorimeter (Gallenkamp, UK) [6].

2.2.2 Thermogravimetric (TGA) analysis

The thermal degradation of sugarcane leaves and corn stover were found using a Thermogravimetric analyzer (TGA 50, Shimadzu, Japan). The sample was heated in a temperature range of 30 – 600 ºC with a heating rate of 10 ºC/min under nitrogen flow.

3. Result and discussion

3.1 The proximate analysis and heating value analysis of sugarcane leaves and corn stover

Table 1 presents proximate analysis and higher heating values of sugarcane leaves and corn stover. The main components of Sugarcane leaves and corn stover were volatile content and fixed carbon.The corn stover contains 61.59 %wt volatile content while the sugarcane leaves is about 32.34 %wt. However, the fixed carbon of the sugarcane leaves is higher than that of the corn stover by 26.31wt%. The volatile content is obtained by the decomposition of hemicellulose and cellulose which could be changed to bio-oil [7]. The fixed carbon is obtained by lignin degradation. The fixed carbon is known as biochar which could be used in fuel application as substitutes for coal [8]. Sugarcane leaves have a higher ash content than corn stover. This could be decreased the liquid fraction in pyrolysis process[9]. Furthermore, the heating value was obtained 14.47 and 20.91 MJ/kg for sugarcane leaves and corn stover, respectively. The heating value is indicated to the amount of carbon source in biomass : the higher carbon source gave a higher yield of pyrolysis products [10].

Table 1. the Proximate analysis (wt%, dry basis) and higher heating values ((HHV in kJ/kg, dry basis) of sugarcane leaves and corn stover

Properties	Sugarcane leaves	Corn stover
Moisture content	6.61	8.39
Volatile content	32.34	61.59
Fixed carbon	54.57	28.26
Ash content	6.48	1.77
Higher heating value	14.73	20.91