The study of ratio and type of binder for the screw press chaff charcoal machine

Sakultala Wannapakhe[1*]

ABSTRACT: The aim of this research was to study of ratio and type of binder for the screw press chaff charcoal machine. The testing stuff was the black rice husk ash from the combustion section of Hayok (2013)'s the chaff charcoal compressing machine. The type of binder was 3 types of cassava starch, molasses, and Ansavanada. The results of testing, it was found that the binders for compressed chaff charcoal were cassava starch and molasses. The suitable ratio of cassava starch binder for charcoal compression was 10:3:10 kilograms (black rice husk ash : cassava starch : water). The suitable ratio of molasses binder for charcoal compression was 10:3 kilograms (black rice husk ash : molasses). The testing results of density value, compression strength in vertical and horizontal, and calorific value were higher than minimum standard of compressed charcoal.

Keywords: compressed charcoal, chaff charcoal, husk

Introduction

Thailand is a country rich in natural resources and the Thailand's area is suitable for agricultural. The cultivation of Thailand is not only for domestic consumption but the cultivation of Thailand is for export to countries outside. Especially the Thai rice is the popular of agricultural product for domestic consumption and exportation. The waste product of rice grain processing is rice husk. The value of rice husk is very low cost therefore if the rice husk was converted to black rice husk ash; the cost of black rice husk ash is higher than rice husk.

The processing for pressing chaff charcoal is 2 ways as the hot and cold compressions. It has many researches about charcoal compressing machine such as in 2005, Vechakul (2005) studied in topic of design of a bagasse charcoal briquette-making device for use in Haiti; in 2011, Wongsaroj et al. (2011) studied about biomass briquette production from Jatropha. Walairat and Vitidsant (2012) studied about production of smokeless briquette charcoals from wet cake waste of ethanol industry, etc. In 2014, Wannapakhe and Booddachan (2014) studied about a case study of rice husk combustion using electric heater. Moreover, Hayok et al. (2013) studied in topic chaff charcoal compressing machine. The chaff coal compressing machine was divided into 2 sections as follows: the combustion section and the compression section. This machine was used for testing in this research because Hayok et al. (2013)studied only designed and built the chaff

[1] Department of Agricultural Engineering for Industry, Faculty of Industrial Technology and Management, King Mongkut's University of Technology North Bangkok,129 Moo 21, Tumbol Noen-Hom, Amphur Muang, Prachinburi Province, 25230, Thailand

* Corresponding author: Sakultala.W@fitm.kmutnb.ac.th

charcoal compressing machine but did not study about ratio and type of binders for the screw press chaff charcoal machine. Therefore, the aim of this research was to study of ratio and type of binder for the screw press chaff charcoal machine.

Experimental setup and procedure

The testing stuff was the black rice husk ash from the combustion section of Hayok et al. (2013)'s the chaff charcoal compressing machine for finding the ratio and type of binder for the screw press chaff charcoal machine. In Figure 1 shows the design of combustion by using heaters testing machine (Hayok et al., 2013). The device structure of machine in Figure 1 was divided into 2 sections as follows: the combustion section and the compression section. The screw conveyor was used for rice husk transport to combustion section by 2 band heaters of 2,000 Watts. The diameter of screw conveyor cover of combustion section was 90 mm and the diameter of screw conveyor of combustion section was 76.2 mm for transferring rice husk through heater. The speed of screw conveyor for combustion test was set as 10 rpm. The rice husk after combustion as shows in figure 2 is used for making rice husk charcoal by compressing machine. For the compression section, the diameter of extrusion cylinder cover was 62 mm. The end of extrusion cylinder was 45 mm. The 2 horse power, 3 Phase 220/380V, 1420 rpm was used for testing. The gearbox of ratio of 1:60 was used for transmitting power. The pulleys of 60, 76.2 and 304.8 mm were used for changing ratio of screw press speed.

The experimental procedure for properties of chaff charcoal compressed testing by mixing of binder and rice husk from combustion section of compressing machine was mixed by using mixer machine of 10 minutes. The mixer machine was separated from the screw press chaff charcoal machine, in this research the mixer machine was small cement mixer of jishun in model js140c1. The type of binder was 3 types of cassava starch, molasses, and Ansavanada. The ratios of cassava starch binder for charcoal compression testing were 10:1.5:10, 10:2:10, 10:2.5:10, 10:3:10 and 10:3.5:10 kilograms (black rice husk ash : cassava starch : water). The ratios of molasses binder for charcoal compression testing were 10:1.5, 10:2, 10:2.5, 10:3 and 10:3.5 kilograms (black rice husk ash : molasses). The ratios of Ansavanada binder for charcoal compression testing were 10:1.5, 10:2, 10:2.5, 10:3 and 10:3.5 kilograms (black rice husk ash : Ansavanada). The husk charcoal compressed was tested density value, compression strength in vertical and horizontal, calorific value, residence time and ash percentage. The compression strength and calorific values were tested by using the universal testing machine, Shimadzu UH200A and bomb calorimeter, Gallenkamp CAB101.AB1.C, respectively.

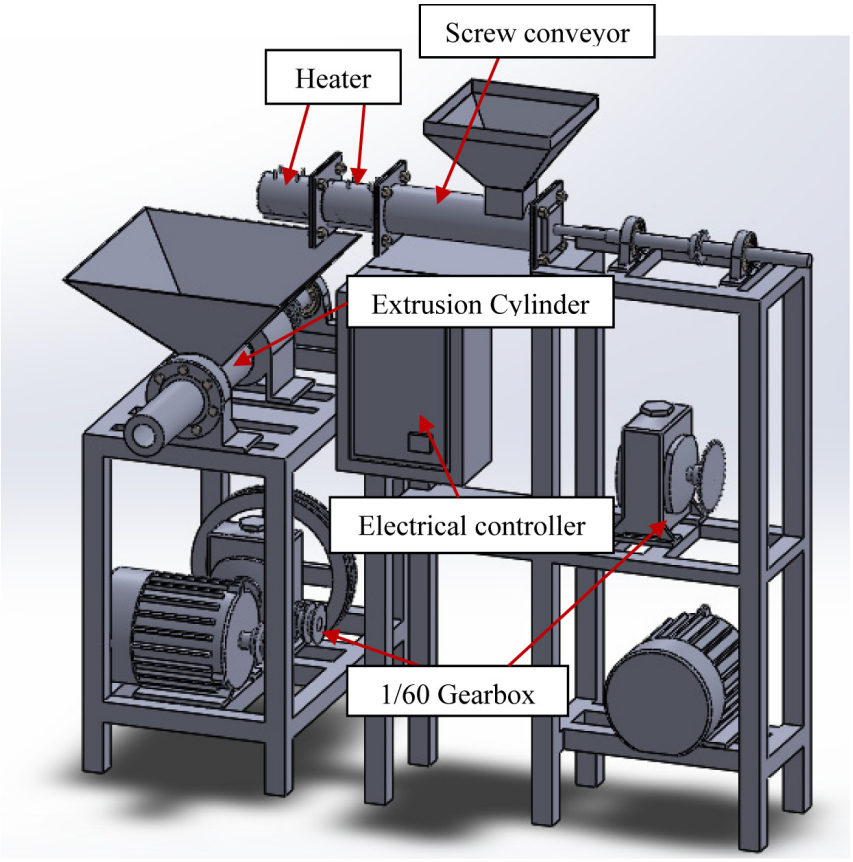

Figure 1 The design of combustion by using heaters testing machine

Figure 2 Characteristic of husk from combustion section of compressing machine, speed motor of 30 rpm

The experimental results

The results of testing, it was found that the binders for compressed chaff charcoal were cassava starch and molasses. The ratio of cassava starch binder for charcoal compression was compressed and clumped begins at ratio of 10:2.5:10 kilograms. The suitable ratio of cassava starch binder for charcoal compression was 10:3:10 kilograms. The charcoal of ratio of cassava starch binder of 10:3:10 kilograms shows in Figure 3(a). The ratio of molasses binder for charcoal compression was compressed and clumped begins at ratio of 10:2.5 kilograms. The suitable ratio of molasses binder for charcoal compression was 10:3 kilograms. The charcoal of ratio of molasses binder of 10:3 kilograms shows in Figure 3(b). In case of by using Ansavanada binder, it cannot make charcoal in any ratio of Ansavanada binder. The results of chaff charcoal testing of density value, compression strength in vertical and horizontal, calorific value, residence time and ash percentage are showed in Table 1. The results testing of charcoal properties in Table 1 of compression strength in vertical and horizontal, calorific value, residence time were higher than the standard of charcoal (KU. – BAAC. NF030/2549). The minimum standard value of compression strength is 0.375 MPa. The minimum standard value of calorific value is 5,000 cal/g., the residence time is over 60 minutes. The results of chaff charcoal testing of density value are lower than 800 kg/m^3.

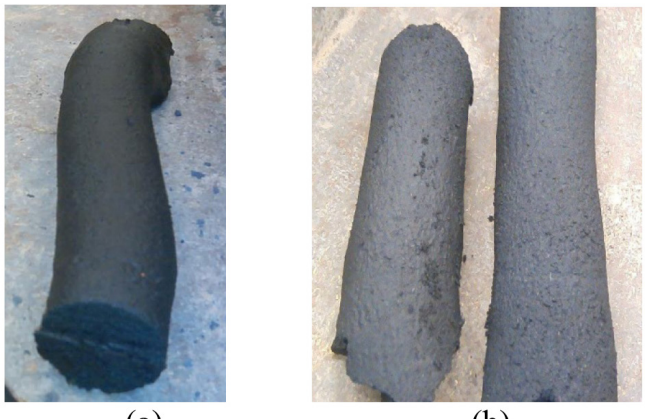

Figure 3 The chaff charcoal : (a) chaff charcoal by using cassava starch binder of 10:3:10 kilograms; (b) chaff charcoal by using molasses binder of 10:3 kilograms.

Table 1 The results testing of chaff charcoal properties

Type and Ratio of Binders	Density (kg/m^3)	Compression Strengths (MPa)		Calorific Value (Cal/g)	Residence Time (minute)	Ashes Percentage (%)	Annotation
		Vertical	Horizontal				
Black Rice Husk Ash : Cassava Starch : Water (10 : 1 : 10)	-	-	-	-	-	-	Not forming
Black Rice Husk Ash : Cassava Starch : Water (10 : 1.5 : 10)	-	-	-	-	-	-	Not forming
Black Rice Husk Ash : Cassava Starch : Water (10 : 2 : 10)	-	-	-	-	-	-	Not forming
Black Rice Husk Ash : Cassava Starch : Water (10 : 2.5 : 10)	-	-	-	-	-	-	Not forming
Black Rice Husk Ash : Cassava Starch : Water (10 : 3 : 10)	706.66	0.40	0.58	38,309.9	191	10.5	-
Black Rice Husk Ash : Cassava Starch : Water (10 : 3.5 : 10)	-	-	-	-	-	-	Incompress-ible

Table 1 The results testing of chaff charcoal properties (Cont.)

Type and Ratio of Binders	Density (kg/m^3)	Compression Strengths (MPa)		Calorific Value (Cal/g)	Residence Time (minute)	Ashes Percentage (%)	Annotation
		Vertical	Horizontal				
black rice husk ash : molasses (10 : 1)	-	-	-	-	-	-	Not forming
black rice husk ash : molasses (10 : 1.5)	-	-	-	-	-	-	Not forming
black rice husk ash : molasses (10 : 2)	-	-	-	-	-	-	Not forming
black rice husk ash : molasses (10 : 2.5)	-	-	-	-	-	-	Not forming
black rice husk ash : molasses (10 : 3)	726.64	0.39	0.56	77,122.2	338	9.8	
black rice husk ash : molasses (10 : 3.5)	-	-	-	-	-	-	Not forming

Conclusions

As the results of experimental of 3 types of binder, it has 2 types of binder for charcoal compression as cassava starch and molasses. The suitable ratio of cassava starch binder for charcoal compression was 10:3:10 kilograms. The charcoal of ratio of cassava starch binder of 10:3:10 kilograms. The suitable ratio of molasses binder for charcoal compression was 10:3 kilograms. As the result of comparison of charcoal properties value (Calorific value and residence time), it was found that the best of ratio and binder type for charcoal compression was molasses at ratio 10:3 kilograms.

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