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Controlling Temperature of Corn Cob Briquette Materials Using Automatic Induction Heater

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***Abstract*— Corn Briquettes can be made using direct combustion such as burning of fuel. But this methode is unhealthy which can produce danger particles and smoke. One methode to burn something without direct burning is using vessel reactor (oven). This research aims to built an electric oven using induction heater. Controlling oven temperature was conducted using induction heater automaticly. The temperature of the oven will be controlled automaticly by varied the induction heater. Oven was built of 3 (three) item induction heater and was set in 3 (three) condition. At first condition, first heater is set at 50ºC. After reaches 50ºC, the second induction heater is on, then at 100ºC the third induction heater is on. Maximal value of temperature is 300ºC. With Corn Briquette Materials is in the oven, it wil be created briquette charcoal. A microcontroller based thermocople K-Type sensor will control these condition. It achieves 50ºC, 100ºC and 300ºC each for 1st heater, 2nd and 3rd . For 20 minutes oven temperature reaches 50ºC, after next 100ºC in 1 hours and reaches 300ºC in 4 hours, the material reduces it's weight about 20 grams in 4 hours starting in 50ºC.**

***Keywords*— Temperature; Corn Briquette Materials; Induction Heater; Automatically**

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I. INTRODUCTION

Land area of public plantation in Indonesia in year 2023 is about 2,49 million hectare [1]. At Sumatera Barat province, land of corn area until year 2022 reaches 128.944 hectare with 853.024 tons production [2]. Many of efforts in producing corn briquette as heat sources energy is intended for economic values and persist of energy as well as sustainability. A processing to produce the corn briquette is by using direct combustion in a vessel and flushing water. But this methode produced low quality charcoal with high water content and smoke with carbon dioxide (CO_2) as air pollution [3]. Based on this fact, it is needed a process in producing environmentally friendly charcoal briquette to reduce smoke. Carbonication is a process to burn corn cob in an enclosed vessel with high temperature until 500ºC. This methode can reduce dust level [4]. It is called pyrolysis or non direct combustion. For comparation, result of charcoal only 30% of its input material with diesel fuel direct combustion. Other for LPG (Liquid Petroleoum Gas) charcoal result are 2,1 times its input but water level is 3,6 times and low heat value about 20%, high dust level 6,6 times [5] with carbon dioxide (CO_2) in the air. Alternatifly, an induction heater with increasing variabel temperature until reach optimum value for every 2 hours [6]. Combustion with wood biomass is difficult to control and burning quickly [7]. Temperature level more than 500ºC caused it can break griquette quality. This research aims to built a device to burn corn cob and produce briquette with pyrolysis methode attached with induction heater and controlling tempertaure. Final value will be found influence of temperature and time of burn to percentage of cahrcoal briquette result, water and dust and heater electric energy. For on-off induction heater is using thermocopel K type temperature sensor and amplifier mikrokontroller based which is layed in carbonize induction heater.

II. THE MATERIALS AND METHOD

This research is conducted in two steps. First is to build and apply sensor as well as microcontroller and induction heater. Another is measuring technique.

A. Induction Heater

An Induction heater is constructed with wound diametric, work object and heated material. These 3 (three) kind of factor are characterized the heater. It is needed to know effect of heater performance due to diameter and amount of induction turns. Induction heating is constructed and tested. According to [8] at 100^{o}C temperature with no load it is needed 1,32 minutes to heat process with 7 cm object diameter and 7 turns. Otherwise for 7 cm diameter and 12 turns it takes 2,22 minutes. Then testing and measurement is conducted to 231 mili litre water as load. It takes 2,794 minutes. Lowest energy cosumption is about 83,89 kJ.

B. Automatic controlling

Induction heater working is controlled by temperature sensor and microcontroller arduino type. Heat temperature value is generated from enclosed heat vessel. Temperature controlling based on software arduino uno [9]. Temperature Sensor thermocouple K type is applied to this device with amplifier based on microcontroller. Block diagram of this sensor system follow as figure 1.

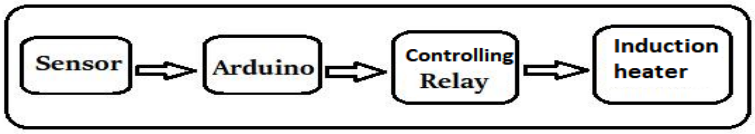


FIGURE 1. Block Diagram of the sensor system

Sensor is placed in the vessel with corn cob material and heated for 200^{o}C to maximum 500^{o}C.

At first step, 1st induction heater is on, and will reach temperature about 200^{o}C. Then 2nd and 3rd induction heater is on until vessel temperature reaches 500^{o}C. Controlling relay will turn off induction heater. This system suitable for the block diagram in the figure 2.

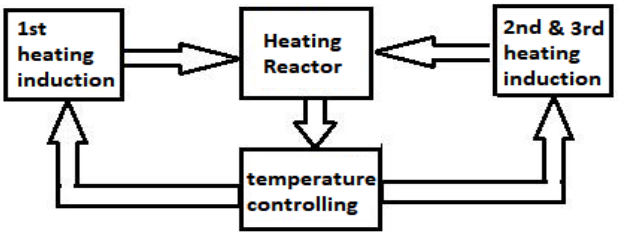


FIGURE 2. Block Diagram of the induction heater system

C. Contruction design

For vessel construction design, it should defined corn cob material capacity [10]. Density of corn cob material is about 1,31 gr/cm3 [11].

Volume of corn cob = weight (gr) / desity (gr/cm^3) (cm^3) (1)

For 5 kgs corn cob then :

Volume = 5000 gr / 1,31 gr/cm^3 = 3.817 cm^3

Reactor vessel will be made about 4 times of corn cob material volume.

It is 4 x 3.817 = 15.267 cm^3

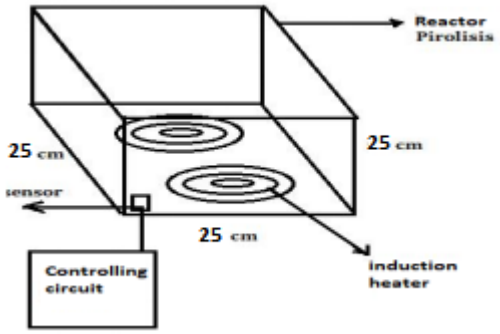


FIGURE 3. Construction and mechanic device

III. RESULTS AND DISCUSSION

Result divide into 3 step : Induction heater circuit, controlling temperature and corn cob output.

A. Induction heater Circuit

Induction Heater circuit follow circuit diagram in figure 4.

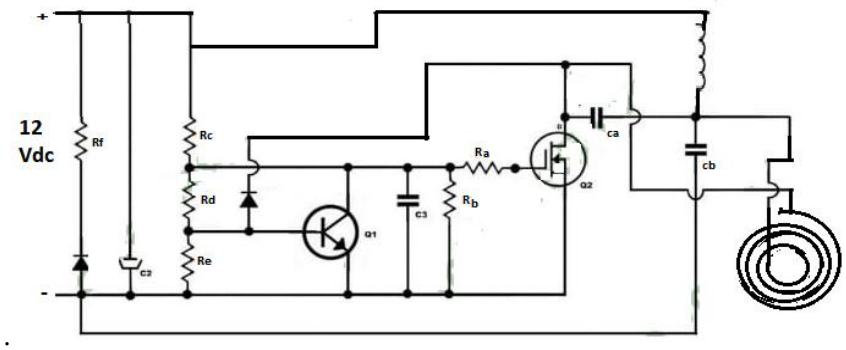


FIGURE 4. Induction Heater Circuit

Figure 5 is real circuit of induction heater.

B. Controlling Temperature

Controlling temperature is conducted by arduino uno completed with thermocouple K type sensor with amplifier. Figure 6 is a vessel reactor



FIGURE 5. Applied of Induction Heater Circuit



FIGURE 6. Vessel Reactor

Result of the heater condition and temperature in the vessel according to table I.

TABLE I
temperature and condition of heater

No	Heater and temperature	
	1st heater (°C)	2nd and 3rd heater (°C)
1	50	0
2	100	50
3	150	200
4	250	250

C. Corn cob output for briquette

Effect of the device to the corn cob material for briquette is describe as the temperature of the device to the output of corn cob weight, which is represent the level of water content as attaced in table II.

TABLE II
weight of corn cob reducing and % of water losses

No	Corn cob output for briquette		% reducing of weight
	Input (grams)	Output (grams)	
1	50	20	60
2	75	40	47
3	100	60	40
4	200	160	20
		Average	41,75

The curve of the % reducing of weight is represented in figure 7.

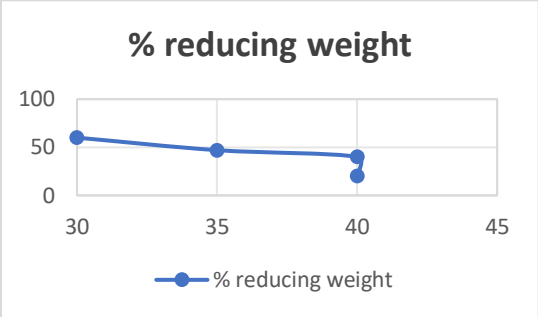


FIGURE 7. % reducing weight of corn cob for briquette material

Range of the reducing weight of corn cob is between 30% to 40%..

IV. CONCLUSION

After 4 hours the temperature of the vessel reactor reaches 300ºC, the reducing of weight of corn cob material for briquette is between 30% to 40%. It present reducing the level of water content attent of weight losses.

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