



Designing a Waste Power Plant (PLTSA) Prototype Based on the Type of Waste as a Renewable Energy Source

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Abstract. Renewable electricity from waste is one of the solution to overcome the problem of the energy crisis of fossil fuels and solutions to reduce the increasing waste population in Indonesia. The abundance of rubbish in Indonesia with the existence of Waste plant can produce enough electricity and can also reduce the problem in Indonesia itself, namely the lack of electricity in some regions. In this journal, we make a prototype of a waste power plant (PLTSA) using the incinerator method or what can be called combustion. The initial step to do is collecting reference data in the form of journals. Then the PLTSA prototype was assembled, and finally the prototype was tested. Based on the results of the prototype test conducted by comparison of different types of waste, namely used wood, dry leaves, and paper with a load of one LED. Obtained an average power of 0.1763 watts. From prototype testing that we have done, it can be concluded that the type of used wood waste that produces greater power.

Keywords: Electricity · mobile · Rubbish

1 Introduction

Waste is a small problem that if left unchecked will become a serious problem. Until now, most of the people think that waste is a dirty object, and there is no value. The amount of waste that exists is the same as the amount of goods we use every day [1].

In Indonesia, waste is an environmental problem that is rampant in Indonesia. Along with the development of science and technology, a solution was finally found for the waste problem.

In addition to the waste problem, the problem that occurs in Indonesia is the uneven distribution of electrical energy in remote areas of Indonesia. With these two problems, a solution was found to overcome the lack of electricity distribution and reduce the amount of waste in Indonesia. The solution to this problem is to use waste to become a power plant.

Waste power plants are an example of the use of renewable energy. By utilizing this waste energy, it is hoped that it can reduce the use of so much waste, and can reduce environmental pollution that occurs.

Previously, there has been a lot of research conducted in the design of PLTSA [2]. However, in the process, the PLTSA takes a considerable amount of time to produce large amounts of power. Here we make a PLTSA prototype as a simulation of the actual PLTSA with relatively cheap tools and materials to see the potential power generated and also make a comparison on which type of waste has the greatest final power value so that the PLTSA in the process is more effective and efficient.

1.1 Characteristics of Waste

Waste is a waste that comes from human daily activities or is a process from nature that forms solids [3]:

Based on its nature, waste comes from 2 types, namely:

a. Organic waste

That is, waste that comes from the food waste of living things such as humans or animals, or the kind of waste that can be decomposed without interference from humans. An example of organic waste is dry leaves.

b. Inorganic Waste

Is waste that can last longer than organic waste. This type of waste is difficult to decompose by microorganisms and inorganic waste has the potential to pollute the environment if not handled properly. This waste can usually be recycled back into usable items. Such as used plastic and cans.

Based on research from (BPTT), the composition of organic waste has variations, between seventy percent to eighty percent. The calorific value of waste has variations including 1000 to 2000 kcal/kg and the moisture content contained between 50% to 70% [3].

1.2 Waste Potential

The following is data on waste in Indonesia, according to the Ministry of Environment (KLH) 2013 [4] (Fig. 1).

PLTSA is one of the many plants that can produce electrical energy whose main fuel is waste, both organic waste and inorganic type waste. In generating electrical energy using waste, 2 processes can be used, namely thermal conversion and biological conversion. For thermal conversion, it uses inseneration technology, pyloric and gasifics technology, while for biological conversion using Anaerobic Digestion and Landfill gasification.

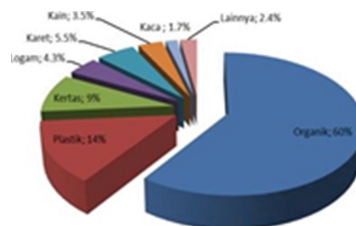


Fig. 1. Junk data by its components

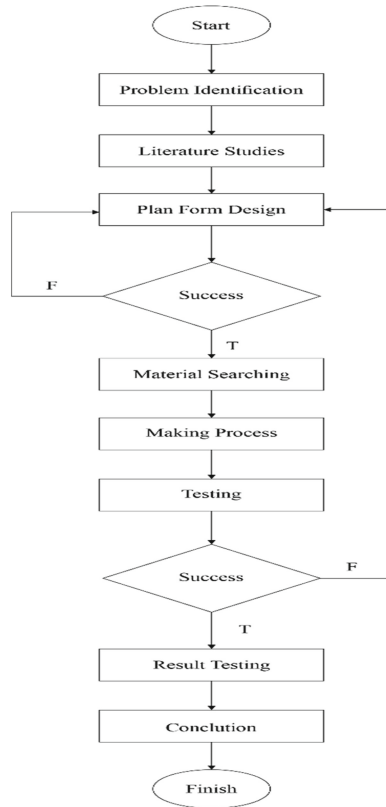


Fig. 2. Research Flowchart

The incineration conversion process is one of the methods of eradicating waste by burning the waste with high temperatures and in its operation is also not difficult and safe for the environment, because the output of this process is environmentally sound and meets the requirements of the Ministry of Environment based on Kep.Men LH No.13/MENLH/3/1995 [5].

2 Methods

2.1 Research Procedures

(See Fig. 2)

2.2 Research Tools and Materials

The tools and materials we use to support this research are, Digital multimeters, used cans, 3V LEDs, 25 mA, Cables, Dynamos, Used cardboard, Hammers, Cut Tang nails, Cutters, Solder, Glue, Tin, Wood, Paper, Dry leaves, Tap Water. This experiment did not use a garbage bunker because of the small size of the prototype and also in sorting waste we did it manually.

2.3 Design

The first design started from the Boiler. The materials used are used cans made of aluminum and katubs made of thin aluminum. The function of this boiler is to heat water, where water is put into the can through the katub. After the water is heated and produces steam, the steam will rotate the turbine (Figs. 3 and 4).

Next is to design turbines and generators. The material for the turbine is aluminum with each blade with a diameter of 2 cm. As well as the generator attached to the turbine. To refute the turbine used cardboard that has been assembled in such a way that it looks like a picture. A rotating turbine will turn on the generator so that it generates electricity. And the LEDs are spliced using a cable as an indicator. Here we do not use a condenser because the turbine we use is small and the power generated is not too large (Fig. 5).

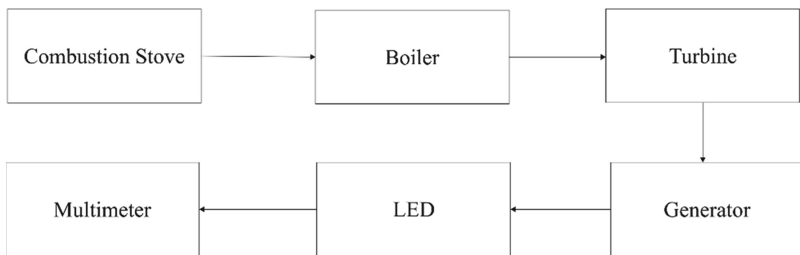


Fig. 3. Process Diagram PLTSA



Fig. 4. Boiler Design



Fig. 5. Turbin and Generator Design

3 Results and Discussion

3.1 Burning Time

Based on the experiments that have been carried out, the following data were obtained (Table 1);

From the experiment above, wood waste takes 45 min to burn, dry leaves take 50 min and paper takes 70 min to burn. The waste that takes the longest to reach the boiling point is paper and the garbage that takes the fastest time to reach the boiling point is firewood.

3.2 Calculation of Heat in the Combustion Furnace

The following equation is used [2]:

$$Q_f = MS \times CVS \tag{1}$$

Information:

Qf: Heat in the kiln (KJ/Hour)

MS: Waste Mass (Kg/Hour)

CVS: Calorie Value of waste (KJ/Hour)

If known:

MS = 1 kg/hour

CVS = 674.57 kcal/kg = 161.1 kJ/kg

For 1 kJ/Kg = 0.2388 kcal/kg

So that:

Qf = MS × CVS = 1 × 161.1 = 161.1 kJ/hour

Where there are 3 types of waste used and have different calculation results as in Table 2.

3.3 Calculating the Heat Coming Out of the Incinerator

To calculate the heat coming out of the incinerator, the following equation is used [2]:

$$\eta = \frac{Q}{Q_f} \tag{2}$$

Table 1. Length of Waste Incineration to reach the desired boiling point

No.	Types of litter	Required Time (minutes)
1.	Firewood	45
2.	Dry Leaves	50
3.	Paper	70

Table 2. Heat Result in the Furnace Combustion

No.	Types of litter	Heat results in combustion furnace/Q _f (KJ/h)
1.	Organic	161,1
2.	Paper	56,2
3.	Firewood	9,1

Table 3. The rate of heat coming out of the incinerator

No.	Types of litter	The rate of heat coming out of the incinerator/Q (KJ/hour)
1.	Organic	128,88
2.	Paper	44,96
3.	Firewood	7,28

where:

η = Boiler efficiency (%)

Q = The rate of heat coming out of the incinerator (Kj/h)

Q_f = Heat in the combustion furnace (Kj/hour)

So to calculate the amount of heat that comes out of the incinerator is:

$$Q = \eta \times Q_f \quad (3)$$

As known:

$$\eta = 80\% = 0.8$$

$$Q_f = 161.1 \text{ kJ/kg}$$

So that:

$$Q = \eta \times Q_f.$$

$$= 0.8 \times 161.1$$

$$= 128.88 \text{ kJ/hour}$$

Where there are 3 types of waste used and have different calculation results as in Table 3.

3.4 Calculating the Steam Time Flow

To calculate the time flow of steam used the following equation [2]:

$$M = \frac{Q}{h_2 - h_1} \quad (4)$$

Information:

M = The speed at which the mass of steam comes out of the boiler (kg/h)

Q = The rate of heat coming out of the incenerator (kj/h)

h1 = Enthalpy of water in the boiler(kj/kg)

h2 = Enthalpy of the boiler outgoing steam(kj/kg)

As is known:

Incoming temperature = 300 C

Boiler pressure = 14 Mpa

So that it can be known:

h1 = 125.8 kJ/kg

h2 = 2637.6 kJ/Kg

Q = 128.88 kJ/hour

So that:

$$M = \frac{Q}{h2 - h1} = \frac{128,88}{2637,6 - 125,8} = \frac{128,88}{2511,8} = 0,0051 \text{ kg/h}$$

where there are 3 types of waste used and have different calculation results as in Table 4 (Table 5).

Based on the data above, the power generated from each waste is by using the Ohm’s Law power formula.

$$P = V \times I \tag{5}$$

Information:

P = Power (Watts)

V = Voltage (Volts)

Table 4. Time Flow rate of the steam

No.	Types of Litter	Time Flow rate of the steam/ M (kg/h)
1.	Organic	0,051
2.	Paper	0,017
3.	Firewood	0,002

Table 5. Power Generator

No.	Types of Litter	Voltage (V)	Current(A)	Power (Watt)
1.	Firewood	2,66	0,04	0,1064
2.	dried leaves	2,01	0,03	0,0603
3.	Paper	0,32	0,03	0,0096
Power Average (Watt)				0,1763

I = Current (Ampere)

Based on experiments, the waste that has the greatest power is firewood and the waste that has the smallest power is paper. And the average power produced is 0.1763 W.

4 Conclusion

1. In the process of generating waste power, it is carried out Combustion with one type of garbage so as to heat the boiler that has been filled with water, after the water in the boiler boils and produces steam, the steam will come out of the boiler funnel and rotate the turbine that has been connected to the dynamo as a generator, and from the dynamo it produces electricity which then turn on the LED light.
2. In our experiment, an analysis was obtained that solid waste (wood) gets a faster time than other types of waste in the combustion process to produce electricity, while paper waste gets the longest time compared to other waste in the combustion process to produce electricity, in the results of power acquisition obtained solids (wood) waste gets the highest power value of 0.1064 w, Organic waste gets a power of 0.0603 w, and the lowest power is produced by paper waste, which is 0.0096 w.
3. The average power generated in the waste power plant experiment is 0.1763 W.

Acknowledgement. To add success to this study, we should use larger tools so that the results of the energy that are cooled are appropriate.

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