Design and build a waste power plant (WPP) at the University of Singaperbangsa Karawang

Dani Oktariansyah [a]*, Kemal Mustafa* [a]*, Efis Muafin Aulawi* [a]*, Rizki Abdul Rahman Nasution* [a]*, Rais Darmawan* [a]*, Marno Marno* [a]*, Iwan Nugraha Gusniar* [a]*, Najmudin Fauji* [a]*, Jojo Sumarjo* [a]

[a]*Department of Mechanical Engineering, Faculty of Engineering, Universitas Singaperbangsa, JL. HS Ronggo Waluyo, no. 1, East Karawang, West Java 41363, Indonesia*

[1]*E-mail:* 1610631150037@student.unsika.ac.id

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ABSTRACT

Garbage is one of the issues that are still being resolved. The trash volume continues to grow and has developed into a severe issue in Karawang, particularly at the University of Singaperbangsa Karawang. Converting trash into electrical energy is one of the waste applications. Utilizing a waste power plant (WPP) is one method of converting garbage to electrical energy. The waste energy plant comprises many significant components, including boilers, incinerators, turbines, generators, control panels, and the mainframe. Stainless steel plates, iron plates, stirrup iron, brass, L iron, hollow iron, bricks, cement, iron pipes, and stainless steel pipes are the materials required to manufacture WPP. The test procedure produced a maximum pressure of 5 bar, a combustion chamber temperature of 162.2°C, and an alternator voltage of 21.9 volts using data acquired from 180 minutes of burning with heterogeneous or mixed trash. After 135 minutes of burning wood, the pressure in the combustion chamber is 5 bars, and the temperature is 205.4 degrees, producing an alternator voltage of 22.1 volts.

ABSTRAK

Sampah merupakan salah satu permasalahan yang terus dicari solusinya. Volume sampah dari hari ke hari terus meningkat dan menjadi masalah yang serius di Kota Karawang khususnya lingkungan Universitas Singaperbangsa Karawang. Salah satu pemanfaatan sampah yaitu mengubahnya menjadi energi listrik. Salah satu alternatif untuk mengolah sampah menjadi energi listrik yaitu dengan menggunakan pembangkit listrik tenaga sampah (PLTSa). Pembangkit listrik tenaga sampah terdiri dari komponen-komponen utama seperti boiler, incinerator, turbin, generator, control panel, dan juga rangka utama. Material yang dibutuhkan untuk membuat PLTSa adalah plat stainless steel, plat besi, besi behel, kuningan, besi L, besi hollow, batu bata, semen, pipa besi, dan pipa stainless steel. Dalam proses pengujian didapat data pembakaran dengan sampah heterogen atau campuran selama 180 menit didapat tekanan maksimal 5 bar, temperatur ruang bakar 162,2°C, dan menghasilkan tegangan alternator sebesar 21,9 volt. Pada pembakaran dengan kayu selama 135 menit didapat tekanan 5 bar dan temperatur ruang bakar 205,4 menghasilkan tegangan alternator 22,1 volt.

1. Introduction

Garbage is an urban problem, especially in big cities in Indonesia, including in the Karawang district. The waste problem is a challenge for every city to manage waste. The more people there are, the more waste generated. Good waste management is needed to overcome problems related to waste. The most widely used method in processing waste is by landfilling waste, but this method has no added value [1]. Alternative technologies used in waste processing that have added value are combustion technology (incinerator) and methane gas

fermentation technology. Waste power plant (WPP) using incinerator has been used in many countries because it can utilize up to 90% – 95% of waste. However, the application of incinerator technology can cause problems, such as hazardous chemical compounds formed during the waste combustion process (emissions), especially for heterogeneous waste.

The results of harmful emissions are dioxin and furan compounds that are harmful to the health of the human body. However, this compound is formed on combustion at a temperature of 400-600ºC. If the waste burning process is complete, it will not produce dioxin compounds [2]. This research aims to reduce waste's negative impact and generate electricity by using a waste power plant with incinerator technology at The University of Singaperbangsa Karawang. The waste power plant consists of main components such as boilers, incinerators, turbines, generators, control panels, and the mainframe.

A steam boiler is an energy conversion machine that functions to produce steam where the steam boiler converts the liquid water phase into a steam phase with a specific temperature and pressure. Steam boiler construction is usually in the form of a closed tube filled with water so that when the steam boiler receives heat from the waste combustion process, it can boil water in the steam boiler [3-4]. Steam boilers have two main components, namely fire tube boilers and water tube boilers. In a fire tube boiler, the fluid flowing in the pipe is the heat energy from the combustion, transferred to the water through the heating pipe. The purpose of these fire pipes is as a heater and facilitates the distribution of heat to the water. In a water pipe boiler, the fluid flowing in the pipe is water, and the heat energy generated from the combustion is transferred through the outside of the water pipe so that the water pipe can receive heat energy from the combustion [5].

An incinerator is a combustion furnace to process solid waste (garbage) into heat, smoke, and ash (bottom ash and fly ash) in a controlled and closed system from the surrounding environment. High-temperature waste processing is defined as thermal treatment. The heat generated from combustion in incinerators can be used as power generation energy [6]. Steam turbines include power machines or energy conversion machines where other machines use the energy conversion results to produce power. There is a change from the potential energy of steam into kinetic energy in the turbine, which is then converted again into mechanical energy on the turbine shaft, then the mechanical energy is converted into electrical energy in the generator [7].

The control panel functions to place electrical components as a support for electrical machines to operate according to the working principle of the electric machine itself. To secure electrical components so that they are protected from influences around them. To arrange components or electrical circuits to make them look neat and safe. The control panel facilitates the operation of electrical machines and is an indicator of the machine when the machine is operating or in operation. These things can be seen in the indicators installed on the panel [8-10].

2. Material and Methods

The steps used in this study to design a waste power plant are:
a. Conduct field observations and relevant literature studies
b. Designing a waste power plant based on field studies and literature studies
c. Make waste power plant components: boilers, incinerators, frames, turbines, control panels, and chimneys
d. Doing the test
e. Doing finishing and painting

Tests are carried out by filling the boiler with water as much as half of the maximum capacity. The waste is put into the incinerator room. After the waste is added, the combustion process is carried out. The heat from the combustion will change the water phase into steam. After the water becomes steam, wait until the pressure reaches 5 bar, then the nozzle valve is opened. The steam that flows will turn the turbine, and the turbine will turn a generator. The generator will convert kinetic energy into electrical energy. The electricity generated by the generator will go through the solar charge controller, auto cut, battery charger, then put into the battery. The electric current in the battery is charged with DC, converted using a power inverter into an AC charger, then the electricity is ready for use [11-12].

3. Results and Discussion

3.1. Boiler

3.1.1. Steam Boiler Design Calculation

The boiler made is a water pipe-type steam boiler with a pressure capacity of 5 bar using a SUS 304 stainless steel steam boiler body. The specification obtained are as follows:

Material	: Stainless Steel SUS 304
S (Maximum allowable stress values)	: 138 Mpa = 20015 $^{lb}/_{in^2}$
P (Design pressure)	: 10 Bar = 145 $^{lb}/_{in^2}$
E (Joint coefficient)	: 85 % = 0.85
R (Steam boiler body radius)	: 250 mm / 9.85 inc
Steam boiler length	: 600 mm

3.1.2. Determining the Thickness of the Plate on the Steam Boiler Body

The plates used in the steam boiler water tubes and pipes are permitted using the ASME Section IV 2004 equation [8]. With a design pressure of 10 bar or 145 lb/in2 and a boiler body radius of 9.85 in with maximum allowable stress on SUS 304 stainless steel material of 138 Mpa or 2015 lb/in2, it can be seen the minimum thickness plate used on the body 2mm steam boiler.

$$t = \frac{PR}{SE - 0.6\,P}$$

$$t = \frac{145\,{}^{lb}/_{in^2} \times 9.85\ in}{20015\,{}^{lb}/_{in^2} \times 0.85 - 0.6 \times 145\,{}^{lb}/_{in^2}}$$

$$t = \frac{1{,}428.25\,{}^{lb}/_{in}}{17{,}012.7 - 87\,{}^{lb}/_{in^2}}$$

$$t = \frac{1{,}428.25\,{}^{lb}/_{in}}{16{,}925.7\,{}^{lb}/_{in^2}}$$

$$t = 0{,}08\ in$$

$$t = 2\ mm$$

3.1.3. Determining the Thickness of the Nozzle Pipe

The material used for the nozzle pipe uses SUS 304 Stainless Steel. In SUS 304 Stainless Steel, the following data are obtained:

Material	: SS SUS 304
S (Maximum Allowable Stress Values)	: 138 Mpa = 20015 lb/in2
P (Design pressure)	: 10 Bar = 145 lb/in2
E (Joint coefficient)	: 85 % = 0.85
R (Pipe radius)	: 1.5 in = 0.75 in

$$t = \frac{PR}{SE - 0.6\,P} + 0.04$$

$$t = \frac{145\,{}^{lb}/_{in^2}\ x\ 0.75\ in}{20015\,{}^{lb}/_{in^2} \times 0.85 - 0.6 \times 145\,{}^{lb}/_{in^2}} + 0.04\ in$$

$$t = 0.00642\ in + 0.04\ in$$

$$t = 0.04642\ in$$

$$t = 1.17\ mm$$

With a design pressure of 10 bar or 145 ${}^{lb}/_{in^2}$, and a nozzle pipe radius R = 0.75 in with a Maximum Allowable Stress on SUS 304 type material of 138 Mpa or 20015 ${}^{lb}/_{in^2}$, can be seen the minimum thickness of the nozzle pipe used in the steam boiler 1.17 mm.

3.1.4. Steam Boiler Component Assembly

The design of the incorporation of boiler components that have been designed using the INVENTOR software is shown in Figure 1. The boiler components composed of specified materials, the intended size of the boiler components, and the boiler's supporting components are all detailed in Tables 1 and 2.
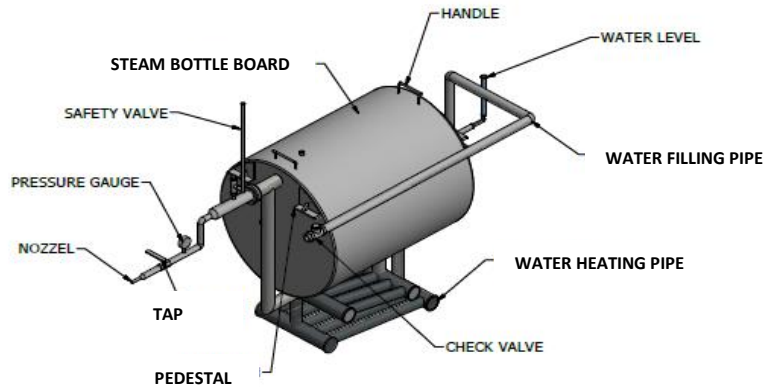

Figure 1. Water pipe boiler assembly

Table 1. Specifications of designed water pipe boiler components

No	Components	Material	Size
1	Steam boiler tube	Plate SS SUS 304	Diameter : 500 mm, length: 600 mm, thickness : 4 mm
2	Water heater pipe	Pipe SS SUS 304	Diameter : 40 mm, length : 400 mm, thickness : 3 mm, total : 10 pipes
3	Water filling pipe	Pipe MS	1/2 inc, thickness 3 mm
4	Steam output pipe	Pipe SS SUS 304	Diameter : 50 mm, length: 150 mm, thickness 3 mm
5	Pedestal	Plate SS SUS 304	Thickness : 5 mm
6	Handle	Stirrup iron	Diameter : 10 mm

Table 2. Specifications of supporting components for designed water pipe boilers

No	Components	Material	Size
1	Check valve	Brass	Diameter 1/2 inch
2	Flens	SS SUS 304	Diameter 1/2 inch and 2 inch
3	Water level	Glass and Stainless Steel	Glass diameter : 10 mm, length 20 mm
4	Safety valve	Brass	Pipe input diameter : 3/4 inch, maximum pressure 10 Bar
5	Pressure gauge	Stainless Steel	Maximum pressure 10 Bar
6	Elbow	SS SUS 304	Diameter : 1/2 inch, angle 90 º
7	Reduser	SS SUS 304	Steam input diameter 50 mm, Steam input diameter 1/2 inch
8	Double coupler	Stainless Steel	Size 1/2 inch
9	Valve	Stainless Steel	Size 1/2 inch
10	Bolt L	Stainless Steel	M6 x 1.5

3.2. Incinerator

The process of making incinerators for WPP uses components with specifications, as shown in Figure 2.

a. Dimensions   : 85 cm x 75 cm x 135 cm
b. Main frame   : Iron elbow (30mm x 30 mm x 3 mm)
c. Combustion chamber   : 65 cm x 60 cm x 85 cm
d. Ash container   : 63 cm x 75 cm x 7 cm
e. Wall   : Red brick
f. Incinerator body   : 1 mm thick iron plate
g. Thermocouple   : Type K
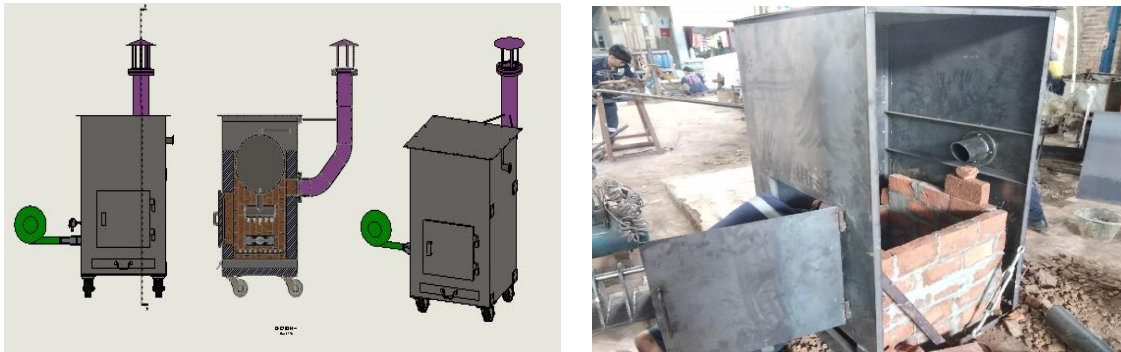h. Blower   : Conch blower

Figure 2. Design and manufacture of incinerators

The insulator is installed in the incinerator using glass wool. The insulator acts as a barrier to the combustion chamber's temperature, preventing heat from being transferred straight to the incinerator's exterior body. The process of making an incinerator is shown in Figure 3, through several stages:

a. Make a casing on the incinerator for all sides using iron plate material with a thickness of 1mm. The casing serves to protect the incinerator from being easily damaged.
b. Make an incinerator door with a brick inside for a heat barrier (insulator).
c. Make ash shelters to make it easier to take the ash from the combustion. Ash storage uses iron plate material with a thickness of 1 mm.
d. Paint the incinerator casing, doors, and ash catcher to protect them from corrosion and enhance their appearance. Paint materials use paints that are resistant to high temperatures so that they are not damaged when exposed to high temperatures during the combustion process.

Operators or users may perform regular maintenance on incinerator components. Inspections may be conducted before and after incinerator usage to identify any damage. After utilizing the incinerator, it is often necessary to clean the ash reservoir.

3.3. Steam Turbine

Figure 4 illustrates the turbine that was created using the Solidworks 2018 program. Table 3 details the components of the steam turbine that will be manufactured using the specified material and the dimensions of the components intended for the steam turbine.

a

b

c

d

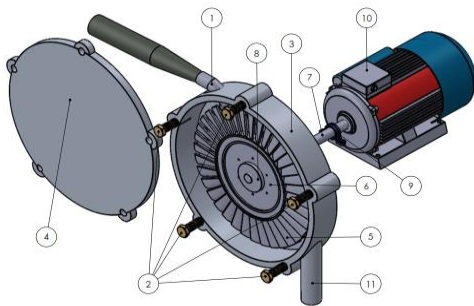**Figure 3. (a) Incinerator casing; (b) Incinerator door; (c) Ash storage; (d) Painting process**

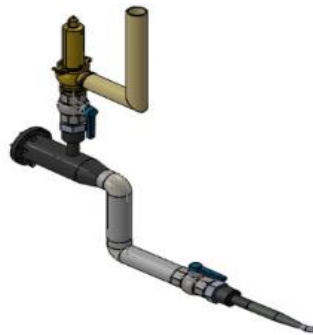**Figure 4.** Steam turbine assembly
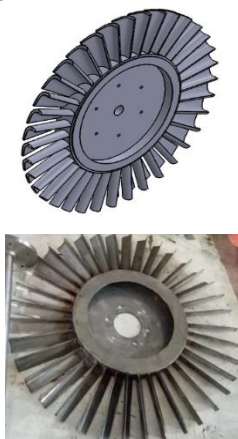
Figure 5. Input pipe (Nozzles)

Figure 6. Turbine blade

Figure 7. Turbine shaft

3.3.1. Main Components of Turbine

The turbine component consists of an input pipe (nozzle) that drains pressurized steam from the boiler to the blade shown in Figure 5. The turbine blade converts heat energy in the steam into motion energy, which is into rotation which the shaft will transmit to the alternator [13-15] shown in Figure 6. Thus, the turbine shaft serves as power transmission to the alternator shown in Figure 7. The turbine casing functions as a turbine housing and serves to accommodate steam to not come out to the environment (leakage), as shown in Figure 8.

Table 3. Components of making steam turbine

No	Component	Material	Specification
1	Nozzles	*Stainless steel SUS 304*	Diameter : 5 mm, length : 10 cm, thickness : 1mm
2	Bolt	*Stainless steel SUS 304*	M8, length : 20 mm @ 12, length : 80 mm @ 7, M12, length : 30 mm @ 7
3	Turbine case	*Stainless steel SUS 304*	Diameter 420 mm, thickness 1 mm
4	Close the case	*Stainless steel SUS 304*	Diameter 430 mm, thickness 1 mm
5	Turbine blade	*Stainless steel SUS 304*	Length : 100 mm, width : 30 mm, Tilt angle : 20 $^{\circ}$, number of blades : 37 tablespoons, tickness 1,3 mm
6	Turbine wheel	*Stainless steel SUS 304*	Diameter : 200 mm, thick front : 3 mm, thick back :2 mm
7	Turbine Shaft	*Stainless steel SUS 304*	Diameter : 1 inch, length : 30 cm
8	Flange Ø 1"	*Stainless steel SUS 304*	Diameter: 80 mm, number of holes : 6 baut
9	Bearing UCP 205	*Casting*	Diameter : 25 mm, length : 140 mm, width : 70 mm
10	Alternator	*Alumunium alloy 6061*	Diameter : 115 mm, length : 200 mm, DC 1 Phasa
11	Output pipe	*Stainless steel SUS 304*	Diameter : 1/2 inch, length : 70 cm

Figure 8. Turbine casing

3.3.2. Turbine Shaft Calculation

The shaft serves as a conduit for power transmission and turbine rotation, as well as the placement of discs (turbine wheels) and blades, such that the shaft experiences the following load:
1. Bending load derived from the weight of the blades and discs.
2. The torsional load originating from the disc. [16]

3.3.2.1. Power Plan

$$P_d = f_c \, P = (1.2)(1.45) \text{ kW} = 1.74 \text{ kW}$$

3.3.2.2. Torsion Moment (T)

$$T = (9.74)(10^5)\left(\frac{P_d}{n_1}\right) = (9.74)(10^5)\left(\frac{1{,}74 \text{ kW}}{1500 \text{ rpm}}\right) = 1{,}131 \text{ kg.mm}$$

3.3.2.3. Allowable Shear Stress (τ_a)

This design uses SUS 304 AS-Rolled stainless steel material for medium rotation shafts and heavy loads, which is 565 MPa = 57.62 kg/mm².

$$\tau_a = \frac{\sigma_b}{Sf_1 . Sf_2} = \frac{57.62 \text{ kg/mm}^2}{(6.0)(2.0)} = 4.8 \text{ kg/mm}^2$$

3.3.2.4   Shaft Diameter (d_s)

$$d_s = \left[\frac{5{,}1}{\tau_a} K_t C_b T\right]^{\frac{1}{3}} = \left[\frac{5{,}1}{4.8 \frac{\text{kg}}{\text{mm}^2}}(3)(2.1)(1{,}131)\text{kg.mm}\right]^{\frac{1}{3}} = 19.64 \text{ mm}$$
$$d_{\text{actual shaft}} > d_s$$
$$25.4 \, mm > 19.64 \, mm$$

The diameter of the shaft used in this design (dp) is 1 inch = 25.4 mm, following the standard shaft from the calculation results.

3.3.3. Bearing Calculation

The type of bearing used in the design of this steam turbine is a rolling bearing type UCP 205. The specifications are as follows:

d = 25.4 mm

D = 33.7 mm

v = 1 (rotation factor)

H = 36.5 mm

C = 14 kN → 14000 N

C_o = 7.8 kN → 7800 N

$F_a = F_{0,1}$ = 171.57 N

F_r = Disc weight + shaft weight

F_r = 74.46 N + 12 N

F_r = 86.46 N

$\frac{F_a}{F_r} = \frac{171.57 \text{ N}}{86.46 \text{ N}}$ 1.984 > e

X = 0.56

y = 2.3

3.3.3.1. Equivalent Load (W_r)

$$W_r = XvF_r + yF_a = (0.56)(1)(86.46) \text{ N} + (2.3)(171.57) \text{ N} = 443.031 \text{ N}$$

3.3.3.2. Age Factor (f_h)

$$f_h = \left(\frac{33.3}{n}\right)^{3/10} \frac{C}{W_r} = \left(\frac{33.3}{8470 \text{ rpm}}\right)^{3/10} \left(\frac{14000 \text{ N}}{443.031 \text{ N}}\right) = 5.99877 \approx 6$$

3.3.3.3. Nominal Age (L_h)

$$L_h = 500(f_h)^{10/3} = 500(5,99877)^{10/3} = 196114,95 \text{ hour} = 22,39 \text{ year}$$

3.3.3.4. Age Reliability (L_n)

$$L_n = \frac{60 L_h n}{10^6} = \frac{(60)(96114.95 \text{ hour})(1500 \text{ rpm})}{10^6} = 17650.35 \text{ hour} = 2.015 \text{ year}$$

The age of bearings suitable for use is 2,015 years, or bearing replacements must be carried out every two years.

3.3.4. Turbine Casing Calculation

The turbine stator has a flexible shape. Calculation of the forces acting on the turbine housing using the equation:

$$\sigma_t = \frac{DP}{2\delta} = \frac{(42 \text{ cm})\left(6.1183 \frac{\text{kg}}{\text{cm}^2}\right)}{(2)(0.1 \text{ cm})} = 1284.843 \text{ kg/cm}^2$$

Cylinders for small and medium capacity turbines are made of Stainless steel SUS 304 with tensile stress $\sigma_b = 57,62 \text{ kg/mm}^2 \rightarrow 5762 \text{ kg/cm}^2$, and the value of the safety factor taken is $k = 4$, so

$$\sigma_{bp} = \frac{5762 \text{ kg/cm}^2}{4} = 1440,5 \text{ kg/cm}^2$$

because $\sigma_{bp} > \sigma_t$, then the construction of this turbine house is safe.

3.4. Mainframe Design and Manufacture

The main frame needs the following materials: elbow iron 40 x 40 x 4 mm and hollow iron for the holder on the frame wheels.

Figure 9. Main frame design and control panel

3.4.1. Holder Manufacture

The holder for the turbine, the material used is angled iron with a size of 40 x 40 x 4 mm, which is welded using CO_2 welding.

| (a) | (b) |

Figure 10. Stand making, (a) Turbine actual stand, (b) Generator actual stand

3.4.2. *Water Tub Holder*

The holder for the water bath is made with angle iron with a size of 40 x 40 x 4 mm, which is welded using CO_2 welding.

Figure 11. Water tub holder

3.5. *Control Panel Design and Manufacture*

The materials used to make the control panel are angled iron with 40 x 40 x 4 mm and a steel plate with a thickness of 2 mm, which is bolted using M12 size bolts and welded using CO_2 welding.

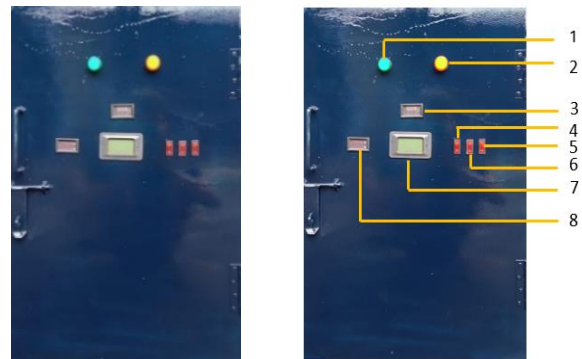

Figure 12. Control panel

Figure 13. The outside of the control panel

The material used to make the control panel door is a steel plate with a thickness of 2 mm, given a hole using a carving grinding machine to install the electrical supporting components. In assembling the electrical system, the first thing that must be done in making the control panel is the design of making drawings of the outside and the inside of the control panel. This process is carried out to facilitate the placement of components and control panel assembly. In designing a control panel for a waste power plant (WPP) it is necessary to know the function of each component. The following process is the installation of components on the outside of the control panel door. The following is a description and function of the parts of the control panel :

1. The AC pilot light serves to determine whether there is AC power entering the panel. If there is an incoming electric current, the light on the pilot light will turn on.

2. The DC pilot light serves to determine whether there is DC electricity entering the panel. If there is an incoming electric current, the light on the pilot light will turn on.

3. The battery indicator is used to measure the voltage on the 12V battery.

4. The switch on/off box serves to the breaker and connects the power inverter.

5. The on/off box switch functions as a breaker and a pump connector.

6. The on/off box switch serves to the breaker and connects the generator.

7. Digital KWH watt meter functions as a computer circuit using sample values to calculate RMS voltage, RMS current, VA, power (watts), power factor, and kilowatt-hours (kwh). The simple model displays the information on the LCD screen.

8. The voltmeter functions as a measuring instrument to measure the magnitude of the electric voltage in an electrical circuit according to the component's location being measured [17-18].

The following process is the installation of components on the inside of the panel. The layout of the installation of these components must be following the inside design drawings of the panel.
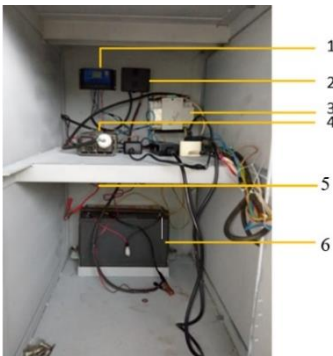

Figure 14. Inner control panel

(a)   (b)

Figure 15. (a) Combustion chamber and (b) Combustion chamber temperature

Description and function of components:

1. SCC (solar charge controller) regulates the direct current charged to the battery and taken from the battery to the load.

2. The auto-on/off automatic charger kit functions as an automatic battery breaker when the battery is fully charged, not overcharge.

3. Automatic transfer switch functions to turn on and connect the power inverter to the load automatically when the PLN goes out.

4. The power inverter functions to convert direct electric current (DC) to alternating electric current (AC) at the required voltage and frequency according to the circuit design.

5. The DC fan is used for air conditioning and ventilation.

6. The VRLA (Valve Regulated Lead Acid) battery functions as a power store that can be recharged with a design resistant to overcharging, overcharging, and disturbing vibrations from outside the system.

The following process is the cable installation process. This cable installation uses an NYAF type cable. In installing this cable, it must be following the circuit drawings that have been made. In installing the cable, the cable used is not too long and not too short so that the installation on the control panel looks neat.

3.6. Discussion

In the test, during burning waste with specifications of mixed waste of 30 kg and 22 kg of wood, it was obtained. The combustion chamber temperature of 260.6°C with mixed waste fuel and trees for the combustion process can be seen in Figure 15. From the waste burning test results, the combustion temperature is 260.6°C, and the steam pressure data is 3.5 bar at a steam temperature of 153°C, including the type of wet steam. The results of the test can be seen in Figure 16.

(a)   (b)

Figure 16. (a) Steam pressure and temperature (b) Turbine and alternator

From the results of previous trials, data obtained from waste, temperature, steam pressure, turbine rotation, alternator rotation, and the resulting voltage are summarized in Tables 4 and 5.

Table 4. Test results of burning heterogeneous waste

No	Time (minutes)	Input temperature (°C)	Steam pressure (Bar)	Output temperature (°C)	Turbin speed (RPM)	Alternator speed (RPM)	Output alternator (Volt)
1	30	24.8	0	27	0	0	0
2	60	68.3	1.8	27	0	0	0
3	90	81.2	2.4	27	0	0	0
4	120	124.6	3.4	27	0	0	0
5	150	141.3	4.1	27	0	0	0
6	180	162.2	5	68.6	1500	1500	21.9
7	210	128.2	3.2	82.6	142	142	18.2
8	240	114.9	1.8	67.1	900	900	12.4
9	270	98.4	0.2	55.3	244	244	3.17

Table 5. Test results of burning wood waste

No.	Time	Room temperature °C	Steam temperature °C	Pressure (Bar)	Voltage (Volt)
1	15	73.7	50	0	0
2	30	200.5	52.8	0	0
3	45	134.9	57.8	0.2	0
4	60	156.8	60.7	0.4	0
5	75	185.4	79	0.6	0
6	90	290	118.5	1.2	0
7	105	320.2	145.4	2.6	0
8	120	243.3	134.9	3.4	0
9	135	205.4	137.3	4.2	22.1
10	150	187.7	162.8	5	17.3
11	165	152.4	142.3	3.8	15.4
12	180	127.9	131.7	2.6	12.7
13	195	112.8	112.1	1.8	8.3
14	210	82.6	97.6	0.6	3.2

Tables 4 and 5 show data on combustion with heterogeneous or mixed waste obtained a maximum pressure of 5 bar and a combustion chamber temperature of 162.2°C producing an alternator voltage of 21.9 volts with a combustion time of 180 minutes. In wood burning, the pressure is 5 bar, the combustion chamber temperature is 205.4, which produces an alternator voltage of 22.1 volts with a burning time of 135 minutes.

4. Conclusions

The waste power plant (WPP) is a tool that is quite helpful in reducing the waste problem and reducing dependence on fossil fuels which are increasingly depleting. Ash from combustion can be used as a primary material for making paving blocks, bricks, and cement mixtures so that the processed waste does not leave the rest of the rest of the waste. The working principle of the incinerator is that waste is put into the incinerator to be burned in the combustion chamber to produce heat which is used to heat the boiler to produce steam which will drive a turbine that is connected to a generator to produce usable electricity.

Charging the battery based on its combustion in a day is not the same every time, depending on how long the combustion is produced in driving the turbine, because the more stable the turbine rotation is, the faster the battery can be charged. Therefore, charging the battery depends on the type of waste burned and the turbine's rotational stability. In the testing process, data obtained from combustion with heterogeneous or mixed waste for 180 minutes obtained a maximum pressure of 5 bar, a combustion chamber temperature of 162.2°C, and an alternator voltage of 21.9 volts was obtained. On burning with wood for 135 minutes, the pressure of 5 bar and the temperature of the combustion chamber is 205.4 resulting in an alternator voltage of 22.1 volts.

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