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Design And Construction of Electromagnetic Induction Heater for Solid B3 Waste Processing

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ABSTRACT Hospitals are health service facilities that carry out various activities that produce non-medical waste and B3 waste that can cause pollution or damage to the environment and threaten environmental sustainability and threaten the health and existence of humans and living. Approximately 10-20% of medical hazardous waste is produced, while 75-90% is non-hazardous waste. Incineration is one alternative method. An incinerator is a device for processing hazardous waste using high temperatures of up to 800°C to reduce combustible and non-recyclable waste, chemicals and to kill bacteria and viruses. In this study, an induction heater was used which uses the principle of eddy current heating generated by magnetic flux originating from a coil supplied with alternating electric current. The induction heater was designed and manufactured by assembling several components, including a 220V AC - 12V DC power supply, a 18V 35A induction heater, and an induction heater coil. The device was tested by measuring the output voltage and current required to reach temperatures of 184°C.

INDEX TERMS B3 waste, coil, induction heater.

I. INTRODUCTION

Hospital is a health service facility that provides equitable health assistance by organizing various facilities such as inpatient care, outpatient care, emergency care, laboratory and other medical support facilities with the aim of improving the health of the community and as a place of education or training for health workers such as doctors, nurses, pharmacists or other health workers. Hospitals produce waste that is categorized as non-medical waste (domestic waste) and medical waste which is also categorized as hazardous and toxic waste (B3).

Incineration is a tool used to burn solid waste and is operated using combustion technology at a specific temperature. This technology is an alternative for reducing waste accumulation. Because it involves high-temperature combustion, the resulting heat energy can be used as a source of electricity. The incineration process can reduce waste volume by up to 90%, while composting, landfills and open dumping can only reduce the volume by 40%. Solid waste processing process by burning at temperatures above 800°C to reduce combustible waste that can no longer be recycled, kill bacteria, viruses and toxic chemicals.

Induction Heating works by following the phenomenon of electromagnetic induction, namely when there is a closed circuit in which AC current flows, it produces an electromagnetic field like the working principle of a transformer.

II. INCINERATION DESIGN

Incineration requires a 220V voltage source with the circuit shown in Figure 1

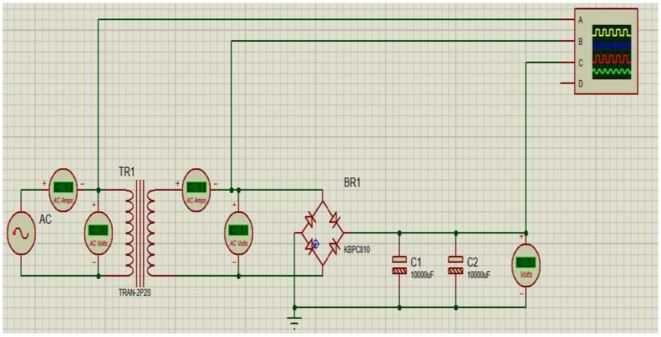


FIGURE 1. Power Supply circuit.

The 220V source voltage is stepped down using a 35A transformer, taking the 18V output. The 18V output then enters the MB3015 50A diode bridge, which converts AC to DC. From the MB3015 diode, it then enters a 10,000uF capacitor, which acts as a current filter to prevent fluctuations.

Induction Heater circuit has a working principle of converting electrical energy into a magnetic field that moves very quickly, causing molecular friction to occur in the working coil and causing iron objects that enter the working coil to become hot.

The induction heater input comes from the 18V 35A power supply which is divided into 3 paths, the first goes to the 470Ω resistor, then to the IRFP46686, enters the base leg and exits the collector leg then to the toroid inductor. The function of this MOSFET is to divide the positive and negative paths. The diode is used to prevent the voltage from the MOSFET's collector leg from flowing to the base leg, which could damage the MOSFET. The toroid inductor functions as a voltage booster from the circuit to the toroid inductor, so that a voltage of more than 1000V AC can be obtained. The second path has the same function and flow as the first path. The third path is directly connected to the toroid inductor. While the capacitor is used to store the working coil voltage, working as a heater or fast moving magnetic field. The Induction Heater circuit is shown in figure 2

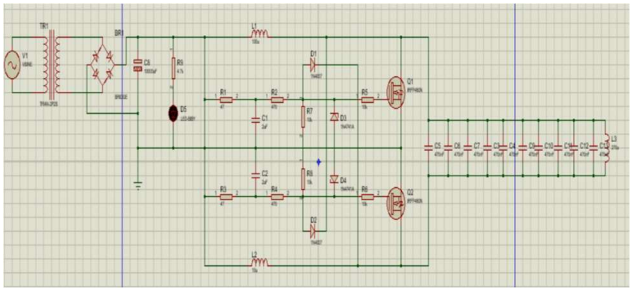


FIGURE 2. **Induction Heater Circuit.**

The working coil and the combustion furnace flow an electromagnetic magnetic field very quickly and strongly to move the molecules in the load so that it produces heat as shown in figure 3

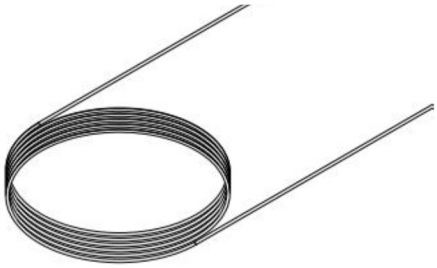


FIGURE 3. **Induction Heating Working Coil.**

The overall design of an Electromagnetic Induction Heater for B3 Solid Waste Processing is shown in Figure 4.

FIGURE 4. **Induction Heating Working Coil.**

III. RESULTS AND ANALYSIS

The power supply circuit is divided into two parts: a rectifier circuit and a filter circuit, and the circuit is constructed using the Proteus application. The first stage of circuit creation is the creation of a circuit schematic simulation. After the simulation runs smoothly, the PCB circuit is assembled. The circuit is assembled by soldering the circuit to the PCB according to the design shown in Figure 5.

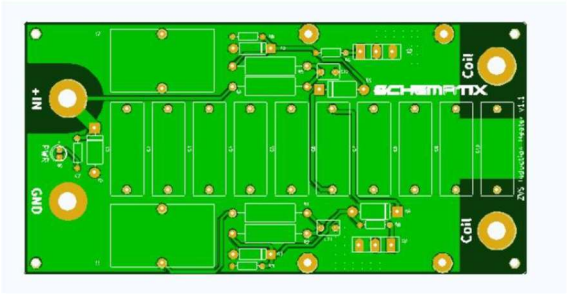


FIGURE 5. **Power Supply Circuit on PCB.**

The first step in creating the circuit is creating a simulation circuit using PSIM software. After the simulation runs smoothly, the circuit schematic is then assembled into the PCB circuit diagram. Before assembling the PCB, a layout is created using Proteus Pro.8 software to simplify soldering and mounting components on the PCB. The circuit is then assembled by soldering the PCB according to the design that has been created, with the layout shown in Figure 6.

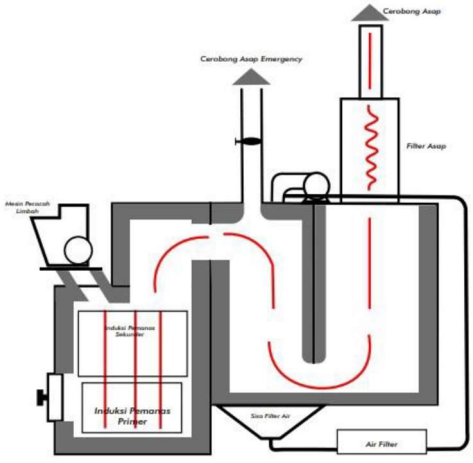


FIGURE 6. **Electromagnetic Induction Heater Layout.**

Then the circuit is given a component that is used as an Induction Heater which is shown in Figure 7

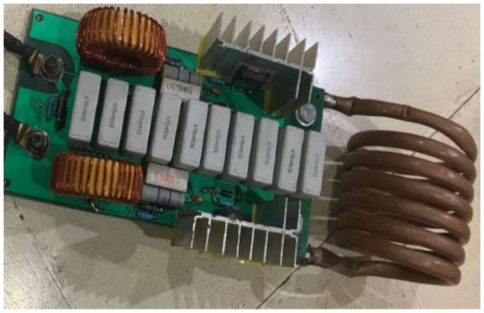


FIGURE 7. Induction Heater Circuit on PCB.

Testing is carried out by providing a voltage source from the power supply of 18V 35A, by providing an iron plate into the heating coil to find out that the components installed in the circuit are working properly. The test results are shown in Figure 8.

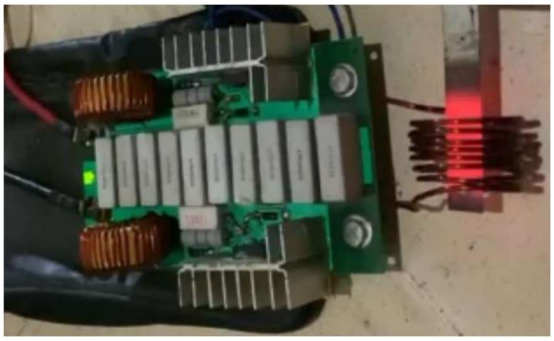


FIGURE 8. Heater testing.

Further testing used medical waste from the hospital in the form of masks and syringes. Each test was conducted for 5-10 minutes with two different treatments. The experiment involved melting medical waste masks and syringes without shredding them and those that had been shredded. This test was conducted to assess the duration of the hospital's hazardous waste combustion. The results of the electromagnetic induction test for hazardous waste combustion showed positive results.

The hazardous waste processing test used electromagnetic induction to incinerate the waste. Each test was conducted for 5-10 minutes, using waste masks and syringes as test objects. The test was conducted in two ways: first, by melting the medical waste without chopping it. Then, for the second test, the waste was chopped.

The combustion test results are shown in Tables 1 and 2, which display images of the combustion results. Temperature measurements indicate that the heat used by the equipment is 184°C, as shown in Table 3.

TABLE 1
UNSHREDDED WASTE COMBUSTION TESTING

No	Test Result	Combustion Result
1		B3 waste that is not shredded
2		Combustion Process
3		Combustion process at temperatures above 99°C
4		Combustion results

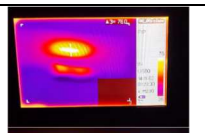
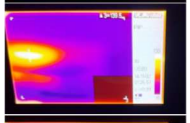
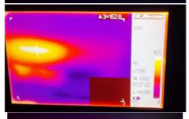
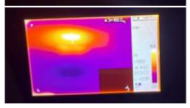
Results of waste processing with Unshredded treatments..

TABLE 2
WASTE INCINERATION BY SHREDDING

No	Test Result	Combustion Result
1		B3 Waste: Shredded Masks and Syringes
2		Combustion Process
3		Combustion process at temperatures above 99°C
4		Combustion results

Results of waste processing with Shredded treatments..

TABLE 3
TEMPERATURET MEASUREMENT USING DIGITAL TESTER THERMAL

Voltage	Current	Temp (C^0)	Thermal Camera
14	137	75	
14,5	137	107	
15	137	138	
15,5	138	151	
16	138	168	
16,5	138	173	
17	138	184	

Vertical lines are optional in the table.

The results of the temperature measurements show that the maximum heat that the equipment can produce is 184^0C, which is obtained in 30 seconds.

IV. CONCLUSION

The design results show that the equipment can destroy hazardous waste at a temperature of 184°C. However, the waste must be shredded first. Therefore, this equipment still requires additional equipment in the form of a waste shredder. The author believes that increasing the voltage or current will speed up the process of melting hazardous waste. This equipment still requires improvements to the voltage booster or the coils used as heaters.

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