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The Application of Cool Air from Thermoelectric for Reduce Temperature in Ozone Tube of Ozonizer Affecting to Ozone Gas Quantity

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Abstract: This research paper presents to the temperature reducing in ozone tube of ozonizer by applied thermoelectric for producing cool air. To observe the amount of ozone gas produced is ozonizer using inverter high voltage high frequency of half-bridge type at switching frequency 25 kHz and controls its operation using pulse width modulation (PWM) technique and can produce high voltage at 3 kV for supply to the ionizing bar at the highly non-uniform electric field ozone tube of two level insulator cylindrical, which in the first hour of the test machine can produce ozone gas at 216.8 mgO_3/hr of temperature is 29°C. When researcher use cool air from thermoelectric to blow the bar of ozone, it can produce ozone at 379.5 mgO_3/hr of temperature at 25°C. Thereby producing a cooling air by thermoelectric result in temperatures drop. As a result, the rate of decomposition of ozone gas gets lessening and can produce higher ozone gas. Therefore, future research will be designed to produce ozone gas from the cooling system thermoelectric to develop a real application for removal of odors from the food industry.

Keywords: Ozone Tube, Temperature, Ozonizer, Half-Bridge Converter, Thermoelectric, Cooling, High Voltage, High Frequency

1. Introduction

Ozone gas is widely brought to use for living such as using ozone to clean the vegetables instead of manganese to kill diseases and reduce a quantity of chlorine in water. Bringing ozone to clean the air purely has some drawbacks. For examples, if it is used too much concentrated, it can irritate to the body. It is useful to the health if quantity is properly used and is applied for work suitably. Therefore, to control the quantity of ozone gas should be matched with the work. This is the reason why to study and generate ozone gas. This paper presents a study of the effect of temperature decreasing at ozone tube using cool air from thermoelectric to the ozone gas quantity. The high voltage high frequency is constructed by using a principle of switching AC power supply. A high voltage high frequency is supplied to the load, which are two-layer electrode in series, for producing ozone gas. The generating ozone gas is based on the principle of spreading molecules of oxygen. It will produce ozone gas from the equation of $O_2+O= O_3$. The ozone gas can withstand a high voltage level. Also, the heat affects to the quantity of the occurring ozone gas. Therefore, the quantity of voltage and the suitable frequency have to be controlled to generate ozone gas [1].

2. Method

2.1. Diagram Block of Ozonizer Using Air Cooler

Figure 1 shows the diagram block of ozonizer, which is constructed from the AC high voltage high frequency switching power supply. The ac input voltage is 220V 50Hz supplied to rectifier circuit in order to produce the dc voltage of 310V. From the dc voltage to ac voltage, the inverter controlled by Pulse Width Modulation (PWM) is used to obtain the high frequency of 25 kHz. The low voltage of inverter from the primary side steps up to high voltage of the secondary side at 3 kV in order to produce the High Frequency High Voltage (HF-HV) into the ozone tube. Then, it generates the ozone gas by applied thermoelectric for produces cool air of temperature decreasing in ozone tube.

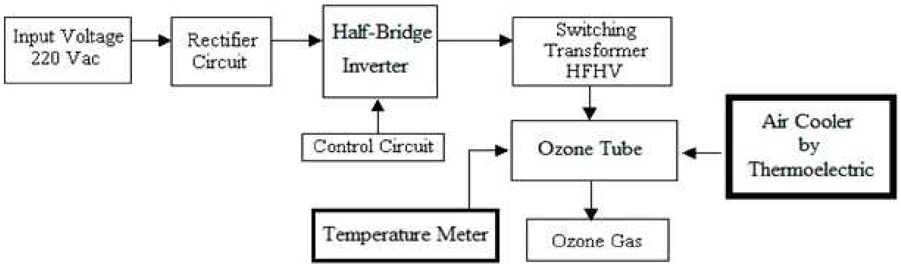

Figure 1. *Block diagram of ozonizer using cool air production system.*

2.2. Part of Ozonizer

2.2.1. Design of Ozone Tube

The principle of ozone tube designing is the ozone gas quantity will occur well under unsmooth electric field. Therefore, two-layer electric insulator is chosen for the ozone tube design as the difference permittivity (ε) of the electric insulator. It is suitable for non-uniform electric field to have the nearly ε of each layer in electric field stress. Therefore, two-layer co-core of cylinder ozone tube design is chosen under the followings as shown in Figure 2.

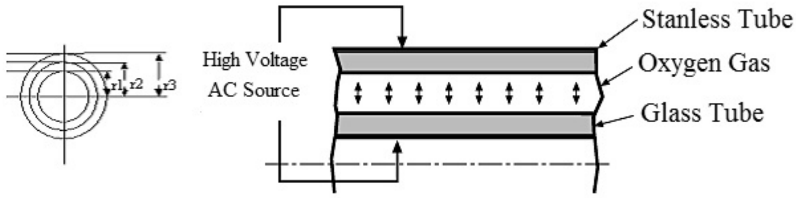

Figure 2. *The structure of ozone tube.*

Energy per volume $W = \frac{1}{2}\int_{Vol} \varepsilon E^2 dv$ (1)

From equation (1), E_{min} and E_{max} are given by $E = \sqrt{\frac{2\times W_{min}}{\varepsilon\ vol}}$

The voltage (V_{min} and V_{max}) of ozone tube is given in equation (2)

$$V = \frac{E.r_2.\varepsilon_2\left(\varepsilon_1 \ln\left(\frac{r_3}{r_2}\right) + \varepsilon_2 \ln\left(\frac{r_2}{r_1}\right)\right)}{\varepsilon_1 \times \varepsilon_2} \quad (2)$$

Where V_{min} and V_{max} are the minimum and maximum voltage of the ozone tube set in order to produce ozone gas, respectively.

2.2.2. The HF-HV Switching Power Supply for Ozone Tube

The HF-HV AC switching power supply is controlled by IC#TL494 [6] as shown in Figure 3 Switching devices, Power MOSFETs, are used in the half-bridge inverter controlled by the PWM strategy from IC#TL494. The switching frequency is 25kHz. The energy from inverter can transfer through a HF-HV transformer to produce HF-HV AC supplying 3kV for the ozone tube. This AC supply is shown in Figure 3.

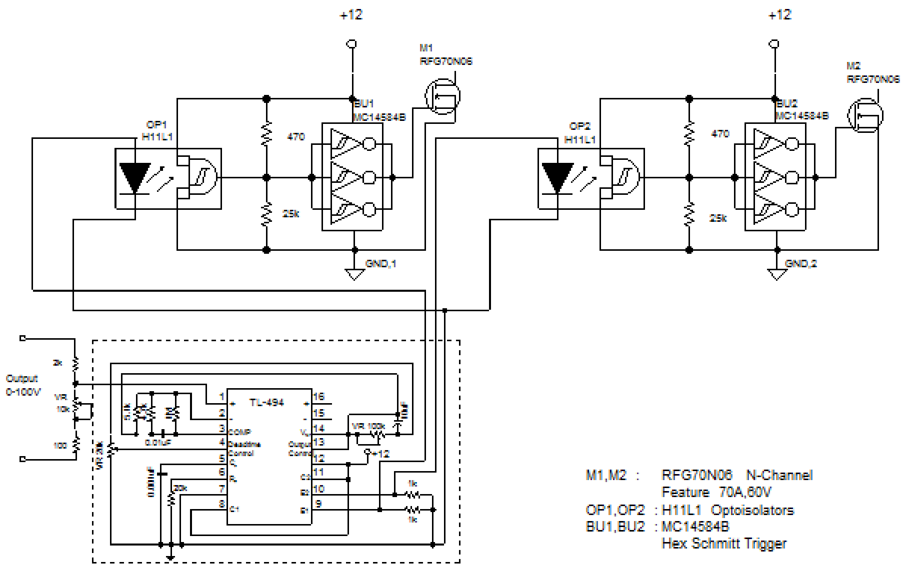

Figure 3. *HF-HV switching power supply circuit using half-bridge inverter.*

2.3. Part of Cool Air Production System from Thermoelectric

2.3.1. Principle of Thermoelectric Cooling

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). They can be used either for heating or for cooling (refrigeration), although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools [5] shown in Figure 4.

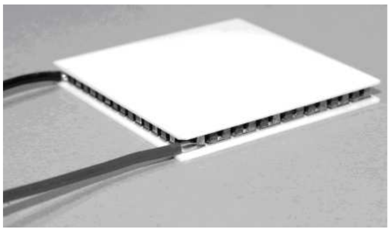

Figure 4. *Thermoelectric /Peltier cooling (12V$_{dc}$ 40W).*

2.3.2. DC Switching Power Supply 12V 100A

The system specifications are as follows
Rated load VA rating= 1.2 kVA
Rated load voltage= 12 V
Rated load current= 100 A
Rated dc link voltage = 310 V
AC main supply= 220 V 50 Hz 1 phase

3. Results and Discussion

The experiment results of the first part are input current signal and input harmonics current signal of Direct Current (DC) switching power supply 12V 100A for thermoelectric shown in Figure 8 In second part are the results of the used power, temperature of ozone tube and ozone gas quantity of ozonizer shown in table 1.

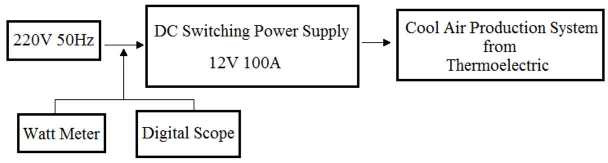

Figure 5. *Diagram block for results measurement of electrical.*

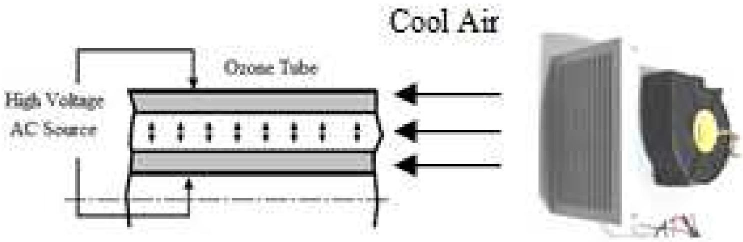

Figure 6. *The connecting of ozone tube and Cool air production system by applied thermoelectric.*

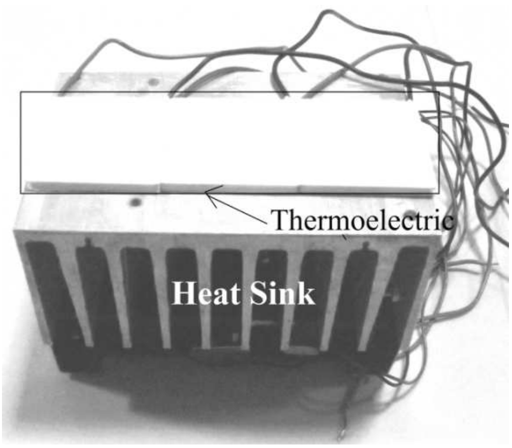

Figure 7. *Cool air production system from thermoelectric.*

3.1. Results of Electrical Parameter of DC Power Supply

The results of measurement of input current signal and input harmonics current signal of DC switching power supply 12V 100A of cool air production system from thermoelectric shown in Figure 8.

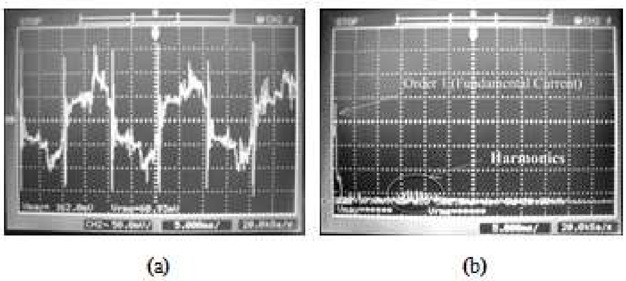

Figure 8. *(a) Input current signal and (b) Input harmonics current of DC switching power supply 12V 100A of cool air production system from thermoelectric.*

3.2. Results of the Power, Temperature Measurement of Ozone Tube

The results of the power, temperature measurement and ozone gas quantity of ozone tube shown in table 1.

Table 1. *The result of the power, temperature of ozone tube and ozone gas quantity of ozonizer.*

Power(kW)	Temperature (°C)	Ozone gas quantity (mgO_3/hr)
0.3	29	216.8
0.3	25	397.5

4. Conclusion

To test the temperature of the ozone tube in ozonizer by the application of cold air produced from thermoelectric. It is found that when used in the production of ozone gas from ozone tube, the measured temperature is equal to 29°C, the amount of ozone gas that is equal to 216.8 mgO_3/hr and production of harmonics quantity of input current as shown in Figure 8 (b) But by the cold air production from thermoelectric blowing into the ozone tube, it is found that the temperature will drop to 25°C, but the amount of ozone gas will increase as 379.5 mgO_3/hr by maintaining the power at 0.3 kilo-watt. It is concluded that while cold air production of thermoelectric reduces the temperature, and it can help to increase the amount of ozone gas because when the temperature drops, the decomposition of ozone gas is less. In the future, researcher will increase the amount of ozone gas to be used to solve environmental problems in various industries as well as to find ways to reduce the harmonics quantity for less in order to maintain the stability of the electrical system to be better.

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