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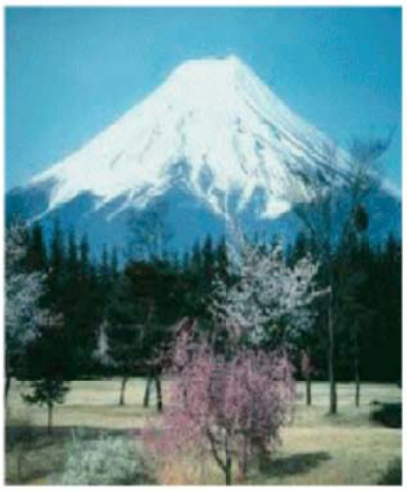

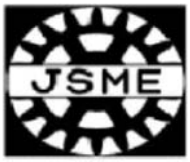

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Wastewater Treatment Using Plasma Technique

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This research was aimed to develop wastewater treatment using plasma technique by applying high frequency voltage switching to generate corona discharge. The power supply was high voltage direct current Flyback converter. It can generate output voltage from 1 KV to 10 KV. The operation was controlled by pulse technique with modulation and IC TL494 was used to control the switching device at 25 KHz frequency. The power supply was tested by distributing high voltage into electrode tube for 10, 15, 30 minutes with 22% oxygen from normal dry air. Small pump was used to pump air through electrode tube. The electrode tube could generate around 200 mgO_3/hr and 300 mgO_3/hr of ozone gas. Then, the ozone gas was put inside silicone tube and dissolved in 10 liters of water. Therefore, plasma water was achieved with concentration of 0.3-0.4ppm which was sufficient for effective wastewater treatment within 15-30 minutes.

Keywords: Switching, Plasma, Corona,Ozone gas

INTRODUCTION

At present, ozone gas is widely used for daily life such as plasma air-conditioner which generates ozone gas to purify the air and to stop the growth of germ, to deodorize all bad smells, to increase the amount of oxygen, to reduce the allergy and illness caused by bacteria, virus and fungus in the air. This study will develop plasma device to generate ozone gas and to dissolve it in wastewater instead of chemicals to kill germs and reduce foreign matter as well as to reduce chlorine in the water so that the water becomes pure and healthy. This is the main aim of the development of wastewater treatment using plasma technique.

In this study, the changes in frequency and voltage will be measured in relation to the amount of ozone generated through the power supply of high frequency voltage switching to distribute high frequency voltage to load or electrode set to generate ozone. Normally, ozone will emerge after the breakdown of oxygen molecule. In other words, ozone follows this equation: $O+ O_2 =O_3$

Nowadays, toxins are used in agriculture to prevent plants from weeds. However, farmers lack of knowledge and understanding. Therefore, vegetable is usually contaminated because they might overuse toxin with their plants.

High voltage direct current can be caused in nature such as during heavy rain. There will be electrical charge inside clouds, resulting in voltage between cloud and ground. In practice, high voltage direct current can be generated for application. However, in this research high voltage direct current will be generated through

switching with Flyback adapter which can distribute direct current of 1 KV to 10 KV, based on the principle of Flyback converter.

In this research, electrode was used to change air oxygen into ozone gas through Corona discharge. The ozone gas generator was designed and developed out of 2 main parts: Part 1 was to design and develop high voltage power supply to distribute it to Part 2 which is the tube to generate ozone from electrode. The ozone could be pumped out through the air. These 2 parts are in relation to the amount of ozone generated. In the experiment, high voltage would be tested to be distributed to electrode because the difference in voltage can affect the density of Corona ray and the amount of ozone generated.

PRINCIPLE OF PLASMA AND OZONE GENERATION

Ozone is found in the atmosphere at the height of around 50-10kilometers above the earth surface, normally known as stratospheres. It can reduce the danger of UV radiation in the nature. Ozone is caused by high voltage in the air such as lightning. Oxygen molecule is broken down to oxygen atom and then it is combined with other molecules in the surrounding to generate ozone. This process of breaking down of O 2is called "Corona discharge" or Electric discharge. Ozone in the nature is also caused by UV ray from the sun with the length of 185nanometers to break down oxygen molecule (O .(2However, the ozone (O (3from this process has low concentration of around .%0.10-0.01

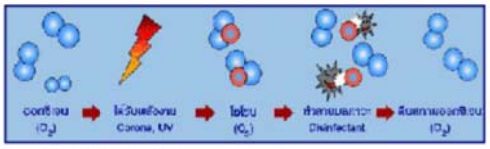

Fig. 1 Principle of Ozone generation

Ozone gas can be generated by the following methods.

.1 There are 2 kinds of raw material for the generation of ozone

1.1 Common dry air with %22 oxygen

1.2 Pure oxygen

.2Ozone generator can be classified into 2 kinds:

2.1 Ultra Violet (UV) lamp will generate ozone with low concentration to purify air. Putting ozone in the water will be ineffective because the dissolution is very low.

2.2 Electrical principle called "Corona discharge" can be classified into 2kinds according to frequency: Low and high. For tropical area, high frequency is better than low frequency because it can generate ozone with higher concentration.

PRINCIPLE OF FLYBACK CONVERTER

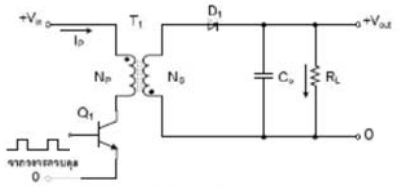

Fig. 2 Basic circuit of Flyback converter

The circuit process will be as follows: Power transistor Q 1will work by making and stopping induction intermittently. When Q 1induces, the current will flow through primary coil (Ip). However, the adapter is adjusted so that primary and secondary coils are in reverse direction. Therefore, while Q 1induces diode D1, the bias is reversed and there is no current across RL load. The energy is stored in primary coil of the adapter when Q 1stops induction. The magnetic field in the adapter will contract and the voltage of secondary coil will be reversed. The stored energy in primary coil will be distributed to secondary coil and the current can pass the load. When the circuit is at stable state, the output voltage from the converter will follow this equation.

$$V_{out} = \frac{t_{ON} \times (N_s / N_p)(V_{in} - V_{CE(sat)})}{(T - t_{ON})} - V_D$$

when T is the working time of Q1 (second)

T_{ON} is time period

N_p is the number of primary coil round

N_S is the number of secondary coil round

V_{out} is output voltage of converter (volt)

V_{in} is input voltage of converter (volt)

$V_{CE(sat)}$ is voltage acrossQ1during induction at saturation (volt)

V_D is voltage across diode D1 during induction (volt)

Design and Development of High Voltage Power Supply with Switching mechanism

Structure of high voltage power supply with switchingwas shown in Fig. 3

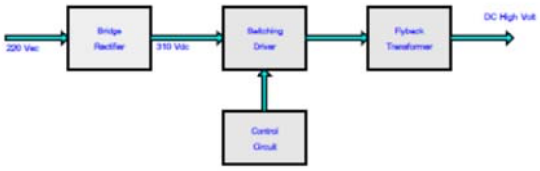

Fig.3 Diagram block of high voltage direct current power supply with switching mechanism

DESIGNING HIGH VOLTAGE POWER SUPPLY WITH SWITCHING

In this design of high voltage power supply with switching, IC TL494 was used to generate pulse with modulation to control switching. MOSFET (metal–oxide–semiconductor field-effect transistor) was used for induction. The frequency for switching was around 25 KHz. Then, it was passed at high frequency adapter to generate high voltage as desired.

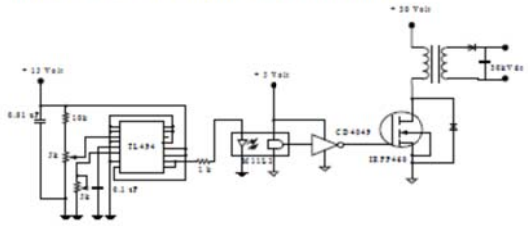

Fig. 4 Control circuit and gate drive circuit

High frequency inverter circuit contains Flyback inverter circuit to change direct current of 30V to high frequency alternate current of square shape with 25 KHz. Power MOSFET no. IRFP460 is used as a switching device.

Gate drive circuit uses IC Optocoupler no. TLP250 which has amplifier inside in order to link between control part and inverter part as shown in Fig. 4. Electrode tube to generate ozone gas contains 3 layered cylinders. The outmost layer is made of stainless steel or aluminum. The second layer is Pyrex glass. The third layer, the innermost part, is think stainless steel or aluminum foil. The size and the length of the cylinder will determine the concentration of the ozone generated.

RESULTS AND COMMENTS

Table 1 will show the relationship between parameters and the amount of ozone gas as well as the concentration of Corona ray at electrode at 25 kHz frequency. The Vout was 1 kVdc to 10 kVdc. The

adjustment of the duty cycle in the control circuit was to adjust the output voltage as shown in Table 1.

High voltage Attached to the rod electrode (kV)	The amount of Ozone(mg cc/hr)	The intensity of dissolved in 10 liters of water		
		10 min	15 min	30 min
1	165.6	0.07	0.08	0.15
2	186.6	0.08	0.12	0.18
4	188.4	0.08	0.12	0.25
6	209.8	0.09	0.14	0.32
8	236.2	0.12	0.15	0.35
10	257.4	0.14	0.16	0.45

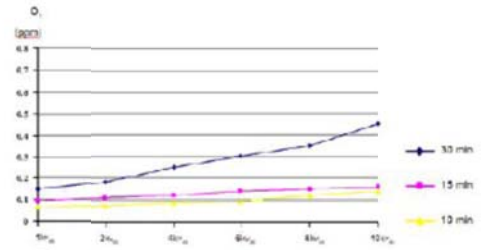

Fig.6 Graph showing the amount of ozone gas dissolved in the water for 10, 15 and 30 minutes.

CONCLUSION

This research on the development of wastewater treatment plant using plasma technology shows that the device can be 200-300 grams of ozone, which is sufficient to treat wastewater. The device can be 200-300 milligrams of ozone per hour, resulting in plasma concentrations of 0.3-0.4 ppm are sufficient amounts of toxic chemicals for cleaning the water for about 15-30 minutes.

APPLICATION

1. Ozone gas can be used to remove toxins from contaminated water.
2. To reduce the waste significantly as compared to other methods
3. Waste water treatment is not left out of the water with toxic residues. Because ozone is treated by oxidation reactions.
4. Table1The relationship between parameters and the amount of ozone gas and plasma.
5. Make the environment better.

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