Ozone Production by Atmospheric Pulsed Discharge Using a Double Discharge Method and Partly Covered Electrode

S. Kaneda, N. Hayashi, S. Ihara, S. Satoh and C. Yamabe

Department of Electronic Engineering, School of Science and Engineering,
Saga University, 1 Honjyo-machi, Saga 840-8502, JAPAN

The brand new double discharge type ozonizer was proposed in order to enhance the ozone concentration. The ozonizer has an anode partly covered with the dielectric, which increases the discharge volume. Basic parameters such as discharge voltage and current waveforms, and ozone concentration were investigated to characterize the discharge.

1. Introduction

Recently, the ozone has attracted the attention in the environmental improvement technology, when the environmental problem becomes a topic in world scale. Since ozone is one of the strongest oxidants, it is employed for treatment of wasted water and offensive odors, disinfections and the removal of organic substances. The discharge plasma methods such as silent discharge, surface discharge and positive streamer corona discharge have been introduced to obtain the higher efficiency and higher ozone concentration.

Atmospheric pulsed discharge has been used for efficient ozone production. In this research, the double discharge method was employed to obtain a atmospheric pulsed discharge. This method consists of two discharges, i.e., a pre-discharge and main discharge. However this configuration has problem that the discharge power and volume are limited by occurrence of arc discharge.

In order to revise the problem, the discharge electrode covered by dielectric was proposed. As the result, the discharge power and volume was increased, and the ozone concentration and generation yield were enhanced.

2. Experimental apparatus and method

Fig. 1 shows the equivalent electrical circuit for ozone generation using pulsed discharge with pre-ionization. The electrical system consists of a thyratron for triggering of circuit, ceramic type capacitor C_1, C_2 and discharge electrodes. C_1 (200 nF) is the smoothing capacitor. The energy used for the discharge is charged in C_2 (200 pF). It was charged at a certain high voltage. The charging voltage was controlled in 0-30 kV. The thyratron turn on by external pulsed voltage after the capacitor C_2 is charged. After that corona discharge (pre-ionization) occurs in the space between the outside surfaces of the glass tube, which enclose the trigger electrode, and cathode. The main discharge is formed between cathode and anode after occurrence of the pre-ionization.

Fig. 2 shows the schematic examples of discharge formations using electrodes with and without the dielectric. In the case without the dielectric, the discharge is formed between cathode and anode in the straight like Fig. 2 (a), while covering electrode by dielectric can increase the discharge volume like Fig. 2 (b).

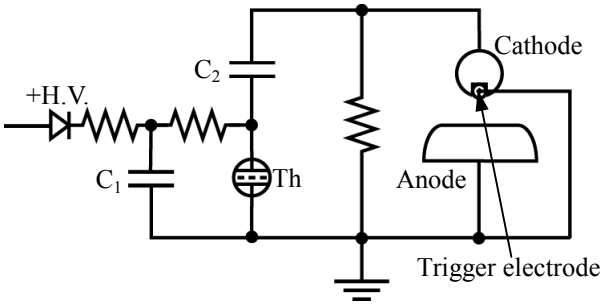
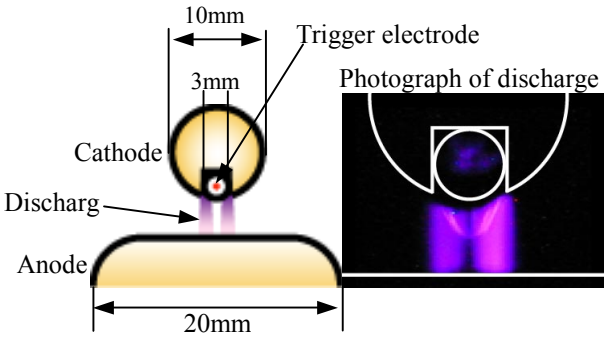
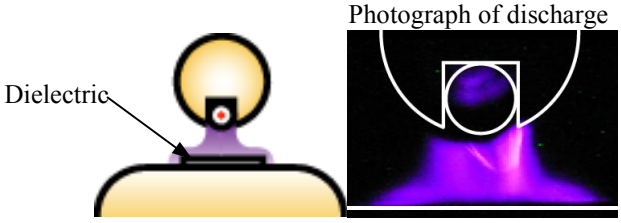


Fig. 1 Equivalent electrical circuit



(a) Without dielectric



(b) With dielectric

Fig. 2 Schematic of discharge formation

In this experiment thin rubber was used as a dielectric, the characteristics of ozone generation were obtained for different widths of the rubber (5 mm, 7 mm, 9 mm, 11 mm, 13 mm 20 mm). The width of Anode, that is plate electrode, is 20 mm. In this experiment atmospheric dry air was used for ozone production.

3. Experimental results and discussion

Fig. 3 shows characteristics of the ozone generation, concentration and yield for different dielectric widths. The widths of 0mm means that the electrode was not covered, and width of 20 mm means that electrode was covered entirely.

In the case of 0 mm width, the maximum concentration of about 300 ppm was obtained at the input power of 0.8 W, and the yield was about 80 g/kWh. In this case, arc discharge occurred above 1.1 W. On the other hands, in the case of 9 mm width, uniform discharge was obtained up to 1.6 W, and about 750 ppm and 90 g/kWh were obtained at input power of 1.5 W. It was found that the ozone concentration and generation yield were improved by the electrode partly covered by the dielectric. In the case of 20 mm width, the maximum concentration of about 500 ppm was obtained at input power of 1.8 W, and the generation yield was about 50 g/kWh. In other words, the concentration and generation yield were lower than those using partly covered electrode.

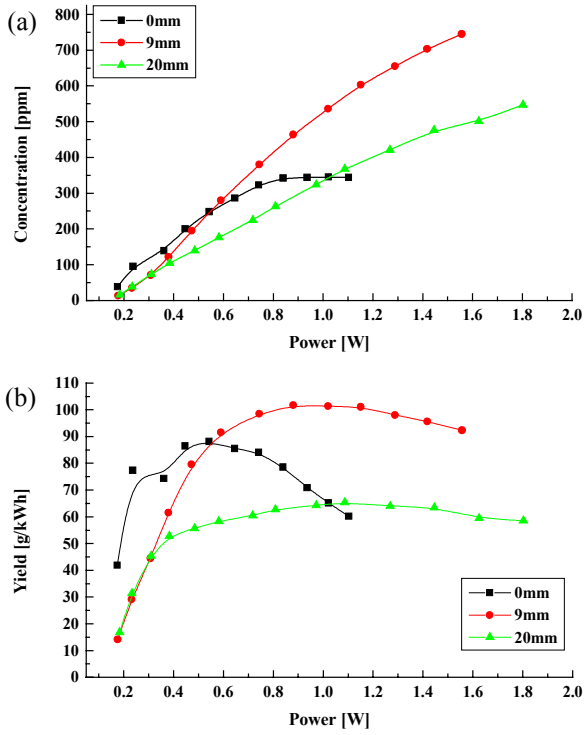


Fig.3 Characteristics of ozone generation.
(a) Ozone concentration, and
(b) Ozone yield.

4. Conclusion

The experiments of ozone generation by atmospheric pulsed discharge are curried out using electrode covered by different widths of dielectrics. In the case of the electrode without dielectric, the maximum concentration of about 300 ppm was obtained at input power of 0.8 W, and the yield is about 80 g/kWh. On the other hands, in the case of the electrode covered by the dielectric with width of 9 mm, about 750 ppm and 90 g/kWh were obtained at input power of 1.5 W. It was found that the ozone concentration and generation yield were improved by the electrode partly covered by dielectric. Then, it was more effective that using partly covered electrode than using electrode covered entirely by dielectric.

Acknowledgments

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References

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