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Development of Dielectric Barrier Discharge Plasma Source for Ozone Generation (water treatment)

Mai Kai Suan Tial[1], Khant Nyar Paing[1], Aung Ko Minn[1], Okka[1], T. Ishijima[2], Y. Uesugi[2]
[1]Department of Electrical Power Engineering, Yangon Technological University, Yangon
[2]Eletric Power and Environment Laboratory, Kanazawa University, Kanazawa
e-mail:maikaisuantial21@gmail.com

A dielectric barrier discharge (DBD) plasma source is developed for efficient ozone generation for removing a variety of pollutants or environmental applications such as water cleaning, air pollutant control or gaseous pollutants with low capital cost and low amount of wasteful energy consumption. The DBD reactor is designed to generate efficient ozone. In addition, a simple AC power source combining with SIDACs is developed in order to generate a pulse voltage output. In this work, the discharge characteristics of DBD plasma are observed by oscilloscope to investigate the pulse voltage output from the SIDACs. Finally, the measurement of ozone generation indicates the evaluation of performance of DBD reactor using the ozone monitor.

I. Introduction

Water and energy are fundamental resources used for economic, social and cultural development. With the increase of population and the developments brought by the industrial revolution, their demand increased and scarcity is now an undeniable result around the world [1]. Highly oxidizing water treatments, like ozonation and UV-ionization, have proven useful in removing organics from water, but they require high capital costs and high amounts of energy consumption. Ozone is generated in dielectric barrier discharge, one of the typical non-equilibrium atmospheric pressure plasma discharges. In this paper, a low cost ozonizer by DBD plasma to reduce the high capital cost and amount of energy consumption for ozone generation. For a simple AC power source which can reduce the energy consumption compared to a high voltage pulse power source or high voltage and high frequency power source which is expensive, it was designed and developed by combining silicon diodes for alternating current: SIDACs [2].

II. Experimental Setup

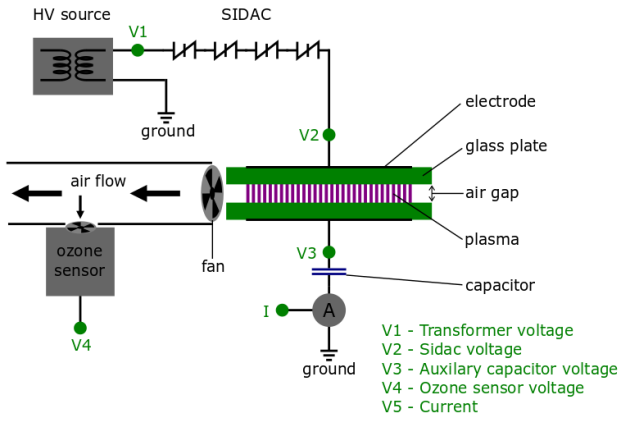

Figure 1. Experimental setup for ozone generation

When the high voltage power source is supplied to electrodes through the SIDACS (V_{BO}=340 ~ 400 V), the discharges are occurred between the two plates during the conducting mode. As the time derivative of the output voltage of SIDAC becomes higher, the more discharges could efficiently using SIDACs.

III. Results and Discussion

Figure 2 shows the emission of DBD plasma when different numbers of SIDACs are used. The amount of DBD plasma increases as the number of SIDAC connected in series is increased. This means the emission intensity of plasma significantly increased when the number of SIDAC is increased.

Figure 3 shows the discharged voltage and current. This confirm that plasma could be generated by meant of SIDACs break over voltage (V_{BO}). We found that the ozone output concentration increase by multiple times when SIDACs are used. The result also confirmed the theoretical speculations assumptions. SIDAC are low cost, long life and low maintaneous components. Therefore, using Silicon Diode for Alternating Current is a easy and inexpensive way to increase ozone output of a dielectric barrier discharge plasma (ozoniser) effectively.

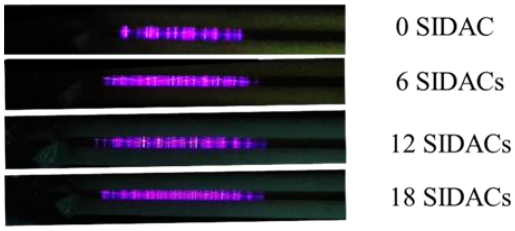

Figure 2. Light Emission of DBD plasma without and with different numbers of SIDACs

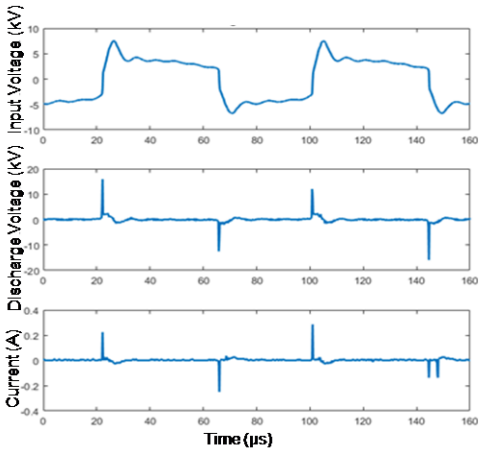

Figure 3. The rate of change of voltage and current across the discharge plate with SIDACs.

References

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[2] Yujiro Summishi, Yoshihiko Uesugi, Yasunori Tanaka, Tatsuo Ishijima, "Enhancement of Non Equilibrium Atmospheric Pressure He Plasma Discharges by Using Silicon Diode for Alternating Current", *Journal of Physics*: Conference Series Vol. 441(2013) 012018.