Development of Plasma Generator for Air Purifier System

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ABSTRACT
This research aimed to develop plasma system used in air purifier. This developed plasma system could be installed in the air conditioners - all split type, also could improve the quality of air equaling to present plasma system. Development processes were as follows: 1) to study the plasma system used in the air conditioners, 2) to design a plasma generator, 3) to develop the plasma generator, and 4) to test its performance in many types of the air conditioners. This plasma system was developed by AC high voltage8 – 12 kv with a frequency of 40-80 kHz. Carbon was a conductor to generate arc in air purifier system. The research was tested by installing the plasma generator in the air conditioners - wall type. Whereas, there were 3 types of installations: air flow out, air flow in, and room center. The result of the plasma generator installed in the air conditioners, split type, revealed that the air flow out installation provided the highest average of o-zone at 350 mg/h. This type of installation provided the highest efficiency of air quality improvement. Moreover, the air flow in installation and the room center installation provided the average of the o-zone at 255 mg/h and 91m g/h, respectively.

Keywords: Plasma generator/ Air purifier/ Air conditioner

1. Introduction

At present, the whole world is facing the greenhouse effect along with air pollution. Air purification and air quality control are important topics due to deficiencies of current adsorbents in filtering toxic industrial chemicals and volatile organic chemicals. Air purification, or cleansing the air, is another issue in which people are getting more and more interested. Every air conditioner sold today, therefore, is equipped with air purification system as an optional feature for customers [1-3]. However, plasma system has some limits affecting its efficiency and the satisfaction of both customers and manufacturers, which are as follows: it can be installed in only one type of air conditioner, namely wall type; plasma generator is too large; customers who have installed air conditioner must re-install it; it is overpriced; it reduces the efficiency of cooling down the temperature; it makes noise when arc is generated; the amount of plasma could not be controlled; and it smells bad after turning on for a long period. According to the limitations cited above, this research was aimed to develop a prototype of plasma generator with the following features: it could be installed in all split type air conditioners; it is small enough; it could be easily installed; customers who have installed air conditioner could install it without buying new air conditioner; the price is reasonable; it does not reduce the efficiency of cooling down the temperature; and it does not make noise when arc is generated.

II. Material and Theory

Both gases, oxygen or air, are still used today for industrial ozone generation, preferably at pressures 0.1 and 0.3 MPa. As mentioned before, in oxygen or air at atmospheric pressure or above, the discharge is of filamentary nature. The number of micro discharges per unit of electrode area and time depends on the power density. Their strength (energy-density, transferred charge), is determined by the gap spacing, pressure and dielectric properties. The control of the plasma conditions inside the micro discharge columns is of eminent importance for optimizing the reaction kinetics of ozone formation. For a given feed gas composition and desired power density this can be achieved by adjusting the operating parameters pressure, and or gap width as well as the properties of the dielectric barrier , and the feeding circuit. The plasma conditions in the micro discharges have to be optimized for exciting and dissociating oxygen and nitrogen molecules. Initially, the major fraction of the energy gained by the electrons in the electric field is deposited in excited atomic and molecular states. Starting from electron impact on ground state O_2 molecules two reaction paths leading to dissociation are available. Ozone is then formed in a three-body reaction, involving O and O_2 , leading to the formation of the O_3 molecule. Ozone is an oxygen molecule which contains three oxygen atoms instead of two. Unstable ozone reacts with contaminants to revert back to its stable oxygen state reducing concentrations of ozone quickly. When ozone contacts something "oxidizable" the extra oxygen atom releases from the ozone molecule and binds with the contaminant. What

remains is the pure and stable oxygen molecule. When most contaminants are oxidized some residual ozone may remain but most is collected by the electrostatic and charcoal deodorizing filter. Air pollutant concentrations should be measured at monitoring sites that are representative of population exposures. Air pollution levels may be higher in the vicinity of specific sources of air pollution, such as roads, power plants and large stationary sources, and so protection of populations living in such situations may require special measures to bring the pollution levels to below the guideline values.

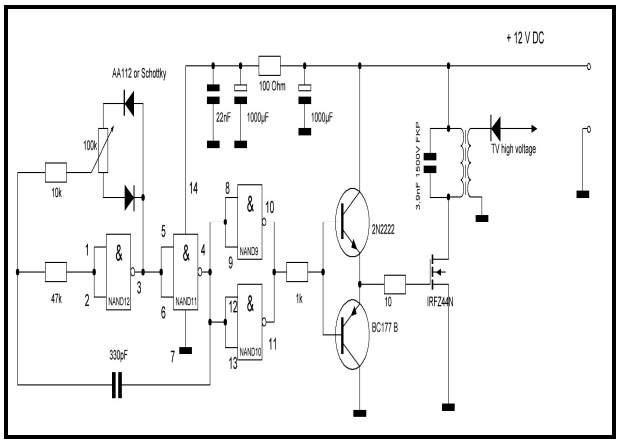

Fig.1 Plasma System for Air Purification

III. Experimental Result

According to Fig. 1, high voltage circuit for plasma source is shown. This is to build up plasma air purifier system in which the voltage at output is measured to be around 6-10 kV.

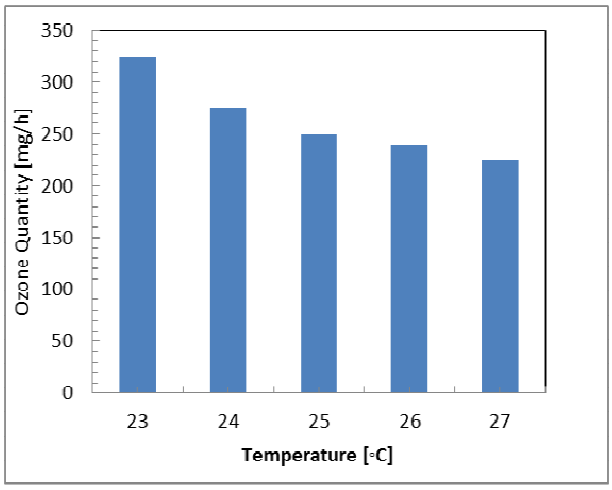

Fig 2. Ozone Quantity vs Temperature setting at High Speed with air flow in position

It was found that the ozone is inversely relation with temperature.

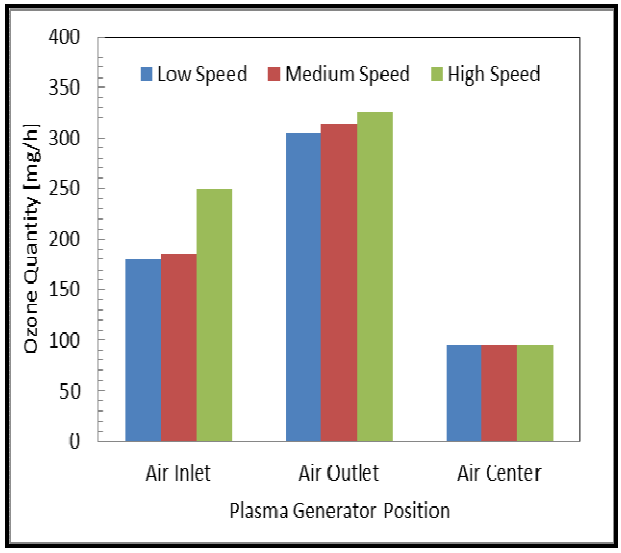

Fig.3. Plasma Generator Position vs Ozone Quantity

Figure 3 shows the ozone quantity depending on plasma generator position. At the air outlet, the ozone quantity is highest value.

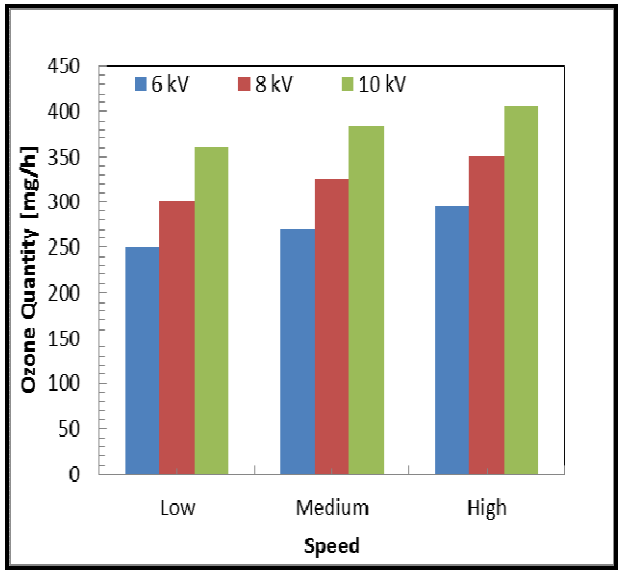

Fig.4. Plasma Generator Position vs Ozone Quantity.

Figure 4 shows the ozone quantity depending on plasma generator output voltage. At the voltage output 10kV, the ozone quantity is highest value. It was found that the plasma form discharge stage is very high when compare with low voltage region. The combinations between O_2 and O from discharge become the ozone. In case of the plasma generator circuit frequency is changed, the quantity of ozone is also changed with frequency in same direction of voltage output as shown in Fig. 5.

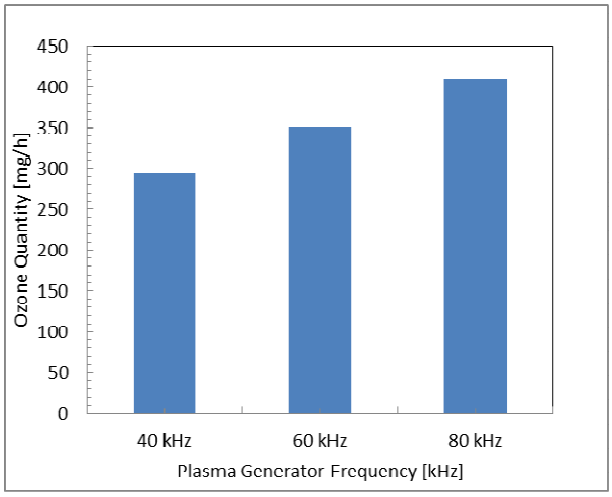

Fig.5. Ozone Quantity vs Plasma Generator Position .

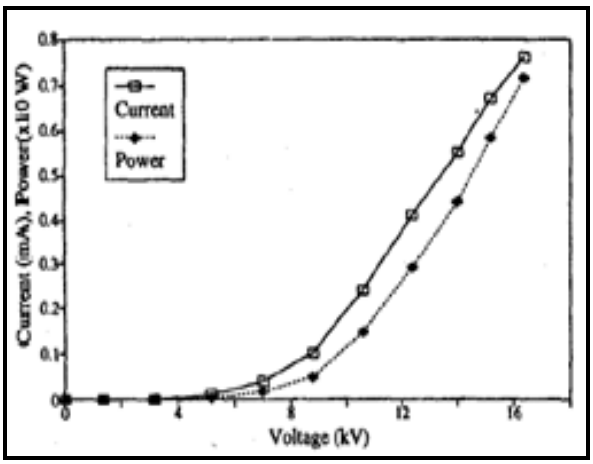

Fig.6. Voltage –Current characteristic of Circuit

It was found that at the middle region, the power of plasma circuit is very high. The voltage-current and voltage-power characteristics of the packed-bed plasma reactor are shown in Fig. *5.*The power consumption was calculated by multiplying voltage, current, and cosine of phase angle of *55* degrees.

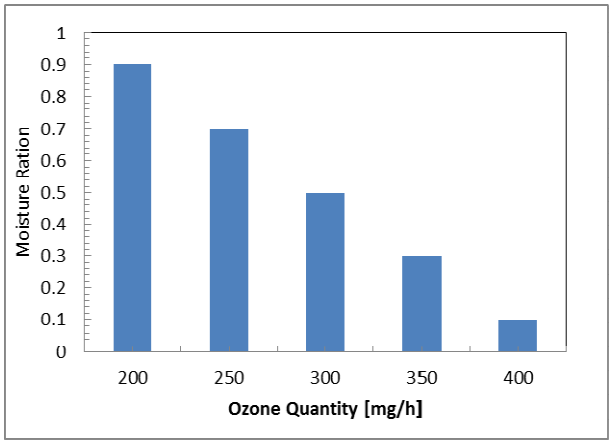

Fig.7. Ozone Quantity vs Moisture ration

Figure 7 show the relation between moisture and ozone quantity. It was found that the ozone increase with decreasing moisture ratio.

IV. 4. Conclusions

This research aimed to develop plasma system used in air purifier. This developed plasma system could be installed in the air conditioners - all split type, also could improve the quality of air equaling to present plasma system. Development processes were as follows: 1) to study the plasma system used in the air conditioners, 2) to design a plasma generator, 3) to develop the plasma generator, and 4) to test its performance in many types of the air conditioners. This plasma system was developed by AC high voltage 8 – 12 kv with a frequency of 40-80 kHz. Carbon was a conductor to generate arc in air purifier system. The research was tested by installing the plasma generator in the air conditioners - wall type. Whereas, there were 3 types of installations: air flow out, air flow in, and room center. The result of the plasma generator installed in the air conditioners, split type, revealed that the air flow out installation provided the highest average of o-zone at 350 mg/h. This type of installation provided the highest efficiency of air quality improvement. Moreover, the air flow in installation and the room center installation provided the average of the o-zone at 255 mg/h and 91m g/h, respectively.

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