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Characteristics of Ozone Generation in Air Fed Cylindrical DBD Using Low Frequency

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ABSTRACT:
Fetal electrocardiogram (FECG) is a signal from an abdominal electrocardiogram (AECG), obtained using non-invasively. FECG is very important to find the situation of fetal health. This article presents a method for FECG extraction from the AECG signal employing Wavelet. Wavelet is used to remove the noise of muscle and fetal movements in the mother's abdomen. Parts of the wavelet result are eliminated such that the signal only consists of QRS fetal. The method is examined using the dataset of the abdominal database from the Physionet. The performance found using this method is 95.01% in terms of accuracy.
Keywords: *cylindrical DBD; electrical characteristics; ozone concentration; low frequency.*

1. INTRODUCTION

Ozone is a triatomic oxygen that has characteristics as a strong oxidizer. Ozone technology is an environmentally friendly technology because if it reacts with other elements will produce oxygen, so that ozone can be called green chemistry in the future. In addition, ozone can also produce hydroxyl radicals that are very reactive and not selective. These compounds can reduce organic compounds with the end result of carbon dioxide and water vapor. One alternative technology that is quite good in producing ozone is plasma Dielectric Barrier Discharge (DBD) technology. Therefore, discussion and research on ozone and DBD technology will always be interesting for the next few years. In addition to being environmentally friendly, ozone also has many benefits for human life, among others; the process of industrial sterilization in the field, in the field of the environment such as waste reduction, in the field of food such as storage of horticultural products, fish storage, and medical application [1-10]. The problems often faced with ozone production is the high cost and low efficiency, therefore a lot of research is done to obtain cheaper generators with good efficiency. Research on ozone production including DBD has been widely carried out to improve efficiency, such as the influence of flow rates, voltage, reactor configuration to influence of frequency and the influence of duty cycles. [8-14]. The purpose of this paper is to determine the working area of ozone formation at low frequencies. This is an important factor in making an ozone production system in accordance with the required capacity and creating an inexpensive and efficient ozone generator.

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2. MATERIALS AND METHODS

Materials. This study uses a cylinder type configuration for dielectric barrier discharge plasma (DBDP). Inner electrodes are used with stainless steel mesh with a length of 19 cm. The outer electrode uses aluminium foil with a length of 19 cm. The dielectric material uses Pyrex tubes with a length of 21 cm and a diameter of 2.8 cm. The DBDP reactor is connected to a high-voltage AC pulse source with an oscillator that can adjust the pulse frequency through a combination of resistors and capacitors. High voltage was measured using a Sanwa CD772 digital multimeter which was first connected to the HV probe SEW-PD-28 x 1000. The magnitude of the electric current was measured using a current tester Kyoritsu KEW SNAP 2433. While the pulse frequency was seen from the digital oscilloscope GWinstech GDS-1052 U. Input source gas comes from the air pump Resun Air pump LP-20 which is connected to a Wiebrock flowmeter 10 L/m. Measurement of ozone concentration using the iodometry method. KI and Na2S2O3 were weighed using the SF-400C Electronic compact scale. Erlenmeyer 250 ml Herma is used to store KI solution. Sodium thiosulfate titration using Gilson micropipettes.

Experiment procedure. The DBDP reactor is connected to the high voltage AC pulse generated from the power supply with the transformer input voltage varying 18 volts, 20 volts and 25 volts. High voltage varies from 1 kV to 9 kV at 1 kV intervals. In each voltage application, the electric current and concentration of ozone produced are then measured. Repetition is performed at a pulse frequency with a variation of 180 hz to 620 hz. Measurement of ozone concentration using the titration method with the calculation formula [11]:

$$C_o = \frac{R \times V_t \times N_t}{V_{gas}}, \qquad (1)$$

Co is the concentration of ozone (ppm), R is the ratio of the analytical mol and the reactant of a balanced chemical equation (the number of moles of ozone is proportional to half the number of moles of sodium thiosulfate ie, O3 is 48 times multiplied by half), Nt is the normality of sodium thiosulfate (mol/L), Vt is the volume of titrant (L) and Vgas is the gas volume of input (L).

The research data is then processed in graphical form using Origin 8.0 software. Graphic processing to determine the electrical characteristics of the current as a function of voltage, dissipation power (current and voltage multiplication) as a function of voltage, ozone concentration as a function of voltage and capacity as a function of voltage. Ozone capacity is calculated using the calculation of the multiplication of ozone concentration (gram/liters) and flow rate (liters/hour) [11].

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3. RESULTS AND DISCUSSION

Electrical Characteristics. The characteristics of ozone generation using a plasma dielectric barrier discharge with a cylindrical electrode type have been obtained. Figure (Fig. 2a) is a characteristic graph of the current relationship a function of voltage at a frequency of 232.3 hz. It appears that the change of electric charge in units of time produced increases with increasing voltage [11-13]. This confirms the results of research conducted by Dinef et al. [15] examining the use of pin to plane non-uniform electrode configurations, showing linear polygonal characteristics as shown in figure (Fig. 2b). These characteristics indicate there are two work areas in the form of no discharge area and ozone generation area which is marked by discharge. The no discharge area is visualized as shown in figure (Fig. 1a). Visualization of the reactor that has formed a discharge is shown in figure (Fig. 1b). The observed characteristic is the emission luminance in the UV region. Previous researchers [16] also confirmed that emissions released from air-based DBDP were observed with wavelength spectrum in the range of 300 to 450 nm (see Fig. 1c) with bands of nitrogen molecules being dominant and oxygen molecules not being observed. DBDP uses a wire-mesh rectangular configuration at a frequency of 50 hz. The dominant spectrum is N_2 because of excitation processes such as electron excitation from the base and first metastable levels, as well as energy transfer from the collision process. The N_2^+ spectrum also arises because of the direct effects of ionization from high-

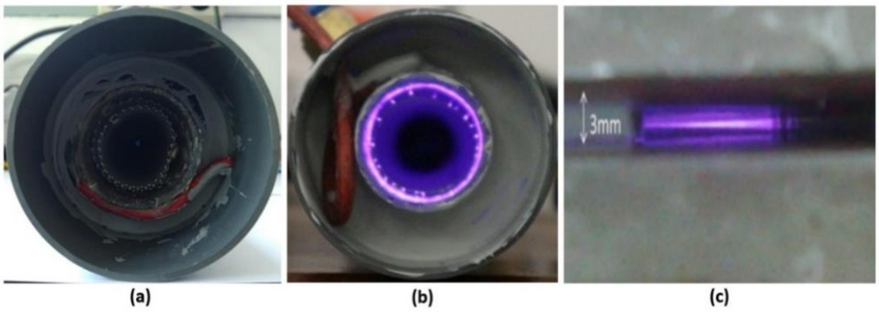

Figure 1. DBDP Reactor: (a) no discharge, (b) discharge plasma, (c) discharge of air DBD at 50 hz [16].

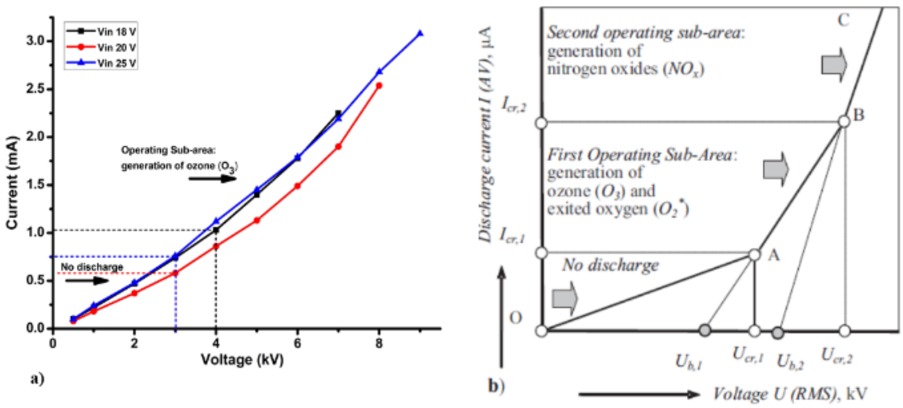

Figure 2. Electrical Characteristics: (a) current as a function of voltage at a pulse frequency of 232.3 hz, (b) linear polygonal model of static volt – ampere [15].

energy electrons. Chandwani et al [17] explained that the Schumann-runge O_2 band has not been observed because it overlaps with a stronger nitrogen molecule emission. Oxygen atoms as the basic ingredients of ozone formation also have a cooling coefficient value greater than the rate of radiation in the transition process, so that the spectrum of oxygen atom emissions is not observed.

Figure (Fig. 2a) shows, the addition of voltage causes an increase in current. The maximum current is obtained at a frequency of 232.3 hz for all transformer input voltages. At the 18 volt input voltage the current reaches a maximum value of 2.25 mA, with a 20 volt input voltage the current reaches a maximum value of 2.54 mA, while the current reaching the maximum value of 3.08 mA is obtained at the 25 volt input voltage. These results confirm a previous study by Garamoon et al [10] called resonance frequency. The resonant frequency occurs when the attainment of the maximum current value is indicated by the circuit impedance value and the reactor reaches the minimum value. At the addition of a voltage below the ignition voltage the current has a slight increase. In this area discharge has not occurred or is called a no discharge area. After the ignition voltage the current increases significantly with the addition of voltage. This is due to electrons getting more energy to do the ionization which will then occur electron fall. In this area is characterized by the discharge and emissions [15]. The characteristic graph at 232.3 hz frequency has a different ignition voltage at each input voltage variation. Using an 18 volt transformer input voltage requires an ignition voltage of 4 kV, whereas for an input voltage of 20 volts and 25 volts requires an ignition voltage of 3 kV. Input voltages of 18, 20, 25 volts also produce different ozone formation working areas, respectively having the following voltage ranges of 4 - 7 kV, 3 - 8 kV, 3 - 9 kV. Thus, the 25 volt transformer input voltage has a longer working area range and has a lower ignition voltage.

Figure (Fig. 3) is a P-V graph, the amount of power needed increases polynomial with the addition of voltage. Andi et al. [14] confirmed that power consumption (voltage and current multiplication) in the DBD surface model of cylinder configurations will increase with the addition of voltage. Figure (Fig. 3) also shows that variations in the input voltage of transformers 18, 20, 25 volts also affect the required power consumption, respectively, increasing, namely 15.75, 20.32, 27.72 watts. It is also seen that the greatest power needed occurs at a pulse frequency setting of 232.3 hz, it is possible that this frequency is the resonant frequency as stated by Garamoon et al [10].

Usually, the formation of ozone made from air is produced from three-body collison $O + O_2 + M \rightarrow O_3 + M$ with M can be O, O_2, N_2, and O_3 [[8]. Ozone formation will increasingly increase along with the addition of voltage at different frequencies [8-14]. Figure (Fig. 4a) is a graph of the relationship of ozone concentration as a function of voltage to

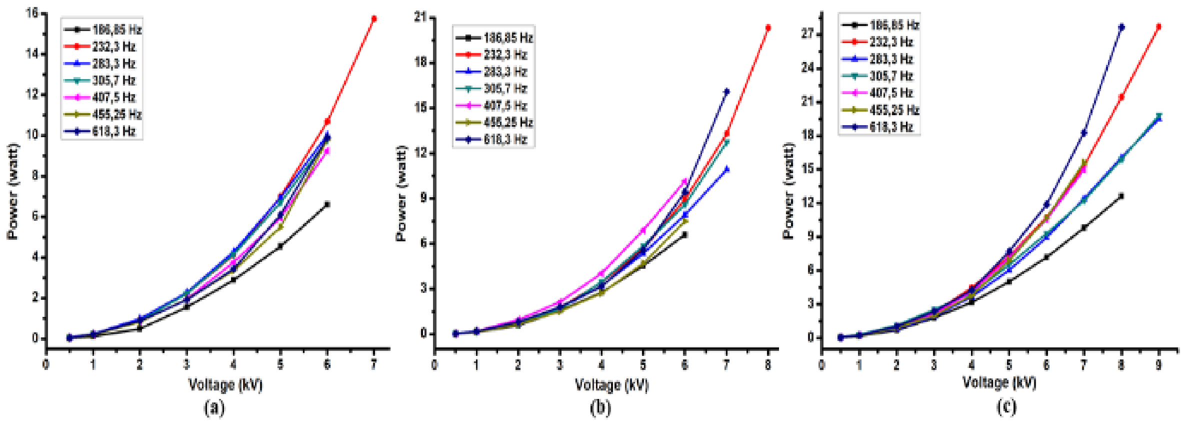

Figure 3. Power as function of voltage: (a) Vin 18 volt, (b) Vin 20 volt, (c) Vin 25 volt

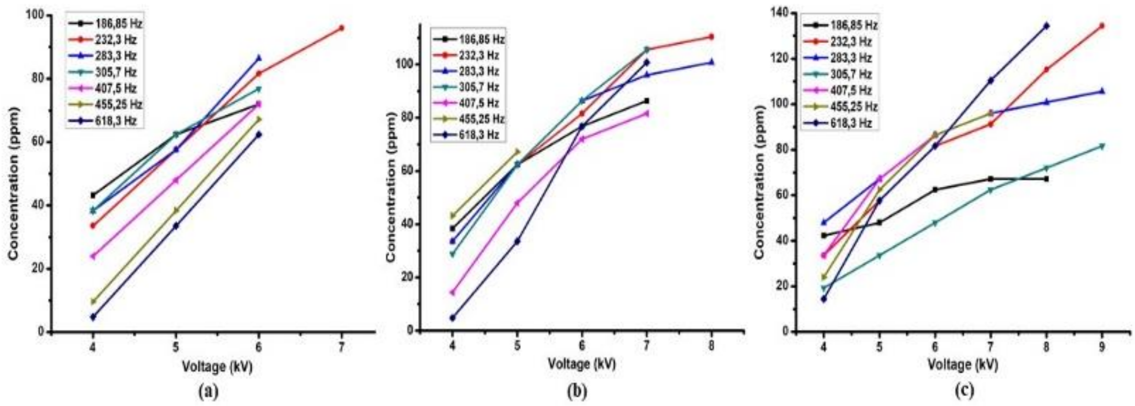

Figure 4. Concentration as function of voltage: (a) Vin 18 volt, (b) Vin 20 volt, (c) Vin 25 volt.

the 18 volt transformer input voltage. The formation of ozone starts from a voltage of 4 kV to 6 kV for all pulse frequencies with a range of 186-618 hz, except at frequencies 232.3 hz which has the longest working range of ozone formation at 4 - 7 kV voltage and a maximum production of 96 ppm. Figure (Fig. 4b) shows ozone production with an input voltage transformer of 20 volts. Ozone formation starts from a voltage of 4 kV stretching to a voltage of 8 kV with a maximum ozone production of 110.4 ppm ie at a pulse frequency of 232.3 hz. Longer ozone formation areas occur in ozone systems with a 25 volt transformer input voltage shown in figure (Fig. 4c), while maximum ozone production is 134.4 ppm.

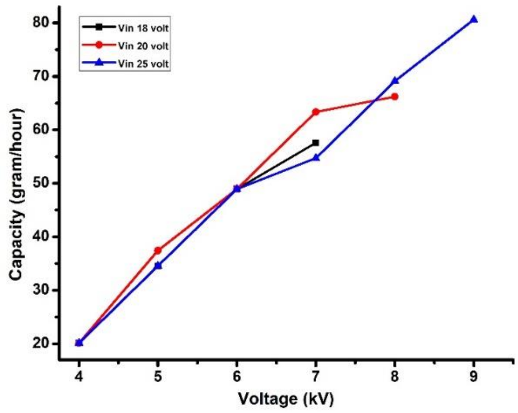

Figure 5. Capacity as function of voltage at frequency 232.3 hz

The effect of voltage on ozone concentration has the same trend in all transformer input voltage variations. While the influence of frequency on ozone formation is greatest at pulse frequencies of 232.3 hz for all transformer input voltage variations. At this frequency the minimum circuit impedance is possible which causes the current to reach a maximum value and the amount of micro discharge also increases so that the probability of ozone formation reaches its maximum value [10]. Figure (Fig. 5) is a graph of capacity as a function of voltage at a frequency of 232.3 hz with all variations of input voltage. Ozone capacity is calculated from the product of ozone concentration (grams/liter) with the input gas flow rate (liters/hour) [11]. At the same frequency and flow rate, ozone capacity is affected by voltage. The addition of voltage correlates the greater the ozone capacity produced, as well as the addition of the transformer input voltage. Input voltage variations of 18, 20, 25 volts produce ozone with capacities of 57.6, 66.24, 80.64 grams/hours, respectively.

4. CONCLUSION

The characteristics of ozone formation using DBD-configured cylinders at low frequencies have been obtained. The resonant frequency occurs at a pulse frequency of 232.3 hz. At the 18 volt input voltage, the working area of ozone formation starts from 4-7 kV with a maximum current value of 2.25 mA, requires a power consumption of 15.75 watts and produces a maximum value of 96 ppm ozone concentration with a capacity of 57.6 grams/hour. The 20 volt input voltage produces a maximum ozone production of 110.4 ppm and a capacity of 66.24 grams/hour, with the working area of ozone formation in the voltage range of 3-8 kV with a maximum current value of 2.54 mA and a power consumption of 20.32 watts. Whereas at the input voltage of 25 volts, the formation of ozone extends at intervals of 3-9 kV, the maximum current value is 3.08 mA capable of producing ozone at a maximum of 134.4 ppm with a capacity of 80.64 grams/hour and a maximum power consumption of 27.72 watts.

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