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Optimation of ozone capacity produced by DBD plasma reactor: dedicated for cold storage

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Abstract. The optimation of ozone production generator that used for cold storage has been done. Ozone generator was constructed by using Dielectric Barrier Discharge Plasma Reactor with single pyrex dielectic. Plasma was generated by HV AC with voltage from 0.5 kV to 11 kV, and frequence of 1 kHZ. This research was conducted in two treatment namely control treatment and ozone treatment by tuna fish, milkfish and shrimp. Ozone treatment are stored into Cold Storage (2 m x 2 m x 2.5 m), temperature (2^0C-8^0C) with average concentration of ozone distributed into the cold storage for 24 points is 6.2 ppm ± 0,14 ppm. The result showed that the optimum to generate ozone by using variations of power input, air flow rate. we obtained that the highest efficiency of 320 grams / kWh and ozone capacity of 65 grams / hour at 15 L / min flow rate with an input power of 210 watts. The concentration of dissolved ozone in the water containing fish and shrimp is almost the same that is equal to 2 ppm ozone flow for 60 minutes with ozone generator production capacity of 65 gram/hour. We test proximate of milkfish, tuna fish, and white shrimp that storaged in cold room (2^0C-8^0C), and we found that until days 15 still meet SNI 01-2729.1-2006, as fresh fish and shrimp**.**

1. Introduction

Ozone (O_3) is a triatomic oxygen molecule that is very unstable, with a very short life span (20-30 minutes). Ozone can be used as sanitation and disinfectant which can reduce and non-active bacteria, viruses, fungi and protozoa. Ozone can decompose quickly to produce oxygen and leave no residue in food [1,2,3]. The Food and Drug Administration (FDA), in 2000 has been agreed to the need for no ozone for food storage (Federal Register, 2001). The Food and Drug Administration (FDA), in 2000 agreed to the need for no ozone for food storage (Federal Register, 2001). Ozone formation can be produced by using a Dielectric Barrier Discharge (DHF) by using two electrodes which flow high electric currents in pure oxygen gas or air [4,5,6]. In general, the factors that influence the formation of ozone are the voltage, dielectric material, pressure, congfiguration of the plasma reactor system and the gas that is included in the plasma reactor. The mechanism of ozone formation is ionization, recombination, dissociation and association [7,8]

Some researchers have used ozone to maintain the freshness of fish as done by [2], with ozone water washing (2ppm concentration) using samples of hake fish (Merlucciusmerluccius) then stored in the cooler at 2ºC for 12 days. In [9] conducted a study of the application of ozone at an ozone concentration of 2.5 ppm given for 90 minutes in containers given ice slurry (40% and 60%) to maintain the quality of amino acids in puffed fish for 12 days of storage. [10] reported that 3.5 ppm ozone concentration with ice slurry (2: 3) can slow the formation of free fatty acid levels in tilapia for 16 days of storage with Organeleptic and TVBN values and TPC in fish still in accordance with Indonesian National Standards (SNI). Based on the research, further research is needed to influence the quality of fish and the most effective way to maintain the quality of fish freshness. In this paper researchers try to conduct fish preservation research using tuna, milkfish and shrimp which represent sea water, freshwater and crutasea fish in cold storage to determine the optimization of ozone production generators using Dielectric Barrier Discharge Plasma fed to cold storage as storage fish by testing the proximate value.

2. Methods

Materials and Methods research was divided into 4 stages. First, it begins with the characterization of ozone generators that use dielectric Barrier Discharge Plasma / DBDP. Second, the ozone produced is used to flow cold storage, the box for placing fish soaked with oozon water. Third, fish and shrimp are stored in the cooling room. Fourth, proximate testing of fish stored in a control cooling room and soaking treatment with dissolved ozone. DBD ozone reactor that has been made by (Teaching Industry - Dipo Technology Company, Semarang). Ozone reactors are made using Pyrex glass (herma) material with a thickness of 1.1 mm, a length of 23 cm, an inner diameter of 27 mm and an outer diameter of 31 mm. The ozone reactor is generated with a cylindrical congfiguration made of two stainless steel steel wires rolled on a pyrex tube and the air rate given is 10 L / min - 15 L / min with a voltage variation voltage to produce electric current. The characteristics of the ozone reactor system can be seen in Figure 1

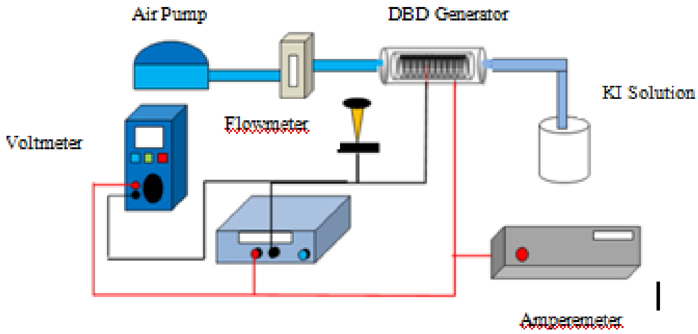


Figure 1. Schematic diagram of the ozone reactor equipment

Figure 2 shows the cold storage, the size of 3 x 3 x 4 m^3 as a fish storage area. The Cold Storage is equipped with an Ozone Generator (D'Ozone, Dipo Technology Company, Semarang) which was generated using a Dielectric Barrier Discharge at a temperature of 2-8^{o}C. In Cold Storage there are shelves that are used as a place to treat fish.

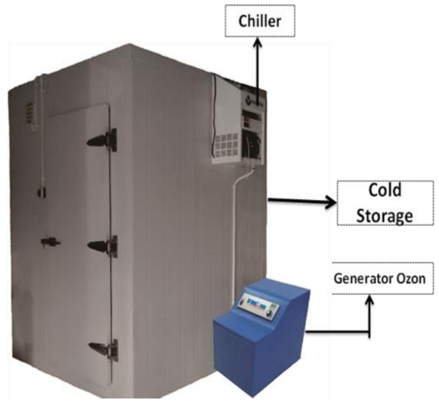


Figure 2: Cold storage, Ozone generator and Chiller

3. Result and Discussion

3.1 Electrical Chracteristic

Figure 3 shows the current and power characteristics as a voltage function. The greater the voltage applied, the greater the current and the power consumption produced. This shows that the AC voltage applied to the DBD (Dielectric Barrier Discharge) reactor will increase the amount of electric charge and the electric field changes in time union.

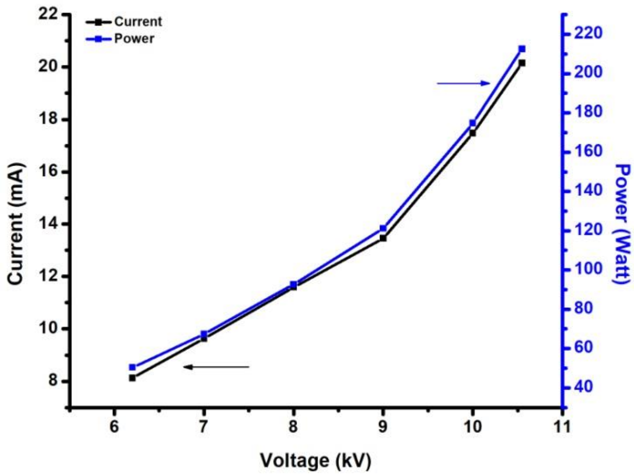


Figure 3 Current as a function of voltage and power as a voltage function

In the voltage current relationship of the graph it can be seen that the capacitive current follows the second order polynomial equation according to the modification of the Robinson equation followed by [7], mathematically written in theequation

$$I_S = \frac{2\,\mu_{RT}\varepsilon_t S}{d^3}\,(V - V_1)^2 \tag{1}$$

Where Is is the current of one constellation (mA), μRT is the carrier charge, ε_t is effective permittivity, d is the distance between electrodes (cm), V and Vi are the voltage and voltage limits . The current in a dielectric barrier plasma reactor is proportional to the square of the voltage shown in equation

$$I = 0.42\ V^2 - 4.37 + 19{,}38 \tag{2}$$

Power consumption is produced by the product of measured current (in milli watts) and the given voltage (in kilo Volts). In the power relation as a function of voltage, there is a very sharp increase in power at a voltage of 9 - 10 kV due to the occurrence of a drop electron (electronicvalance) which causes an unstable electric charge in the plasma. This can explain that in the reactor system there is an impedance with capacitance that changes at any time. From the image of the power hub as a voltage function, follow the 3rd order polynomial equation ($P \approx V^3$) which is shown in equation

$$P = 1{,}62\ V^3 - 34{,}47\ V^2 + 265{,}05\ V - 655{,}4 \tag{3}$$

Of the two tendencies of V influence on I with the influence of V on P can be concluded that in the DBD reactor does not apply law ohm.

3.2 Ozone Production Capacity and Efficiency

Ozone capacity is produced by the product of the concentration (gram / l) and air flow rate (l / h). Figure 4 shows the ozone capacity in various flow rates as a power function, ozone capacity increased significantly at a flow rate of 15 L / min to an input power of 210 watts with an ozone capacity of 65 grams / hour

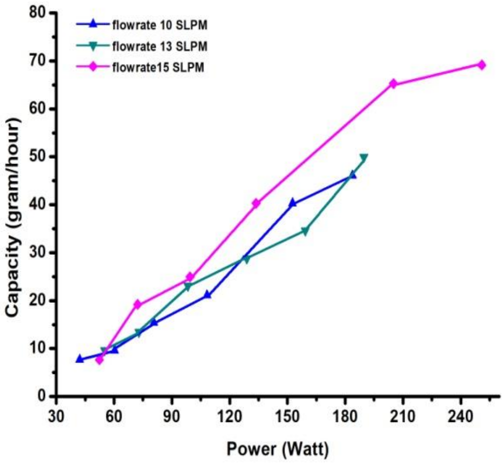


Figure 4. Ozone capacity as a function of reactor power for several flow rates

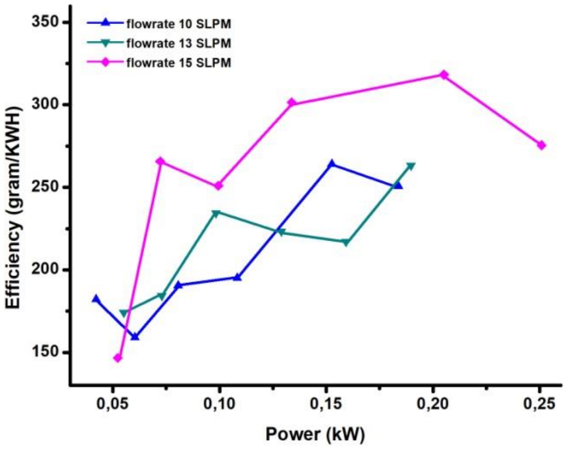


Figure 5. Ozone production efficiency as a function of reactor power for several flow rates

Figure 5 shows the efficiency of ozone production from a reactor that is affected by input power for several flow rates. This efficiency is strongly related to the ozone capacity produced. The reactor input efficiency is the amount of ozone capacity (in grams) for every kilowatt of input power. At a flow rate of 15 L / min the highest efficiency of 320 grams / kWh was produced

3.3 Ozone Treatments For Fishery

Ozone Fish were injected for 30, 60, 90 and 120 minutes into a box containing water where the sample was put in a box with a ratio of 1: 1 (w / v) placed in Cold Storage at a temperature of 20C - 80C. Solved ozone testing is carried out using an ozone test kit (Ozon same kit_CHEMETRICSINK). In Figure 6 shows the dissolved ozone concentration as a function of time, it can be seen that the ozone dissolution for 30 minutes results in an ozone concentration of 1.9 ppm, an increase of 60 minutes to 2.0 ppm, but decreases in the 90 minutes minute by 1.9 ppm and increased by 1.98 ppm for 120 minutes. It can be concluded that the optimal time of ozone dissolution into water is 60 minutes. Next the samples (tuna, milkfish and shrimp) were soaked with ozone-dissolved water for 60 minutes in the morning and 60 minutes in the afternoon. In general, the results of ozone soak treatment are always better than controls.

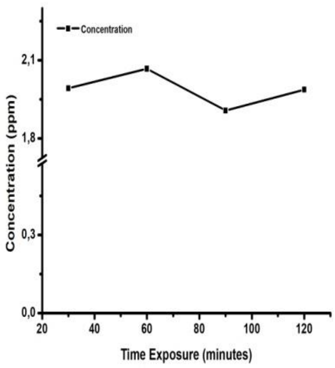
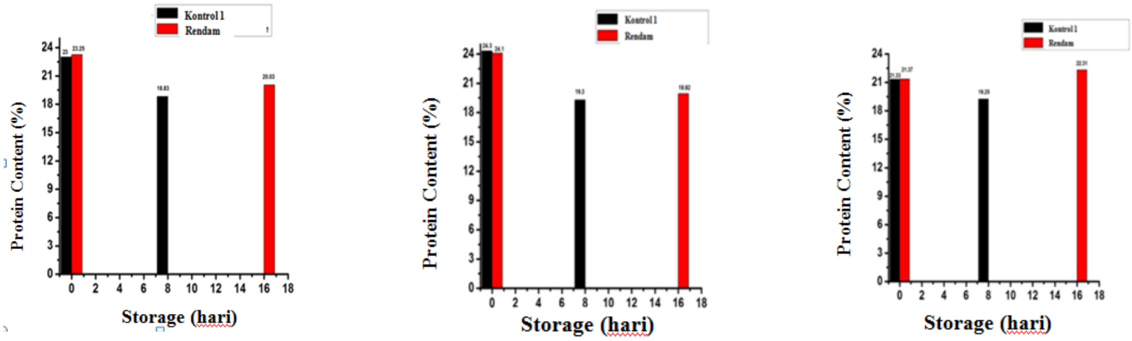


Figure 6. Dissolved ozone concentration as a function of time



a. Milkfish **b. Tuna Fish** **c. Shrimp**

Figure 7. Protein content in (a) milkfish, (b) tunafish, and (c) shrimp as a function of time storage

Tests conducted are proximate tests (protein test) in the control and treatment of ozone baths at the beginning and at the end. Figure 7 shows the results of the ozone treatment soak can retain fish and shrimp for 15 by 20.03% of storage and control days for 8 days at 18.83%.

4. Conclusion

The optimum to generate ozone by using variations of power input, air flow rate. we obtained that the highest efficiency of 320 grams / kWh and ozone capacity of 65 grams / hour at 15 L / min flow rate with an input power of 210 watts. The concentration of dissolved ozone in the water containing fish and shrimp is almost the same that is equal to 2 ppm ozone flow for 60 minutes with ozone generator production capacity of 65 gram/hour. Ozone can be applied to fish storage by proximate tests according to SNI standards SNI 01-2729.1-2006 for 15 days of storage at temperature (2^0C-8^0C) in Cold Storage.

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