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Comparative study of the voltage generation in microbial fuel cell chambers based on different wastewater test

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ABSTRACT –This paper provides the comparative study of the voltage generation for Microbial Fuel Cell (MFC) chambers based on different wastewater test. Several test systems, including single chamber MFC and double chamber MFC with conventional electrodes are used to measure the voltage produced by three types of wastewater, i.e., fertilizer water, lake water and soil water. The experimental results indicate that the fertilizer water with double chamber MFC is more effective in producing electricity compared to soil water and lake water.

1. INTRODUCTION

Recently, harvesting energy from waste water called Microbial Fuel Cell (MFC) becomes one of the popular topic due to the significant increment of waste water population [1]. MFCs is a type of fuel cell that use microorganism that live inside the wastewater and certain electrochemical reaction to generate electricity [2]. MFCs can continue to produce the electricity as long as the microorganism are alive and active. With the continuous supply of food, the microorganism can continue live and reproduce. Besides, MFCs also does not produce harmful waste thus are environment friendly [3]. In MFC, the microorganism is a structure in biofilm and live in close contact with the electrode. An adaptation or change of the microbial community will influence the biofilm structure and properties. In a suitable environment, the microorganism can be active and reproduce hence increase the voltage output by MFC. Different types of wastewater can affect the reproduction of microorganism. Electricity is produced via an electron movement from a decaying certain material in the wastewater.

2. MATERIAL AND METHOD

2.1 Microbial Fuel Cell Chambers

Two types of MFC chambers are used in this study to compare the effectiveness of the MFC in producing the electricity. For the single chamber MFC, a single container with radius of 6 cm and length of 12 cm is used, where it can store up to 1357 cm^3 volume of water as shown in Figure 1. The anode is placed beneath the container while the cathode is mounted on the water. The anode and cathode are made from copper with dimension of 6 cm in width and 6 cm in length, which gives the surface area of 36cm^2.

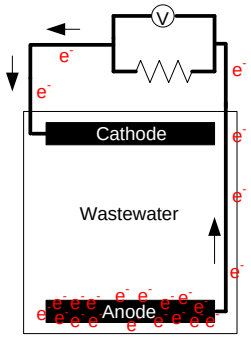

Figure 1 Single Chamber MFC.

In double chamber MFC, two containers are constructed using the same dimension as in the single chamber MFC. These two containers are connected to the proton exchange membrane (create from NaOH), where both anode and cathode were installed in the container to collect the electrodes, as shown in Figure 2. The anode anaerobic and cathode anaerobic chambers are filled with wastewater and distilled water, respectively. The reaction between the flow of electron in anode and the flow of proton in cathode sides would form water at cathode as illustrated in Figure 2.

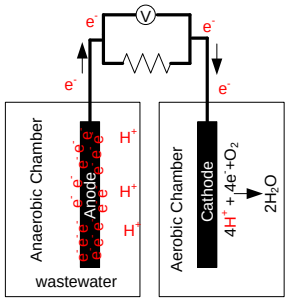

Figure 2 Double Chamber MFC.

2.2 Operational Condition

The MFCs were operated at a room temperature of 25±3°C with pH value range for the wastewater should be around 6.5 to 8.5 to keep the microorganisms alive inside the wastewater. In this experiment, both single and double chamber MFCs were tested for a week with different types of wastewater, where the measurement outputs such as voltage and current were recorded for every 24 hours.

2.3 Types of Wastewater Test

For the comparative study of multi-chamber MFC, three types of wastewater are used namely fertilizer

water, lake water and solid water in order to identify the effectiveness of the wastewater in producing energy.

From the measured output, the current density and power density are calculated by using the following Equation (1) & (2):

$$P_d = \frac{P_{out}}{A} = \frac{V_{out} I_{out}}{A} \quad (1)$$

$$I_d = \frac{I_{out}}{A} \quad (2)$$

Where:

P_d = power density
P_{out} = power output
I_d = current density
I_{out} = current output
V_{out} = voltage output
A = surface area

3. RESULT AND DISCUSSION

3.1 Single Chamber MFC

Figure 3 shows the performance of waste water test for single chamber MFC. The result shows that the fertilizer water outperforms lake water and soil water with higher power density value. This is due to the amount of microorganism produce in fertilizer water that compose by the microbe and bacteria.

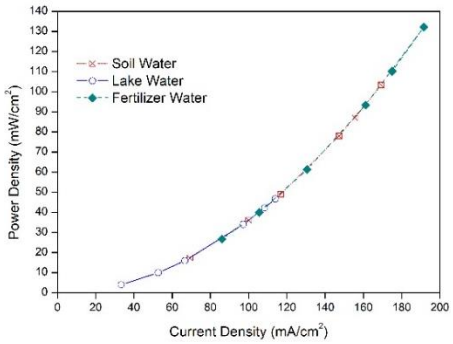

Figure 3 Performance of waste water test for single chamber MFC.

3.2 Double Chamber MFC

Using the similar procedures with single chamber MFC, the double chamber MFC is then tested with the same types of wastewater. This experiment aims to validate the effectiveness of wastewater types with different dimension of MFC chamber. Figure 4 plots the comparison of the power density for fertilizer water, soil water and lake water. It can be seen that the power density of the fertilizer water is higher than lake water and soil water. Therefore, the finding prove that the fertilizer water is the most effective type of wastewater in producing voltage compared to soil water and lake water.

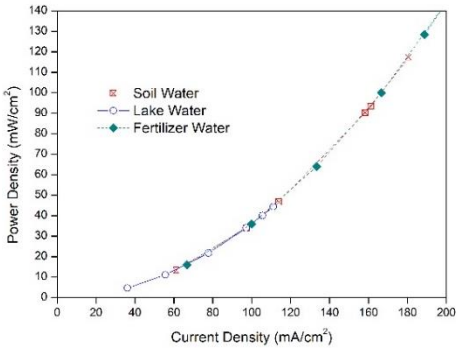

Figure 4 Performance of waste water test for double chamber MFC

Table 1 Comparison of MFC chambers

Single Chamber		
Water	**Power Density(mW/cm²)**	**Current Density (mA/cm²)**
Fertilizer	77.35	141.67
Soil	61.81	126.39
Lake	25.50	78.70
Double Chamber		
Water	**Power Density(mW/cm²)**	**Current Density(mA/cm²)**
Fertilizer	82.08	143.06
Soil	65.87	128.70
Lake	26.03	80.56

Table 1 summarizes the output of single and double chamber MFC based on wastewater test. The result imply that fertilizer water is the most effective wastewater to produce electricity. From this table, it can be seen that the outputs from double chamber MFC are higher as compared to single chamber MFC. Thus, the findings indicate that the productivity of voltage in MFC can be improved by using multi-chamber MFC. This is due to the increment of surface area in MFC.

4. CONCLUSION

The findings show that the fertilizer water can produce more electricity compared to soil water and lake water. In addition, it is found that the double chamber MFC provides more voltage as compared to the single chamber MFC. Future work should consider the investigation on the effect of different electrodes in MFC.

5. REFERENCES

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