

# THE PROSPECT OF ALTERNATIVE ENERGY RESOURCE BY SUPPORTED ELECTRICAL SYSTEM BASED ON MICROBIAL FUEL CELL TECHNOLOGY OF SMALL INDUSTRIES IN INDONESIA

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## 1 General Introduction

Indonesia as a developing country has many small industries which was produced harm waste to environment [4]. It was have to be utilized so that could gave advantage. Example, Microbial Fuel Cell (MFC) technology was applied to waste could reduced a harmful characteristic of waste and produced electrical energy. Those energy was provided by microbe metabolism activity which was motivated electron transfer processed from anode surface in MFC system [11].

The aim of this researched was to explored potency of waste as remained activity from small industries to produce electrical energy with PT. ABC Indonesia cased.

## 2 Methodology

### 2.1 Preparation of Sample

#### 2.1.1 Measurement of pH and *Optical Density* (OD)

Waste obtained immediately measured pH and dissolved oxygen (*Dissolved Oxygen/DO*) waste making its location using a digital pH meter and DO meter.

#### 2.1.2 Nafion 117 Activation

Nafion 117 membrane was boiled in distilled water for one hour, then boiled again

in the membrane in 3% H<sub>2</sub>O<sub>2</sub> for one hour, then boiled again in 0.5 M H<sub>2</sub>SO<sub>4</sub> for one hour, then washed three times with distilled water and soaked in distilled water until it will be used.

#### 2.1.3 Neutralitation Carbon Electrodes

Carbon electrode obtained from batteries graphite stone soaked with 1N HCl for 1 day, rinsed with distilled water, then soaked with 1N NaOH for 1 day, rinsed with distilled water, and soaked in aquadest to be used

## 2.2. Sample Potential Difference Measurements

Sample solution was inserted into the anode vessel and the solution of potassium ferricyanide (K<sub>3</sub>Fe(CN)<sub>6</sub>) which inserted into the cathode vessel. Previously, ion exchange membrane mounted on the valve connecting the two vessels. Graphite electrodes in both vessel mounted and connected with wires and sealed vessel. The two cables, both from the cathode and anode, connected with the multi meter. Multi meter set to measure the voltage at the smallest scale first and then the voltage value indicated on the multi meter screen was observed at a certain time interval. Observations on the potential difference was conducted every 15 minutes, until the measured potential difference was relatively constant. Potential difference measurements performed on a series of parallel and series system (Figure 1 and Figure 2)



Fig. 1. MFC in a parallel circuit

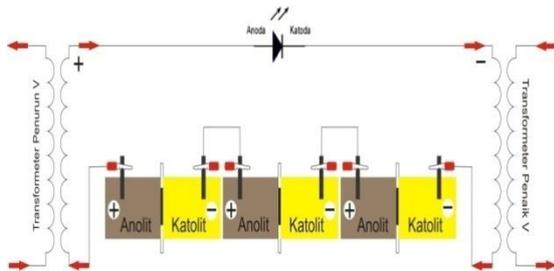


Fig. 2. MFC in a series circuit

### 3. RESULTS AND DISCUSSION

#### 3.1 Measurement of pH and *Optical Density* (OD)

pH measurements before treatment at pH 7.5 and then decreased after the waste being subjected to the MFC system. Initial DO measurement of a sample of shrimp effluent by 0.95 mg/L, which means the waste is not removed directly into the environment. After the waste being subjected to as anolit in MFC systems for 1 days, there was an increase of DO in the wastewater to meet standards for environmental quality standard 3 mg/L. According to Government Regulation No.20 year 1990 about the Environmental Quality Standard, criteria which may be liquid waste is discharged into the environment must have a DO, a minimum of 3 mg /L.

#### 3.2 Sample Potential Difference Measurements

##### 3.2.1 MFC circuit in parallel

Test results show the electrical energy which is detected in wastewater samples of 0.89 mV shrimp paste, while in pure liquid

culture of *B. subtilis* and the blank of distilled water, and a row of 83 mV and 124 mV. Graph showing the relationship between the time a voltage generated by the wastewater sample is shown in Figure 3 shrimp paste.

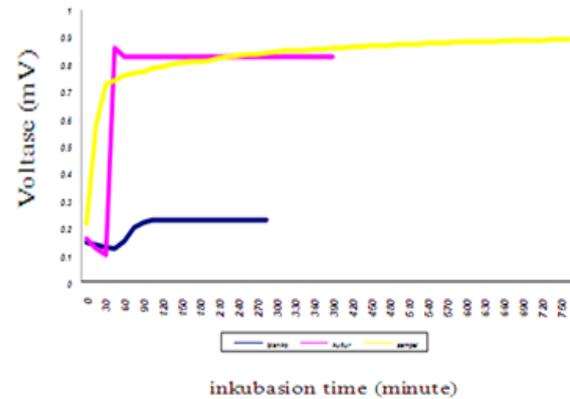


Fig. 3. Graph showing the relationship between the time a voltage generated by the wastewater system shrimp paste parallel

##### 3.2.2 MFC circuit in series

Potential difference generated by MFC series circuit system of 2 volts, greater than the parallel system (Figure 3). This is caused by vessel series MFC system capable of functioning as a charge storage (capacitor) [2]. Loads are given as additional potential difference recorded by the system. This is indicated by the value measured by the multi meter after an additional potential difference is disposed of. Consumption of electric energy generated by the system makes the resulting potential difference decreases. However, at some point the potential difference increased again. This increase indicates that the system is able to restore their own electrical charge. In ordinary capacitor, electric charges remain at a certain value after use. MFC system with the ability to recharge the vessel series without treatment of the electrical charge from the outside is the potential to be expanded [10]

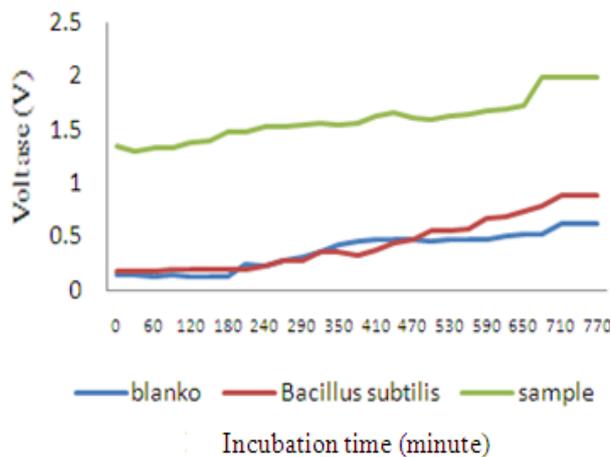


Fig. 4. Graph showing the relationship between the time a voltage generated by the wastewater system shrimp paste series

### 3.3 Identified of Microbe

Results of identification by BiOLOG® shows that the highest microbial consortium contained in shrimp waste is Gram-positive bacterium *Bacillus subtilis*. Reference [5] show to *B. subtilis* using a substrate to oxidize the liquid waste enters the cytosol of bacteria or body cells. Furthermore, will occur in three stages cellular respiration. The first phase, the molecules of organic fuels, such as glucose, fatty acids and some amino acids will be oxidized to produce 2-carbon fragments, namely the acetyl group from acetyl-CoA. Phase two, in aerobic conditions acetyl-CoA entering the citric acid cycle which will describe these molecules enzymatically generate high-energy hydrogen atoms and release CO<sub>2</sub>. The third stage of respiration occurs at the bacterial cell membrane. Hydrogen atoms are separated by an electron carrier molecules, ie the respiration chain to molecular oxygen and is reduced to H<sub>2</sub>O.

In the liquid waste can be found many kinds of fish paste microbial, but not all can be grown in microbial growth media of bacteria in the laboratory. In this experiment *B. subtilis*

that dominated the growth in nutrient agar media. In the MFC system, microbial contained naturally in the wastewater is used for producing fish paste electrical energy through a reaction that allows the transport of protons due process of cellular respiration of the cell surface to the anode. As a comparison, we used liquid culture of *B. subtilis*.

### 3.4 Voltage of Series and Parallel MFC System

Potential difference on a series system of vessels is larger than the series system, which wa 2 Volt. Potential difference generated by a microbial consortium during the measurement at MFC system is unstable. Its value fluctuates at each observation time. This is also related with microbial metabolic activity present in the wastewater. In catabolism activity, some of the energy produced when the complex compound is broken down into simpler compounds. Conversely, some of the energy used during simple compounds are synthesized into complex compounds. Both these types of metabolism occur simultaneously. At a certain time in general (scale microbial consortium) the excess of the total energy produced and used can be increased or decreased, depending on the reaction progress [7]. In addition to its metabolic activity, the potential difference fluctuations also caused by the interaction between the microbial consortium compiler. Fermentation products (such as lactic, succinic, format, etc.) from one type of bacteria can be a substrate for other bacterial species. This causes the fermentation product can not be oxidized to produce free electrons and ions H<sup>+</sup>. The electrons flow from the anode to the cathode is reduced so that the measured potential difference is reduced [1].

Test results show the electrical energy which is detected in wastewater samples of shrimp paste 2 volts, while in pure liquid culture of *B. subtilis* at 83 mV. The magnitude of the voltage measured in the culture of *B. Subtilis* value continues to decline. This is due to a single culture at one time experienced a

growth phase until stationary phase is not produced anymore as a result of death of protons out of cells due to cellular respiration. Therefore, in the form of a consortium of microbial cultures such as those found in shrimp paste liquid waste produced measurable voltage longer.

Increase or decrease in electrical potential difference correlated with the number of free electrons generated by a microbial consortium. Increasing the potential difference measured by the multi meter may happen when the microbial perform simple substrate solution contained in the medium. As for its decline, other than because anabolism activity, the possibility can also occur because of microbial substrate being adapted to break down more complex becomes simple. The increase and decrease in electrical potential difference on the MFC system describes the system as driven by the dynamism of living things.

### **3.5. Potency of Small Industries to Support Renewable Electrical Energy**

Each year, Indonesia produce a lot of waste organic [3] which is not having treatment process [4]. It is become potency to use it to produce electrical energy by MFC technology. This treatment also keep DO value so correct with environment procedure.

Measuring of pH and DO value shows 6,8 and 3 mg/L which is had match with legal environment in Indonesia, PP No.20 tahun 1990 about Standar Baku Mutu Lingkungan. Before it, pH and DO value shows 7,5 and 0,95 mg/L.

MFC systems is one of converter of organic biomass become bio product and bio fuel beside bio ethanol, biogas, and hydrogen gas. Reference [10] shows MFC system has a good efficiency converse which almost reach 100%. It is difference with efficiency converse value of bioethanol is 10-25%, biogas is 80%, and hydrogen gas is 90%.

## **5. CONCLUSION**

Shrimp paste waste was rich of organic material so that can used by microbe as substrate. Microbe respiration process will produce electron and proton which can use in MFC system. This system have a good efficiency value to convert organic biomass become bio fuel. It is Indonesia potency which can developed as small industries based country.

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