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Microbial Fuel Cell (MFC) based Sewage Treatment Plants (STP)

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ABSTRACT
Microbial Fuel Cell (MFC) is the device that converts chemical energy to electrical energy by using microbes that has inside the waste water. The energy contained in organic matter can be converted to useful electrical power. MFC can be operated by microbes that transfer electrons from anode to cathode for generating electricity. Electrode that be used in this project is carbon as anode and aluminum as cathode. The Sewage Treatment plants (STP) are ideal for the type of bacteria that can be used in an MFC. MFC will continuously to be operated as it generates electricity from the bacteria contained in the wastewater. The optimum output voltage for a small scale is near to get 1V.The advantages of this product are can help to reduce cost of bill for lighting plant and save electricity for compound lighting at residential area. STP is not only sewage treatment, but it will become a power plant to generate electricity.

Keywords *– Microbial Fuel Cell, Microbes, Sewage Treatment Plants*

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I. INTRODUCTION

Microbial Fuel Cells is a device that harnesses the power of respiring microbes to convert organic substrates directly into electrical energy. MFC is a fuel cell, which transform chemical energy to electrical energy using oxidation reduction reaction (redox). Sewage Treatment Plants (STP) are ideal for the types of bacteria that can be used in an MFC. MFC can apply at aeration tanks. This is because the process of aeration tanks is to breakdown the organic material in sewage, bacteria require oxygen. Solids in the sewage are held in suspension by the bubbles and bacteria in the sewage break down organic materials. The sludge is drawn off with some being returned to the aeration tank to ensure enough bacteria are present in the tank to continue the process of breaking down newly introduced sewage.

MFC will continuously to be operated as it generates electricity from the bacteria contained in the wastewater. The bacteria works as a renewable energy which it always presence as human lives in this world will produce wastage in daily life. The bacteria will only go extinct when human never produce wastage anymore. Every resident must have their own sewage treatment plant, so the sewage plant gets continues sewage to produce every day, so it's easy to supply the electric.

In a MFC, organic matter is oxidized by microbes and electrons are produced. The electrons are then transferred to a terminal electron acceptor (TEA) which is reduced by the electrons. TEA's such as oxygen, nitrate, and sulfate can diffuse into the cell and accept electrons to form new products that leave the cell. However, some bacteria can transfer their electrons outside the cell (exogenously) to the awaiting TEA. It is these bacteria that can produce power within an MFC system.

Electrons and protons are produced through the oxidation of organic matter. The electrons are transferred to the anode electrode, in the anode compartment, and travel through wire to the cathode electrode, where the wire is connected from the anode compartment, oxygen to form water. A catalyst at the cathode must be used to facilitate this reaction. These reactions produce carbon dioxide, from the decomposition of the organic matter, and small amounts of water at the cathode. Using glucose as an example of an organic substrate, 24 electrons and 24 protons are released in the anode chamber. These protons and electrons both travel to the cathode chamber where 6 molecules of oxygen are needed to create 12 water molecules. Six carbon dioxide molecules are created at the anode.

Anode reaction: $CH_3COO^- + 2H_2O \rightarrow 2CO_2 + 7H^+ + 8e^-$

Cathode reaction: $O_2 + 4e^- + 4H^+ \rightarrow 2H_2O$

II. Objective and scope

The prominent objective of accomplishing this project is to develop a Microbial Fuel Cell based (MFC) on Sewage Treatment Plants (STP). Other objectives are:

1. To find optimum voltage from MFC.

2. To help reduce those costs by producing electricity.

The main scope of this project focuses of MFC by using waste water in aeration tank of sewage treatment plants (STP). Type electrode that be used are aluminium as cathode and carbon as anode. The electrons then move across a wire under a load to the cathode where they combine with protons and oxygen to form wastewater. When these electrons flow from the anode to the cathode, they generate the current and voltage to make electricity.

III. Material and Method

This project flow is used as a guide to complete this project. First of all, the project is started with background study about microbial fuel cell. Upon completion of research, hardware development began with electrode analyzing followed by try and error. Once get a best result between two electrodes. Then, proceed this project with construct the voltage regulator circuit by simulation in Proteus v7.0. Fig.1 demonstrates the project flow chart. Lastly, design the prototype.

The MFC reactor was design and fabricated from plastic material. The electrode is also the main part of this project. It consisted of two electrodes for the anode and cathode compartment. In this project, metal that be used only carbon and aluminum. In the wastewater have oxygen and hydrogen. It easy to produce the oxidation and reduction reaction when plug in the electrode inside the wastewater. In this project is only a small scale that be used, which is two liter of wastewater. The cathode and the anode are connected with an voltage regulator circuit as shown in Fig.3 by using connecting wires. A computerized digital multimeter is connected to circuit to measure and record the open electric voltage produced by the electric flow in the MFC throughout the process. The period that taken was in 48 hours.

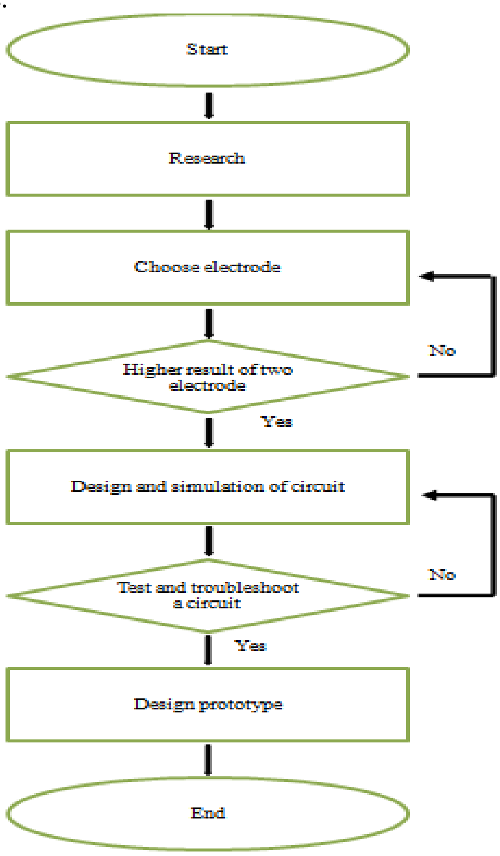

Fig.1 Flow chart for this project

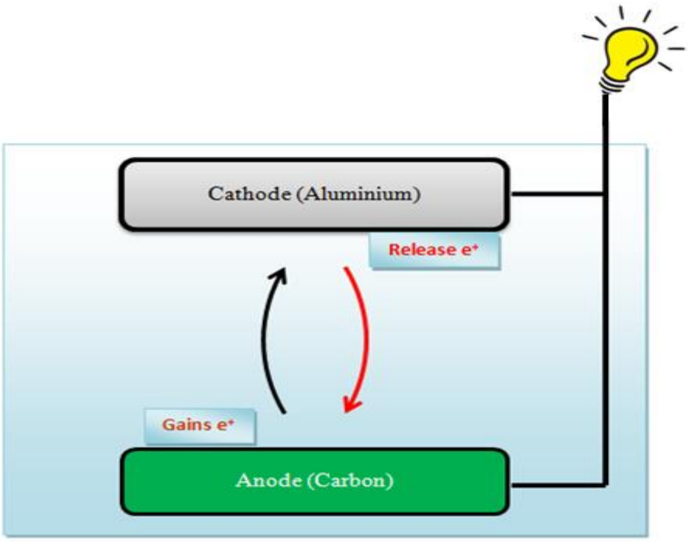

Fig.2 Schematic of MFC

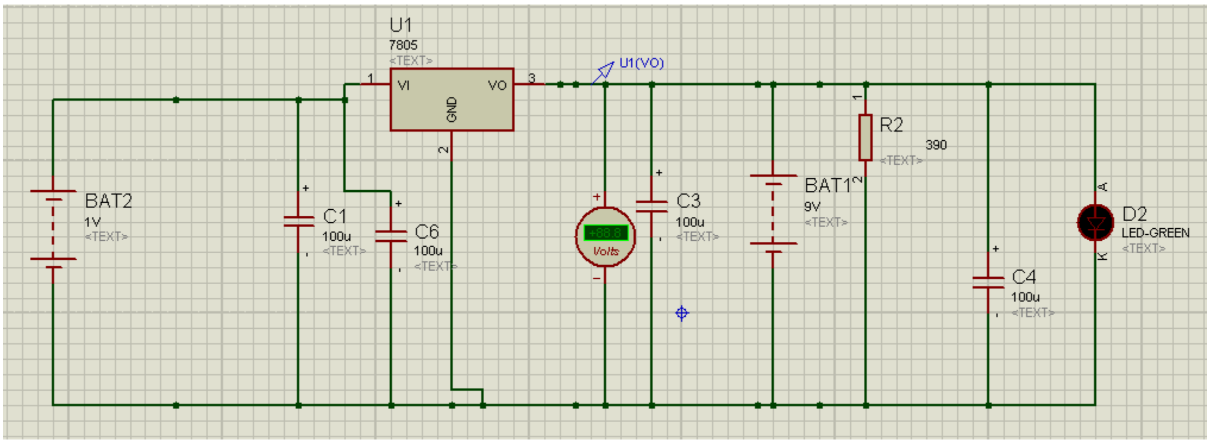

Fig.3 Voltage Regulator Circuit

IV. RESULT AND DISCUSSION

Based on Fig.4 the voltage recorded at the beginning of the study is 0.86V. According to the pattern of the graph shown, the voltage generation start to stabilize 10 hours after the MFC is operated, which mean that the formation of microbes on the surface of electrode took place in 10 hours for MFC operation. After the formation of microbes on the surface of electrode, the rate of voltage decreases because the competition occurs between the microbes to obtain their food from organic matter and nutrients in the waste water treatment. This phenomenon affect the rate of voltage produced becomes lower compared with the beginning of the MFC operation. The graph pattern shown by the operation of the MFC is consistent due to the efficiency of the reaction at the cathode. Another effect that consistency the voltage is the efficient rate of proton transfer to cathode, which helps in completing the electrical circuit.

Based on the analysis done on this project, microbes need energy to survive, in the same way that humans need food to live. It is know that microbes will grow as long as there is an abundant supply of nutrients. The rate of microbes' metabolism at the anode increase when the electrical potential of the anode increases. Accordingly, to get the high voltage of waste water it must keep on replenishing the waste water at regular intervals.

In other words, the phenomenon of voltage drop of MFC should not is regarded as a mere natural electrical phenomenon. It should be appreciated from the perspective that voltage drop is taking place owing to the metabolism of microbes inside wastewater of MFC [4]. More nutrients the microbes get, the more current generation would take place.

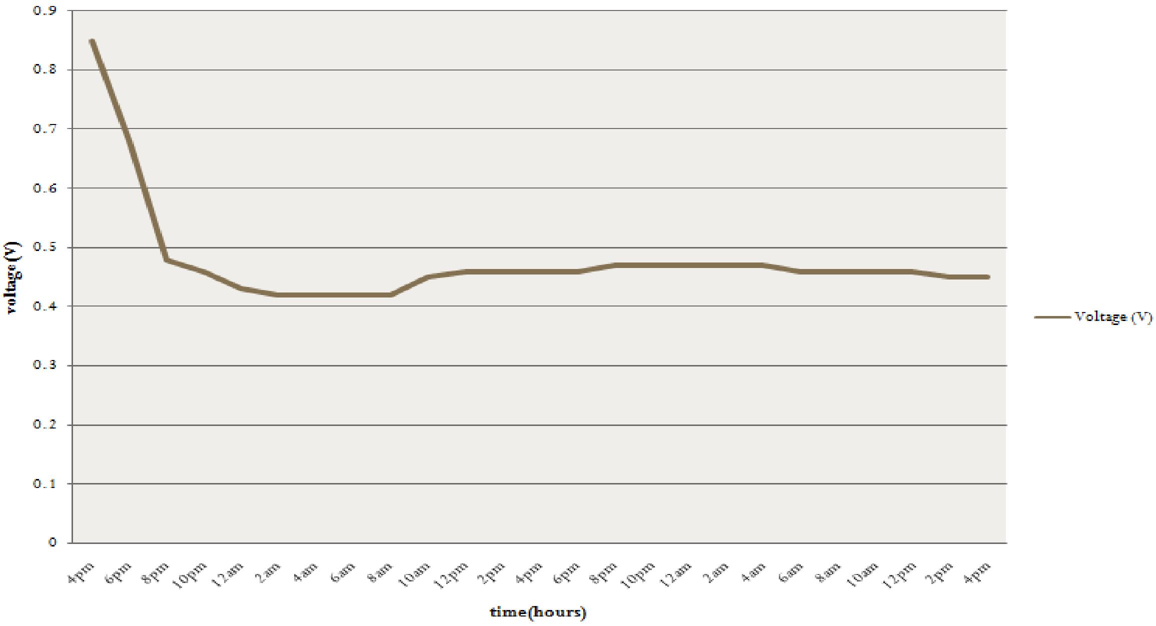

Fig.4 Graph of voltage against times

V. CONCLUSION

The MFC has the ability to generate electricity from the wastewater. The highest rating of voltage is 0.85V. Besides, based on the graph pattern generated, wastewater from Sewage Treatment Plants (STP) most consistent record for electricity generation. In real life, for 3350 PE (population equivalent) has two aeration tanks and total of a volume is 565.5m^3. For each aeration tank, the volume is 289.44m^3 it same in liter which is 289440. So it can assume that each aeration tank can produce 123.01 kV. Its output can help to reduce cost of bill for lighting plant and save electricity for compound lighting at residential area.

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