



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF PICO ENERGY GENERATION  
VIA LEACHATE WATER AS FUEL (REACTOR  
DESIGN AND HARDWARE)**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of the Electrical Engineering Technology (Industrial Power) with Honours.

by

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## **APPROVAL**

This report is submitted to the Faculty of Electric and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

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## ABSTRAK

*Permintaan tenaga di dunia ini adalah permintaan yang sangat tinggi dan memicu kecemasan tenaga di seluruh dunia dan pencemaran dunia ini. Penggunaan gas fosil dan minyak kuasa tidak dapat dikekalkan kerana bekalan yang terhad dan melampaui kesan terhadap sistem ekologi. Di Malaysia, sumbangan tenaga utama adalah dari arang batu dan tenaga jenis ini akan melepaskan pelepasan karbon yang akan menghasilkan pencemaran udara. Pada masa kini, penganalisis menumpukan perhatian pada sumber tenaga boleh diperbaharui dan bebas pencemaran yang penting untuk kebolehan semulajadi dan kewangan. Sel bahan bakar mikrob adalah reaktor yang memanfaatkan kuasa mikrob berulang untuk menukar substrat organik terus ke dalam tenaga elektrik. Pada masa kini, penganalisis menumpukan pada pilihan, sumber tenaga boleh diperbaharui dan hijau yang penting untuk kebolehan semulajadi dan kewangan. Sel bahan bakar mikrob membuang mikrob anaerobik kerana lampiran bakteria pada elektrod yang digunakan untuk menghasilkan tenaga elektrik dan merawat air sisa. Terdapat banyak reka bentuk yang dicadangkan oleh penyelidik untuk meningkatkan output kuasa sel bahan bakar mikrob seperti double chamber, single chamber, stacked, upflow dan cassette electrode sel bahan bakar mikrob. Reka bentuk yang berbeza mempunyai kecekapan yang berbeza. Beberapa ujian telah dijalankan untuk menganalisis prestasi sel bahan bakar mikrob.*

## **ABSTRACT**

The request of energy on this world is quite high demand are triggering the worldwide energy emergency and the pollution of this world. The using of fossil gas and powers oil are unsustainable because of the limited, exhausting supplies and effect on ecological system. In Malaysia, the major of energy contribution is from coal and this type of energy will release the carbon emission that will produce air pollution. Nowadays, analysts are concentrating on option, renewable and green energy sources which are essential for natural and financial supportability. Microbial fuel cell is a reactor that harnesses the power of respiring microbes to convert organic substrates directly into electrical energy. Nowadays, analysts are concentrating on option, renewable and green energy sources which are essential for natural and financial supportability. The microbial fuel cell removes the anaerobic microbes because attachment of the bacteria to the electrode that used to generate electricity and treat the wastewater. There are many designs were proposed by the researcher to enhance the power output of microbial fuel cell such as two-chamber, single chamber, stacked, upflow and cassette electrode microbial fuel cell. Different design has a different of efficiency. Several tests have been conducted to analysis the performance of the microbial fuel cell.

## **DEDICATION**

To my beloved parents

To my kind supervisor

To my irreplaceable family

To all my friends

Thank you for all their love, sacrifice, and encouragement throughout my life.



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I sense this opportunity as a big chance in my career development. I will attempt to use gained skills and knowledge in the working environment. It inspired me to be more creative in develop new technology that will help to improve our daily life.

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## LIST OF SYMBOLS

<b>m<sup>3</sup></b>	–	Meter cube
<b>ml</b>	–	Mililiter
<b>kw</b>	–	Kilowatt
<b>cm</b>	–	Centre meter
<b>l</b>	–	Length
<b>A</b>	–	Ampere
<b>V</b>	–	voltage
<b>mW</b>	–	miliwatt

## **LIST OF ABBREVIATIONS**

<b>MFC</b>	Microbial Fuel Cell
<b>LED</b>	Light Emitting Diode
<b>BOD</b>	Biochemical Oxygen Demand
<b>PEM</b>	Proton Exchange Membrane
<b>UMFC</b>	Up-Flow Mode Microbial Fuel Cell
<b>COD</b>	Chemical Oxygen Demands
<b>PTFE</b>	Polytetrafluoroethylene
<b>CEMFC</b>	Cassette Electrode Microbial Fuel Cell
<b>SMFC</b>	Stacked Microbial Fuel Cell
<b>SCMFC</b>	Single Chamber Microbial Fuel Cell
<b>DCMFC</b>	Double Chamber Microbial Fuel Cell

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Microbial Fuel Cells (MFC) is a cell that improve the power of respiring microbes to change organic substrates into electrical energy. MFC is a fuel cell that will convert chemical energy to electrical energy by using oxidation reduction reaction (redox). Microbes will be oxidized to produce electrons. The electrons are transport to a terminal electron acceptor (TEA) that will be reduced by the electrons. TEA's such as oxygen, nitrate, and sulphate will diffuse into the cell and accept electrons and form a new product that leave the cell. However, some bacteria can transfer their electrons outside the cell to the awaiting TEA [1]. These bacteria are the bacteria that can generate power within an MFC system. Electrons and protons are produced through the oxidation of organic matter. The electrons are then delivered from the anode electrode and through wire to the cathode electrode. A catalyst at the cathode can be used to make up this reaction which these reactions will produce carbon dioxide, from the decomposition of the organic matter and small amounts of wastewater at the cathode.

### 1.2 Statement of the Purpose

The purpose of the project is to develop a microbial fuel cell (MFC) reactor for a wastewater treatment that can produce electricity to power up the waste water plant and treat the waste water and save the environment.

### **1.3 Problem Statement**

The energy demands in Malaysia are increasing due to the population growth and technologies that used electric to support daily life performance. The major contribution in generating the electricity is from coal which is nearly half of the electricity generator came from coal. The coal will release carbon emission which will cause air pollution to the environment and furthermore it is not a renewable and green source. So, this country needs a new technology that are renewable and green source that do not harm the environment.

The used of energy in wastewater treatment and the cost for water treatment is high. Besides, the current wastewater treatment plant technology is unable to meet with ever growing water sanitation needs cause by fast industrialization and population growth and it is not suitable for future water treatment. Plus, the current technology is not a green technology innovation which is green technology will give more benefit in present and the future.

### **1.4 Scope**

For the size of this MFC reactor, it will be a 30 x 10 x 8 cm and the max volume of wastewater to be filled in the reactor will be 1500 ml. This reactor will be design to produce an energy output. The wastewater will be using the Sungai Melaka wastewater.

### **1.5 Objective**

1. To analysis and select the best design of microbial fuel cell reactor to be implemented on the hardware.
2. To analysis and select the properties that enhance the output of the hardware.

3. To construct the hardware based on the reactor and properties that selected.

## **1.6 Project Significance**

Project significance for this project are the development of microbial fuel cell for wastewater treatment can make a less energy use to treat the water and it is producing electricity. Despite, the development of microbial fuel cell for wastewater treatment can contribute to the solution of the problem on reducing energy and cost of the wastewater plant. This project also can make a new development in wastewater treatment plant and applying a green technology which is suitable to developing country like ours. This project will act as an industry driven project and can be a commercialized product in the future.

## **1.7 Expected Output**

The project aims to reduce the use of energy on the wastewater treatment plant and treat the water by developing a microbial fuel cell. This microbial fuel cell expected to produce enough electricity to power up the water motor pump and the lighting of the plant. Besides, the MFC reactor will be developed to be a changer to a green technology in the wastewater treatment plant.

## **1.8 Structure of Report**

Chapter 1 explain about the introduction of the microbial fuel cell, what is microbial fuel cell? And how the microbial fuel cell will be used as technology to treat wastewater and produce electricity. Besides, it will state the objective, problem statement and expected output when developing the microbial fuel cell. Chapter 2 cover the

literature review of the microbial fuel cell. While chapter 3 explain about the flow of the project on how to make the project step by step. Chapter 4 cover the experiment of microbial fuel cell reactor and will explain in detail about the part of design that will enhance the power output from the reactor design.

## **1.9 Chapter Summary**

This chapter cover the introduction of microbial fuel cell for wastewater treatment. The development of microbial fuel cell for wastewater treatment can give benefit in promoting the green technology in our country. Besides, it will make the cost for wastewater treatment reduced. Chapter two covers the literature review and project methodology which gives an overview of microbial fuel cell, design of microbial fuel cell, part that will enhance the energy output, water treatment and current systems.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter contains the literature review about topics relevant to the development of a microbial fuel cell (MFC) for wastewater treatment. It presents an overview of microbial fuel cell and their interaction with electricity and wastewater. Besides, the using of microbial fuel cell in wastewater treatment will be a significant technology in our country.

#### 2.2 Microbial Fuel Cell (MFC)

Microbial fuel cell is device that exploit the living microbes to produce electricity and treat the water. The MFC is a technology regarding a direct bio-electrochemical reactor realizes a conversion of chemical energy in microorganism to electricity, treats the organism as the substrate and utilizes the microbial redox reaction to generate electricity directly. (Xia, Zhang, Pedrycz, Zhu, & Guo, 2018). The original idea in using microbes to generate electricity was find in 1911 when Galvani was experimenting with frog legs and further concept and research were explored since, such as Cohen's 35-unit setup in 1931, Karube et al. catalyst research in the 60's and more research has been conducts in 80s-90s. (Santoro, Arbizzani, Erable, & Ieropoulos, 2017)