OPTICAL AND ELECTRICAL CHARACTERIZATIONS OF LIQUID CONCENTRATIONS FOR WASTE-WATER TREATMENT PLANT

MUHAMAD NAEEM BIN MOHD NAZRI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTICAL AND ELECTRICAL CHARACTERIZATIONS OF LIQUID CONCENTRATIONS FOR WASTE-WATER TREATMENT PLANT

MUHAMAD NAEEM BIN MOHD NAZRI

This report is submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Optical and Electrical Characterizations of Liquid Concentrations for Waste-Water Treatment Plant

Sesi Pengajian : 2017/2018

Saya MUHAMAD NAEEM BIN MOHD NAZRI mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.
✓	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Dr. Hazura Binti Haroon
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Alamat Tetap: No 344, Darulaman Heights Bandar Darulaman 06000 Jitra Kedah

Tarikh : 25 May 2018

Tarikh : 25 May 2018

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this report entitled "Optical and Electrical Characterizations of Liquid Concentrations for Waste-Water Treatment Plant" is the result of my own work except for quotes as cited in the references.

Signature : ....

Author : MUHAMAD NAEEM BIN MOHD NAZRI

Date : 30 / 5 / 2018

APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature	:	
Supervisor Name	:	DR. HAZURA BINTI HAROON
Date	:	30/5/2018

DEDICATION

In this section is specially dedicated to express my highest gratitude to my beloved parents, family, supervisor, lecturers, and friends for all the support, guidance and encouragement throughout completing this project and thesis.

ABSTRACT

The purpose of this project is to design a system that is capable to measure the liquid concentration for the waste-water treatment plant. The polymer optical fiber was employed as the sensor instead of the conventional electronic sensor due to less power usage, low maintenance cost and can be operated in the harsh environment. In comparison with the glass fiber optic, it is flexible, thus it is more durable. The liquid concentrations in consideration were sucrose solution, salt solution, cornstarch solution and a few types of oils. Both electrical and optical testing measurements were taken into account. The outcome of this project is the identification of different liquid conditions, where different liquid concentration produces different refractive index change and the relationship between the value of the refractive index (RI) and the output power. For 0.1 mol of sucrose solution, the RI value is 1.3388 while for 1.0 mol of sucrose solution, the RI value is 1.3849. The RI value for 1.0 mol salt solution is 1.3437 while for 5.0 mol of the salt solution produced 1.3768 of refractive index. Meanwhile, 0.2 mol of cornstarch solution produced 1.3320 and 1.0 mol of corn starch produced 1.3324. In conclusions, the higher the liquid concentration, the higher the refractive index.

ABSTRAK

Matlamat projek ini adalah untuk mencipta suatu sistem yang berkeupayaan untuk mengukur konsentrasi cecair dalam loji rawatan air kumbahan. Sistem ini akan mengguna pakai sensor gentian optik polimer dan tidak lagi menggunakan sensor elektronik konvensional kerana ianya menjimatkan tenaga, mempunyai kos pengendalian yang rendah dan mampu berfungsi dalam persekitaran yang tidak menentu dan ekstrem. Selain itu, gentian optik polimer lebih fleksibel di samping lebih berdaya tahan berbanding gentian optik silika. Jenis cecair yang digunakan adalah cecair sukrosa, garam, tepung jagung dan juga beberapa jenis minyak. Kedua-dua ukuran elektrik dan optik diambil kira. Projek ini memberi inferens kepada keadaan cecair yang berbeza mengikut pengukuran indeks biasan dan juga hubungan diantara nilai indeks biasan dan nilai kuasa output. Untuk 0.1 mol cecair sukrosa mempunyai nilai indeks biasan sebanyak 1.3388 manakala 1.0 mol sukrosa mempunyai 1.3849 indeks biasan. Nilai indeks biasan untuk 1.0 mol dan 5.0 mol cecair garam adalah 1.3437 dan 1.3768. Seterusnya, untuk 0.2 mol cecair tepung jagung mempunyai indeks biasan 1.3320 dan 1.0 mol pula mempunyai sebanyak 1.3324 nilai indeks biasan. Ini menunjukkan bahawa, semakin tinggi kepekatan cecair yang dihasilkan, semakin tinggi nilai indeks biasannya.

ACKNOWLEDGEMENTS

I would like to express my gratitude and deepest thanks to Dr. Hazura Binti Haroon, my supervisor, for suggesting the topic for my research project, her guidance in theory related to my project and providing time and ideas for the experimental setup with her patience and expertise. I would also like to give my gratitude to Dr. Hanim Binti Abdul Razak, my Co-supervisor, for her opinion regarding my project and helping me to get the equipment required for this project.

Besides that, thanks to all of those who have helped and given me the opportunities to fulfill the research and thesis work. I also want to express my gratitude to Nur Hidayah Binti Sulaiman for helping me figure out which method is the best for fabrication of the fiber optic sensor.

Without any of their guidance and patience, I could not have accomplished this research properly, successfully and on time. I also want to thank all my friends for sharing their knowledge and helped me with my project. Finally, I also want to thank my family that always supports me and giving me ideas from their perspectives.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

CYTOP	:	Amorphous Fluorinated Polymer
EMI	:	Electromagnetic Interference
FOS	:	Fiber Optic Sensor
GOF	:	Glass Optical Fiber
OFT	:	Optical Fiber and Digital Communication Trainer
OPM	:	Optical Power Meter
OSA	:	Optical Spectrum Analyzer
PC	:	Polycarbonate
PF	:	Perfluorinated
PMMA	:	Polymethyl-methacrylate
POF	:	Polymer Optical Fiber
PS	:	Polystyrene
RI	:	Refractive Index
VFL	:	Visual Fault Locator

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter explained the introduction of the project background, problem statements, and objectives of this project. In this chapter, these will be briefly explained. In addition, the scope of work also includes in this section.

1.1 Introduction

The usage of optical fiber nowadays is getting more high demand. The optical fiber is used in many fields such as medical, telecommunication, networking, automotive industry, military and space applications. The optical fiber is a transparent fiber that is made of glass or plastic that have almost the same size as a human hair. The optical fiber cable consists of a core which is surrounded by a cladding and protected by the buffer and outer jacket[1].

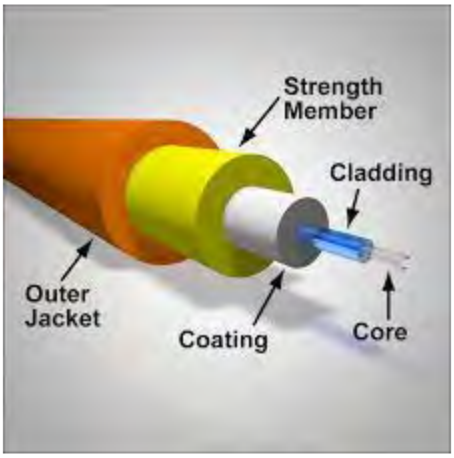

Figure 1.1: Fiber Optic Structure[2]

This project involves the development of a liquid concentration sensor based on polymer optical fiber. The reason polymer optical fiber is selected compares to the glass optical fiber because polymer optical fiber has large core diameter which leads to lower bending loss sensitivity, thin cladding with lower refractive index, more durable with higher flexibility and immune to electromagnetic interference.

1.2 Project Objective

1. To design polymer fiber optic (POF) sensor for liquid concentration.
2. To optically and electrically characterize the performance of the liquid concentration sensor.
3. To develop the mathematical modeling for different liquid solutions.

The main objective of this project is to design and fabricate polymer fiber optic (POF) sensor for liquid concentration. After that, the performance of optical and electrical characterization of the liquid concentration sensor will be tested by using specific equipment and methods. Based on the graph of the result, the mathematical modeling for oil, salt, and sucrose solution can be determined.

1.3 Problem Statement

Currently, the electronic sensors are commonly used in many applications in our daily lives. However, the electronic sensor has limited functionality and it uses a huge amount of power for the sensor to operate. The electronic sensors are pre-built and the sensitivity of the sensor cannot be adjusted.

Therefore, fiber optic technology is being employed rapidly replacing the traditional sensor technology. Fiber optic technology is widely used for data transmission process because it is capable to transfer a large amount of data over a long distance because the fiber optic is very accurate, and it has high precision.

Optical fiber sensor is a better choice to replace the electronic sensors since it requires less power to be supplied to the sensor and it is very small with approximately 0.25mm diameter compared to the electronic sensor. The electronic sensors are bulky and it is hard to carry it around compared to the optical fiber sensor which is very portable. Besides that, the optical fiber sensor is more suitable for extreme weather environments compared to the electronic sensor. This is because the optical fiber sensor is good in strength and it is also immune to electromagnetic interference (EMI) as well. Optical fiber sensor has a longer lifespan compared to the electronic sensor as well.

1.4 Scope of Work

There are a few limitation and condition that must be considered in order for the project to be successful. The project consists of a single mode polymer optical fiber and Photodiode which will act as converter optical signal to electrical current.

The sensor is targeted to detect the level of contamination. However, the materials present in the specific liquid will not take into consideration. The temperature effect will also be neglected for this project. Besides that, any power loss by bending and etching process will also be neglected. The operating wavelength is in the range of 650nm to 1000nm but only 650nm and 850nm wavelength of light source available at the lab. The Optical Power Meter (OPM) can only measure 850nm input wavelength. Therefore, a light source with 850nm of wavelength is chosen for this experiment.

Two experimental setups will be utilized, one is the optical measurement while the other one is the experimental measurement. The measurement equipment that will be used for optical testing is the Optical Power Meter (OPM). For the Electrical measurement, the voltage will be measured by using a digital multimeter. The converter which is a photodiode is used to change the optical signal into an electrical voltage or current. A refractometer will be used to measure the refractive index of the liquid concentration.

CHAPTER 2

BACKGROUND STUDY

This chapter discussed briefly in the related research on the project of the optical fiber by using polymer optical fiber as the sensor. The theory and the study of journals were discussed in this chapter. Besides that, this section also explained about the losses of the optical fiber and the structure of the fiber optic.

2.1 Optical Technology

In general, optical technology is science that relates to light or vision such as visible light or infrared light. An example of an optical device is a computer mouse, where it uses light-emitting diode and photodiode to determine the direction of the mouse movement on a surface[3]. Besides that, there are optical storage devices that are being used to save and retrieve data on discs. It uses a laser light to read and transfer information on the disc.