Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF FIBER OPTIC SENSOR USING DIFFERENT TYPE OF PALM OIL

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Bachelor of Electronics Engineering Technology with Honours

2021

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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Tajuk Projek : Development Of Fiber Optic Sensor Using Different Type Of Palm Oil

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I declare that this project report entitled “Development Of Fiber Optic Sensor Using Different Type Of Palm Oil” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology with Honours.

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DEDICATION

My special dedication is directed to my parents, siblings and friends who have always supported me and who have always encouraged me to help me complete my final year project successfully. Meanwhile, I am dedicating this thesis to my beloved supervisor, DR. AMINAH BINTI AHMAD and co. supervisor, Sir MD ASHADI BIN MD JOHARI who has given me a lot of guidance and guidance on how to achieve success for my final year project. Thank you very much. I appreciate it. I am grateful for their inevitable sacrifice, tolerance, and consideration in making this effort feasible. I cannot provide the appropriate words that can accurately describe my appreciation for their loyalty, support, and belief in my ability to achieve my dreams.

ABSTRACT

Sensors for fiber optics have become one of the most prosperous and powerful people in the world applications of sensor and optical fiber technologies. In recent years, with the rapid development of microns or nanotechnology, the need for fiber optic sensors has become increasingly high. Having higher performance and flexibility, and occupying a small space is also one of the current fiber optic sensor trends. Fiber optic sensors have recently attracted a lot of attention due to its high sensitivity, fast detection speed, and ability to work in difficult conditions. This research is on the Optimisation Performance of Fiber Optic Sensors at different palm concentrations. Fiber optic sensors were developed to detect the concentrations of various types of oil palm. The objective of this project is to use optical fiber as a liquid sensor to detect various types of palm oil. This project requires an understanding, development and analysis of oil concentration sensors from optical loop fibers and needs to know how to perform fiber splicing, cutting and stripping for this purpose. There will be three samples of palm oil to be tested. Before each test, the fibers will be dipped into palm oil and then measured. In the line graph, each measurement will have a different result. The experimental findings will be explained in terms of sensitivity, correlation, and graphical determination coefficients, all of which depend entirely on the concentration of palm oil and the light source. At the end of the project, an optical liquid concentration sensor with high sensitivity readings was formed. Next, the results were analysed using the factorial design method. This will determine the type of palm oil concentration that has the optimum performance in terms of concentration.

ABSTRAK

Sensor untuk gentian optik telah menjadi salah satu yang paling makmur dan berkuasa di dunia aplikasi teknologi sensor dan serat optik. Dalam tahun-tahun kebelakangan ini, dengan perkembangan mikron atau nanoteknologi yang pesat, keperluan untuk sensor gentian optik menjadi semakin tinggi. Mempunyai prestasi dan kelenturan yang lebih tinggi, dan menempati ruang kecil juga merupakan salah satu trend sensor gentian optik semasa. Sensor gentian optik baru-baru ini menarik banyak perhatian kerana kepekaannya yang tinggi, kelajuan pengesanan yang cepat, dan kemampuan untuk bekerja dalam keadaan sukar. Penyelidikan ini adalah mengenai Prestasi Pengoptimuman Fiber Optic Sensor pada kepekatan sawit yang berbeza. Sensor gentian optik dikembangkan untuk mengesan kepekatan pelbagai jenis kelapa sawit. Objektif projek ini adalah menggunakan gentian optik sebagai sensor cecair untuk mengesan pelbagai jenis minyak sawit. Projek ini memerlukan pemahaman, pengembangan dan analisis sensor kepekatan minyak dari gentian gelung optik dan perlu mengetahui bagaimana melakukan penyambungan, pemotongan dan pelucutan serat untuk tujuan ini. Akan ada tiga sampel minyak sawit yang akan diuji. Sebelum setiap ujian, serat akan dicelupkan ke dalam minyak sawit dan kemudian diukur. Dalam grafik garis, setiap pengukuran akan mempunyai hasil yang berbeza. Penemuan eksperimen akan dijelaskan dari segi kepekaan, korelasi, dan pekali penentuan grafik, yang semuanya bergantung sepenuhnya pada kepekatan minyak sawit dan sumber cahaya. Pada akhir projek, dibentuk sensor kepekatan cecair optik dengan bacaan kepekaan tinggi. Seterusnya, hasilnya dianalisis menggunakan kaedah reka bentuk faktorial. Ini akan menentukan jenis kepekatan minyak sawit yang mempunyai prestasi optimum dari segi kepekatan.

ACKNOWLEDGEMENTS

First and foremost, all praise be to Allah the Almighty God for giving me the strength, health, and patience to complete this project entitled “Development of Fiber Optic Sensor Using Different Types of Palm Oil”. With the strength given, I was able to complete my project on time and overcome the difficulties that occurred during the research period.

Besides, I would like to express my gratitude to my supervisor, DR AMINAH BINTI AHMAD and co. supervisor, Sir MD ASHADI BIN MD JOHARI, for their precious guidance, words of wisdom and patient throughout this project and took the time to guide and support me for the first time until this project was completed. His constant guidance helped me a lot by making sure I was on the right project track.

After that, I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support through lending me all the equipment that are needed which enables me to accomplish the project. Not forgetting my fellow colleague, Muhammad Syazwan, Nur Diana Azwa, Shamsul and Daniel for the willingness of sharing his thoughts and ideas regarding the project. While completing a project, we always support each other by sharing our knowledge and ideas to grow our project. My highest appreciation goes to my parents, parent’s in-law, and family members for their love and prayer during the period of my study.

Finally, I would like to thank all the staffs at the Faculty of Electronic Engineering and Computer Engineering, fellow colleagues and classmates, the faculty members and classmates, as well as other individuals who are not listed here for being co-operative and helpful.

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LIST OF SYMBOLS

μm	-	Micrometer
θ_1	-	The incident angle between the light beam and the normal
θ_2	-	The refractive angle between the light ray and the normal
n_1	-	The refractive index of the medium the light is leaving
n_2	-	Refractive index of the material the light is entering
F	-	Fahrenheit
mm	-	Millimeter
nm	-	Nanometer
dbm	-	Decibels per miliwatt

LIST OF ABBREVIATIONS

EMI	-	Electromagnetic interference
RFI	-	Radio frequency interference
$PMMA$	-	Polymethyl methacrylate
$SiO2$	-	Silicon dioxide
UV	-	Ultraviolet
IR	-	Infrared
GB	-	Gigabyte
MMF	-	Multimode fiber
SMF	-	Single mode fiber
LED	-	Light-emitting diode
ISI	-	Intersymbol interference
PKO	-	Palm kernel oil
FFB	-	Fresh fruit bunch

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CHAPTER 1

INTRODUCTION

1.1 Background

Fiber optics, often known as optical fiber, is a medium and system for sending data as light pulses through a glass or plastic strand or fiber. In data networking, fiber optics is utilised for long-distance and high-performance communication. Fiber optics use light particles, or photons, to transmit data across a fiber optic connection. The refractive index of each glass fiber core and cladding is different, bending the incoming light at a different angle. When light signals are sent through fiber optic cable, they bounce in a zig-zag pattern off the core and cladding, a phenomenon known as total internal reflection.

Since the last decade, electronic communications continued to evolve and increase the development demand to transmit and process large data signals in a short period. Therefore, optical fiber is increasingly accepted because it can achieve the desired electronic communication and function as a sensor. The properties of fiber optic sensing set it apart from other sensing systems. These optical fiber sensors are capable of measuring a wide range of chemical and physical factors with excellent sensitivity and speed. One of the primary factors that describes light emission is that a fiber optic detector can test or monitor many physical and chemical properties. Light intensity, phase, polarisation, and wavelength are all important elements to consider. Fiber optic sensors are appealing due to their unique features and prospective potential, which place them at the forefront of Photonics technology. The perceived signal in fiber optic sensing devices is immune to electromagnetic interference (EMI) and radio frequency interference (RFI). We can employ fiber optics for remote sensing applications since the signal they transport has low losses.

The purpose of this study is to develop a fiber optic sensor using several types of palm oil. An SMF28 optical cable or fiber optic pigtail under test, a laser source with a wavelength of 1550nm, an Optical Power Level and Optical Power Meter, and three different palm oils are required for this project. And each oil is tested three times, with the results being the loss (dBm) at the peak of the spectrum obtained with the Optical Power Level and Optical Power Meter equipment. A single optical concentration with high sensitivity was created towards the end of the research.

1.2 Problem Statement

The purpose of this study is to analyse the palm oil in three different scenarios using fiber optics as a tool for the industry. Because palm oil is one of the most important elements in the production of foods, its condition is one of the most important aspects of health. Normally, some in the industry are worried with the status of the palm oil, which has the potential to harm human health. Each type of palm oil utilised today has its own results of concentration, thus we want to know which palm oil has the highest sensitivity.

Next, there are numerous sensors available for measuring liquid concentration, particularly when employing electronic devices. Despite the fact that electronic sensors perform well in practise, they are not user-friendly due to their flammability due to EMI. This difficulty can be remedied by utilising a fiber optic sensor composed of silica glass, which is EMI resistant. During the monitoring procedure, it solely employs light pulses to send the signal. As a result, no EMI from the environment will impair its performance.

Besides, to monitor the liquid concentration, the electronic sensor requires a large amount of power. As a result, the electronic sensor's power consumption will rise, increasing the industry's expense. The cost of employing a fiber optic sensor, on the other hand, can be decreased because it only requires a tiny amount of electricity to provide the optical power source for detection.

Futhermore, some palm oil has a less or high sensitivity and its performance. Therefore, the idea development of fiber optic sensor is to determine which measurements require a low or high sensitivity. As a result, a fiber optic sensor will be used in this investigation to analyse and check the performance of each palm oil.

1.3 Project Objective

The main objectives of this project:

a) To design fiber optic sensors with different type of palm oil.

b) To analyse the performance of fiber optic sensors with different type of palm oil.

1.4 Scope of Project

The purpose of the project is to research fiber optic sensors and create a fiber optic sensor for detecting palm oil concentrations. The performance of the developed sensors will also be evaluated. Single mode fibers are spilced and the fiber optic sensor is spliced using a commercial splicer Fujikura FSM-18R. The fibers are cleaned with alcohol to remove dust and cleaved with a Fujikura CT-30 Fiber Cleaver to obtain a smooth cleavage surface and clean end-uncoated fiber before the sensors are spliced. The 1550nm input wavelength was collected from an optical power source during the testing process, and the output signal was measured in (dBm) units using an optical power meter.

Next, the splicer connects the two fiber optics by splicing the sensors together. Then, for each fiber optic sensor, an optical power supply and an optical power meter are connected to detect and analyse palm oil content.

Furthermore, the three types of palm oil are ready to be placed into the plastic container. As a result, there are three processes in this project for testing palm oil content. The palm oil concentration is tested using the sensors created as part of this project. By utilising an optical power meter, the findings are converted to watts (dBm).This project guarantees that the project is moving in the right path to achieve its objectives.

Table 1.1: Equipment used during this project

Equipment	Experiment Details
Round basin	To concentration the sensors with liquid material
Fiber optic	Single mode (fiber optic pigtail)
Size	125 nm
Liquid material	Brand A(Buruh Oil), Brand B(Alif Oil), and Brand C(Saji Oil)
Hardware	Optical Power Meter
	Optical Power Level/Source (1550nm)
	Commercial splicer Fujikura FSM-18R
	Fujikura CT-30 Fiber Cleaver

1.5 Thesis Organisation

The thesis consists of five chapters, namely Introduction, Literature Review, Methodology, Results and Conclusions. Chapter 1 introduces the project idea briefly. It covers the project background, problem statement, project objectives and project scope. Next, Chapter 2 discusses a review of the literature and theory that has been done from the previous article. Chapter 3 provides an overview of the project methodology. It consists of all the methods used in the previous article, including algorithm design, research and laboratory practice. The initial results described in Chapter 4 and the final chapter are Chapter 5, which is the conclusion of the entire project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Optical sensing technology has taken on new dimensions as a result of recent breakthroughs in the science of optics. They set the norm for a robust optical fiber class sensor when combined with unique but effective transducing technology [1]. The first fiber optic sensors were patented in the 1960s and relied on free-space optics. About ten years later, researchers developed the first intrinsic fiber optic sensor. This improvement provides significant engineering benefits over independent space sensors to obtain reliable mechanical measurements. The use of fiber allows signals to be transmitted in usable media, whereas free space optics depend on viewing distance and cannot be used in operating structures or vehicles. Commercialised in the 1980s, fiber optic gyroscopes were one of the earliest applications of fiber optic sensors and have become important components in stabilisation and navigation systems. In the early 1990s, the civilian industry began applying various fiber-optic sensors in several applications to measure temperature, pressure, pressure, and more. In the early 2000s, another optical fiber sensing technology, distributed sensing, emerged and showed its greatest potential in the oil and gas industry. This technology is mainly used for temperature measurement along the length of the fiber to help improve various drilling processes, including leak detection, injection process monitoring and flow analysis. Although they provide distributed measurements, these technologies have slower refresh rates (a few seconds between optimal acquisitions) and spatial resolution according to the meter sequence [2].

2.2 Fiber Optic

Fiber optics transformed the telecommunications sector when it was introduced in the early 1980s, giving an ideal transmission medium with unparalleled ultra-wide bandwidth and extremely low spread loss. Fiber optic cable is made up of three major components. The core, the coating, and the coating are the three components [3]. The core is a cylindrical rod of dielectric material composed of glass, as depicted in Figure 2.1. Meanwhile, the coating is comprised of a dielectric substance with a lower refractive index than the core, allowing light scattering to occur solely in the core. In addition, the coating protects the fibers from absorbing surface impurities and adds mechanical strength by reducing light loss from the core to the surrounding air, reducing scattering loss on the core surface, and adding mechanical strength. On the other hand, a layer is a material layer that protects the optical fiber from physical damage. Usually, the lining is made of plastic because it must be elastic in nature and prevent abrasion [4].

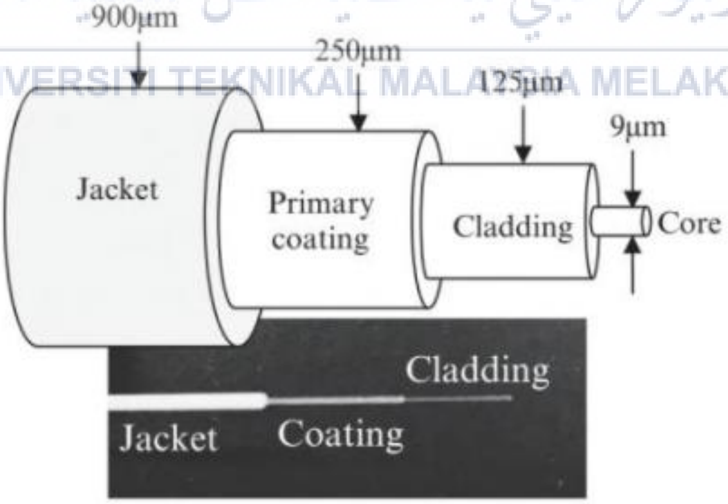

Figure 2.1: The basic structure of Optical Fiber