UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF FIBER OPTIC SENSOR IN DETECTING THE CONDITION OF CORN OIL FOR DAILY USAGE OF HEALTHY DIET BY USING FACTORIAL DESIGN

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

by

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FACULTY OF ENGINEERING TECHNOLOGY

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **OPTIMIZATION OF FIBER OPIC SENSOR IN DETECTING THE CONDITION OF CORN OIL FOR DAILY USAGE OF HEALTHY DIET BY USING FACTORIAL DESIGN**

SESI PENGAJIAN: **2017/18 Semester 1**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Tujuan projek ini adalah untuk mengoptimumkan prestasi sensor gentian optik untuk mengesan keadaan minyak masak. Sensor gentian optik digunakan sebagai alat pengesan dengan menggunakan gentian optik. Serat boleh digunakan kerana saiznya yang kecil atau kerana tiada kuasa elektrik diperlukan di lokasi terpencil, atau kerana banyak sensor dapat dikombinasi sepanjang panjang serat dengan menggunakan pergeseran panjang gelombang cahaya untuk setiap sensor, atau dengan merasakan kelewatan masa sebagai cahaya pas sepanjang gentian melalui setiap sensor tetapi bergantung kepada aplikasi. Sensor gentian optik juga merupakan sistem yang terdiri daripada kabel gentian optik (FOC) yang disambungkan kepada sensor jauh atau penguat. FOC ialah kabel yang mengandungi satu atau lebih serat optik yang digunakan untuk membawa cahaya. Sensor gentian optik boleh mengukur parameter perbezaan seperti cecair, kimia, suhu dan sebagainya. Untuk kajian ini, sensor optik gentian telah digunakan untuk mengukur parameter yang diberikan seperti sumber cahaya, jenis serat dan masa mencelup. Oleh itu, kajian ini adalah untuk menganalisis prestasi sensor gentian optik apabila ia digunakan sebagai sensor cecair untuk mengesan keadaan minyak goreng (minyak jagung) dengan menggunakan aplikasi matematik untuk mengetahui tahap serat optik boleh digunakan secara optimum.

ABSTRACT

This purpose of this project is to optimize the performance of fibre optic sensor to detect the condition of cooking oil. Fiber optic sensor is a sensors uses as the sensing element by using optical fiber. Fiber can be used because of its small size or because no electrical power is needed at the remote location, or because many sensors can be multiplexed along the length of a fiber by using light wavelength shift for each sensor, or by sensing the time delay as light passes along the fiber through each sensor but depending on the application. Fiber optic sensor also a system that consist of a fibre optic cable (FOC) that connected to a remote sensor or amplifier. FOC is a cable containing one or more optical fibres that are used to carry the light. Fiber optic sensors can measure the difference parameters such as liquid, chemical, temperature and so on. For this research fiber optic sensor had been used to measure the parameter given such as light source, type of fiber and dipping time. Therefore, this research is to analyse the performance of fiber optic sensor when it been used as a liquid sensor to detect the condition of cooking oil (corn oil) by using the mathematical application to know at which level fiber optic can be used optimally.

DEDICATION

Specially dedicate to my beloved father and mother, Mohd Rosdi bin Hassan, and Wan Yam binti Seman, my supervisor that help me a lot in making this report Madam Rahaini binti Md Said, my co-supervisor Encik Ashadi bin Md Johari and also thanks to my sibilings or their supports, guides and advices. Also not forget to my friends and people around me who always supporting and help me through this whole time.

ACKNOWLEDGEMENT

Praise to Allah S.W.T for giving me chance and helping me to get an idea and give me strength to overcome all the difficulties and letting me to finish my Final Year Project 1. Next, I would like to thank to my beloved and respected supervisor Mdm Rahaini binti Md Said and my co-supervisor Encik Ashadi bin Md Johari for al guidance and motivation that had been given to me during the process of the project. Without their support, I will not able to achieve the goals of the project.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Nowadays fiber optic sensor used as transmission tool in telecommunication area as the low cost and widely used. The most obvious use of fiber optic is internet, which is information sent digitally through fiber optic across the entire world. Application of the optical fiber in telecommunication are widely used in transmission data, cable television companies used fiber for delivery of digital video and data services. Furthermore, optical fiber sensor found that increasing applications in areas around from structural health monitoring to biophotonic sensing. The fiber optic sensor also is one of the most popular choices for many industries. In other hand, the fiber optic also used a sensor as a tool in applications in oil-well monitoring and fire or leak detection. Fiber optic sensor is a sensing device that uses fiber optic technology for measuring physical quantities such as temperature, pressure, strain, voltages, and acceleration. It also immune to electromagnetic interference and extreme conditions also can be handle. The advantages of using fiber optic sensor as the best choice because its suited for monitoring strain in concrete structures due to their small size, low cost, ability to be embedded internally, and multiplexing capability. Corn oil is extracted from the germ of corn. Its main use is in cooking, where its high smoke point makes refined corn oil valuable frying oil However, this experiment is to analyze sensitivity of fiber optic sensor in determining the viscosity of corn oil. This research mainly focuses on fiber optic sensor use to detect the condition of corn oil. This research may useful for people that want to maintain a

healthy diet. Healthy diet implies a variety of foods that give you the nutrients that you need to maintain your health, feel good, and have energy. Peoples, whose want maintain a good diet normally people take corn oil as their daily usage because corn oil is a replacement of saturated fats. Variable parameter that has been used in this research are type of fiber, type of light source and dipping time. The expected result from this research is output power. The output power of this research is power that display at optical fiber power meter that are in decibel (dB). In this research, to analyse the performance of fiber optic sensor when it used as liquid sensor to detect condition and viscosity of cooking oil by using the factorial design method to develop fiber optic sensor as sensor in detecting condition of corn oil.

1.1 Problem Statement

Most of people nowadays are prefer to practise a healthy diet in their daily life. But, sometimes in the healthy life diet they didn‘t concern about their oil used. Oil used is one of the most important element in healthy diet because oil is the main ingredient to make a food. Normally, people who takes a healthy diet life style, preferred to use corn oil in their food taking because corn oil full of good fats and a powerful antioxidant that can keep good health in their daily life.

In this present day age, there is no tool that had been produce a device to detect the corn oil condition. So, this research conducted to analyse the viscosity of corn oil using the fiber optic sensor as a tool.

1.2 Objective

The objectives of this project are to:

I. To study and develop Fiber Optic Sensor (F.O.S) as viscosity corn oil detection.
II. To investigate best combination of fiber optic sensor which optimize the output power.
III. To establish the mathematical model for output fiber optic sensor as the corn oil condition detection.

1.3 Scope

Before new technology or technique is applied, the system must be tested so that the performance of the design and analysis can be known. However, for any project to be done, the limitation of the scope of the work must be very realistic and applicable. In order to achieve the objective of study, the following were outline as follows:

I. Analyze the concentration corn oil in three condition which is different with first, second, and third usage
II. Develop the fiber optic sensor to detect the viscosity of corn oil
III. Analyze data obtained, select the data that have optimum results and report writing

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, the research has been done by other person which are related with the research that we were discussed. The facts from their research were used to guide this research in correct way. The sources come from journals or articles written by the previous researchers related to this project. Their theories and results help this research as they can be a comparison between this research and their researches.

2.1 Fiber Optic Sensor

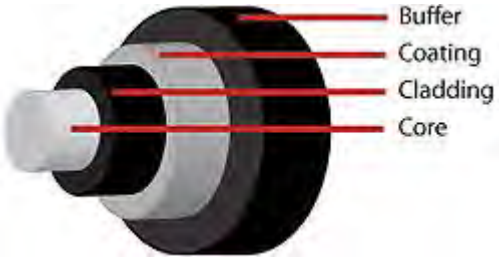

Figure 2.1: Basic Fiber Optic

Fiber optic sensor has an optical fiber that connected to a light source to allow for detect in tight space. It is suitable for checking tension in solid structures because of its small size, low cost, ability to be embedded internally, and multiplexing ability. In particular, it uses an optical fibers as the sensing element, which are recognized intrinsic sensor, or uses them to transport signals from the remote sensor to the signal processing module.

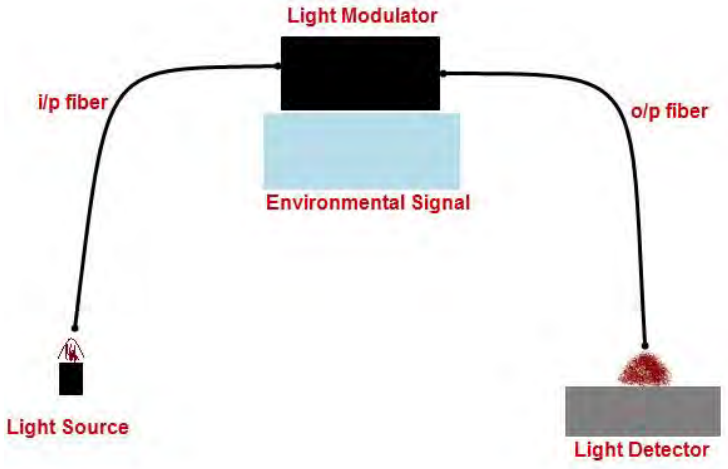

Figure 2.2: Extrinsic Fiber Optic Sensor

It is the basis for recognizing between multiple multiplexed sensors and distributed sensors. In sensors distributed there is only one element of the detector, and the objective of signal processing is to obtain measurement as a position element along the sensing component. In contrast, point multiplexing multiplexing comprises measurements of the appropriate dimensions for each discrete detection component. It must be explained that both types of sensors may coincide within the same network, which occur once again in hybrid networks. As far as the type of optical signal is concerned, one can make an initial qualification between the network capable of combining the sensor by using the optic signal level for data transmission (interferometric sensor network), or that relies on classifying the intensity of light (by some multiplexing techniques) which we will call intensity sensor network. It is an equation of this group that is used in most of its established.

There are various different topologies to make sensors accessible in a network. They are separated into four basic configurations; where everyone become a transmissive or reflective kind. One important thing to have in mind in fiber optic

networks in general and in the sensor ones in specifically is the optimized value of the received transmission level of each sensors. The optical fiber transmission system always has accessible to the scope of optical power scope, for example the current contrast between the maximum level of signal that can be received by a unsaturated detector and the corresponding minimum where the system will work with the acceptable signal to noise ratio. (R.A. Perez-Herrera ⇑, 2013)

According to (R.McColpin, 2013) , with optical fiber sensing distributed, analyzing the reflections of laser light from various spots in the fibers, temperature and glass strain can be determined at any point in the well , and the fiber can be transformed into a series of distributed microphones and hydrophones.

In communication system, systems were initially considered as utilizing single mode, high limit fibers in conjuction with laser sources. It soon was recognized, however that highly multimode fibers in combination with LED (or laser) sources had a vital place too.

2.2 Optical Fiber

Optical fiber is a kind of medium which transmits light beam, it is small and adaptable. Optical fiber is the inner core of the optical cable which is used for transmission. Optical fibers are small, lightweight, and adaptable that can work over a wide range of environmental condition and react to various physical properties. Optical fiber sensor technologies are also developed in recent years that offer a few points of interest such as increased sensitivity, insusceptibility of electromagnetic interference, small volume and light weight.

The fiber optic sensor network represents a major increase in custom sensor networks that ensures various fields such as environmental monitoring, safety and security. Optical fiber sensors can be connected to wireless, copper or fiber optic cables. However, optical fiber is the chosen technology. The important element of optical fiber is their dual function, it not only traces the structure since the induced change of meaningful light properties there is no need for additional telemetry routes,

contrary to what is happening in all other sensing technologies. The ultimate advantage is total immunity to external electromagnetic interference, multi-way reflection of artificial and man-made goods and terrible climate disorders. In addition, it displays broad bandwidth and low transmission loss, empowering broad geographical coverage, where necessary, bypassing the fibers allowing the sensors to be incorporated into the monitored structure, they can work without electrical power from local batteries outside the terminal and they reduce the danger of early conditions. (Lopez-Amo, 2012)

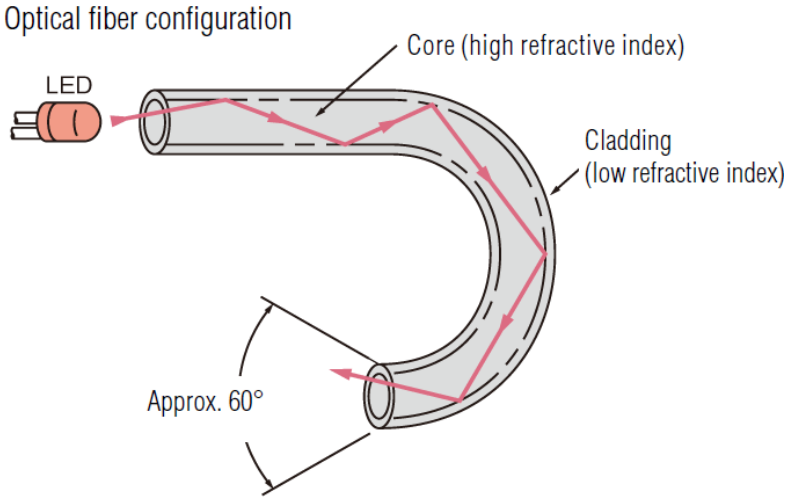

Figure 2.3: Optical Fiber Configuration

Optical fibre is dieletric waveguide. They are designed to guide light waves along their length. For easy creation and use, silica preform are usually drawn into fibers of circular cross section. In general, optical fibers composed of a cylindrical cores, with a refractive index n_1, surrounded by a cladding with an index n_2, with $n_1 > n_2$. If both n_1 and n_2 are uniform across the cross sections, the fiber is known as a step-index fiber (SI). If n_1 differs with the core radius, it is graded-index fiber (GI). Also, if the core diameter is small, such as within 10um, the fiber is a single mode (SMF). If the core diameter is greater than 10 um, it is usually a multimode fiber (MMF).

Optical fibers experience power loss and signal dissipation when signals are sent along the length of the fiber. It is a very low fiber loss and the possibility of zero diffusion at a certain wavelength that promotes us to adapt the fiber to replace the wire or future signal transmission system in the future. (Yeh, 2013)

2.2.1 Fiber Materials and properties

Silica fiber is a fiber optic communication system of basic building blocks. Earlier researchers have focused on enhancing the purity of silica fiber and have achieved fiber losses as low as 0.14dB/km at a wavelength of 1.55um. (Yeh, 2013).

Long distance transmission is not only thing a matters of communications. It is also important to be able to bring a lot of information, which in the communications world is called bandwidth. The wider the bandwidth, more information signal can be carried. Optical fiber can transmit those signals without seriously limiting their bandwidth. Optical fiber are regularly compared to human hair. The sizes are close, but fiber is stiffer. On a microscopic scale, a well-made optical fiber is also much smoother than a human hair. (Hecht, 2015)

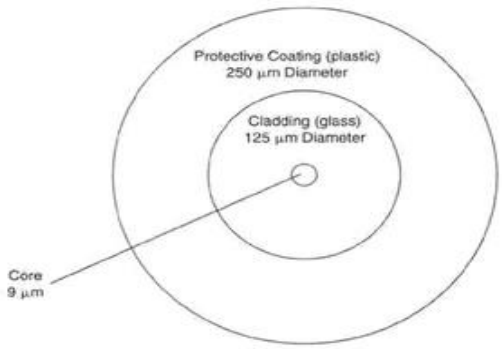

Figure 2.4: Cross section of typical communication fiber

2.2.2 Light Sources and Detectors

To take the advantage of low fiber loss and zero dispersion at longer wavelengths, the pattern in optical fiber communication systems has been consistently moving toward longer wavelength. (Yeh, 2013).

2.2.3 Components

In spite fiber loss has been reduced as 0.14dB/km for single mode fiber, the losses in connector, splices and other components are still very high. Typically, a single connector can have losses in excess of dB, which limits system performance. Optical coupling between optical fiber and source detectors still leave room for improvement. (Yeh, 2013).

2.2.3.1 Optical Cable Performance

Cable insertion loss is comprised of the sum of the attenuation (length dependent) and short length (length-independent) losses. Both sources of loss must be considered when choosing or designing a cable for particular application. (Barnoski, 2012)

2.2.3.2 Mechanical Performance

The primary concerns of cable design are tensile strength, affect resistance, crush resistance, bending fatigue.