UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS PERFORMANCE OF FIBER OPTIC SENSORS IN FULLY SYNTHETIC ENGINE OIL MONITORING SYSTEM WITH DIFFERENT CONCENTRATION

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

by

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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 Engineering Technology Electronic(Telecommunications) with Honours. The member of the supervisory is as follow:

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(MRS RAHAINI BINTI MD SAID)

ABSTRAK

PRESTASI ANALISIS SENSOR OPTIK FIBER dalam **SISTEM MONITORING MINYAK SISTEM FULLY SYNTHETIC** dengan **KONSENTRASI YANG BERBEZA** adalah penyelidikan yang berguna untuk industri automotif untuk memantau prestasi minyak enjin. Sensor ini dibuat dan diletakkan di dalam enjin supaya pengguna dapat mengesan dan memantau tahap minyak sintetik sepenuhnya. Ia akan memberi kesan kepada bahagian komponen tertentu di dalam enjin untuk dikendalikan jika minyak sintetik terlambat untuk berubah. Berdasarkan kajian ini, didapati bahawa penggunaan minyak sintetik sepenuhnya adalah kerana minyak mengekalkan kualiti pelincir dengan tempoh yang lebih lama contoh selang perkhidmatan yang diperluaskan. Selain itu, semasa perubahan suhu ia lebih stabil dan prestasi yang lebih tinggi. Sensor gentian optik untuk minyak enjin sepenuhnya sintetik adalah teknologi yang mengesan kepekatan minyak dalam enjin menggunakan kabel gentian optik. Tujuan projek ini adalah untuk membangun dan menguji sensor untuk kepekatan yang berbeza dan untuk menganalisis di mana tahap kepekatan yang lebih baik perlu diubah. Perubahan panjang gelombang bagi gentian optik dengan masa dan tumpuan akan mempengaruhi peratusan peringkat sintetik sepenuhnya untuk prestasi minyak enjin menjadi sensor. Sensor ini telah menguji dalam 10 peratus kepekatan yang berbeza iaitu 10% hingga 100% , dan juga diuji dengan panjang gelombang yang berbeza pada sintetik penuh dengan kepekatan heksana iaitu 850nm, 1300nm, 1310nm, dan 1550nm. Sensor serat optik direndam dalam campuran sintetik sepenuhnya dengan kepekatan heksana dalam 1 jam dan data yang diambil setiap 5 minit. Akhirnya, kepekatan minyak enjin sepenuhnya sintetik mempengaruhi reaksi sensor gentian optik. Analisis ini mungkin bernilai bagi inovasi dalam sensor untuk industri automotif.

ABSTRACT

ANALYSIS PERFORMANCE of **FIBER OPTIC SENSORS** in **FULLY SYNTHETICENGINE OIL MONITORING SYSTEM** with **DIFFERENT CONCENTRATION** is a research for useful an automotive industry to monitor the engine oil performance. This sensor is create and placed inside the engine so that the user can detect and monitor the level of fully synthetic oil. It will be effect the certain component part inside the engine to be operated if synthetic oil to be late to changes. Based on this study, it is found that the use of fully synthetic oil is due to the oil maintains to the qualities of lubricating with the period longer example extended service interval. Other than that, during temperature change it is more stable and higher performance. Fiber optic sensor for fully synthetic engine oil is a technology that sensing concentration of oil in engine using fiber optic cable. The aim of this project is to develop and test the sensor for a different concentration and to analyze where better concentration level need to be changed is. The changes of wavelength for the fiber optic with time and concentration it will be affect the fully synthetic level of percentages for the performance of engine oil to be a sensor. This sensor has been test in 10 different percentages of concentration which 10% until 100%, and also tested with different wavelength on fully synthetic with hexane concentration which is 850nm, 1300nm, 1310nm, and 1550nm. The fiber optic sensor is immersed in the fully synthetic mixture with hexane concentration within 1 hour and the data taken every 5 minutes. Finally, the concentration of fully synthetic engine oil is influencing the reaction of fiber optic sensor. This analysis might be valuable for innovation in sensor for an automotive industrial.

DEDICATION

This thesis is dedicated to my beloved parents

ABDUL RAZAK DAROS

ROHANA ABU TALIP

The both of them are my “idols” worth more than jewels. To prove this thesis is a part of my life to successful and realize my dream to my beloved parents.

This thesis is also to Mrs Rahaini binti Md. Said a superior supervisor that I have. Special thanks to lecturer, friend and parties involved in helping until complete this project and thesis.

"Every challenging work need self-effort as well as no matter happen and obstacle in front of you trusted you can do it, stay strong, be patient and move forward".

ACKNOWLEDGEMENT

In the name of Allah S.W.T, The Most merciful and The Most Passionate, which gives the permission, strength and ability to me to complete the assignment of this thesis as fulfilling the subject in the curriculum for Bachelor Degree Project I and II minor in Electronic Technology Telecommunication. This research is titled "Analysis of Fiber Optic Sensor Performance in Fully Engine Oil Monitoring System with Different Concentration".

First, I would like to thank my supervisor Mrs. Rahaini bin Md Said as a lecturer in Department of Faculty of Engineering Technology for giving me the opportunity and space to me to undertake this project to ensure that all the information from this research is successful to be completed as my Final Year Project Report.

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LIST OF ABBREVIATIONS, SYMBOLS ANDNOMENCLATURES

FOS	–	Fiber Optic Sensor
ASE	–	Amplified Spontaneous Emission
OSA	–	Optical Spectrum Analyzer
EMI	–	Electromagnetic Interference
SMF	–	Single Mode Fiber
dB	–	Decibel
COD	–	Coefficient of Determination
%	–	Percentages
nm	–	nanometer
Mb/s	–	Megabits per second
Gb/s	–	Gigabits per second
μm	–	micrometer
LED	–	Light Emitting Diode
LD	–	Laser Diode
T	–	Temperature
FO	–	Fiber Optic
VI	–	Viscosity Index
SAE	–	Society of Automotive Engineers
W	–	Winter
PAO	–	Polyalphaolefin
API	–	American Petroleum Institute
t	–	Time
min	–	Minutes
COD	–	Coefficient of Determination

CHAPTER 1
INTRODUCTION

1.0 Introduction

For this chapter, it will give outline for the title research, background of the research, project objectives, project scope, and problem statement related in research by analysis performance of fiber optic sensors in fully synthetic engine oil monitoring system with different concentration applications. In detail, the other information will be discuss on the next chapter in literature review, methodology, and expected result in study of research.

1.1 Project Background

Nowadays, Optical Fiber or called fiber optic is one of the applications required in industry that people used light to transmit data for hundreds of years. It is the communications medium works as sending optical signal down plastic fiber to be used any application due to its inherent advantages over copper conductor. Generally, optical communication introduced not until 1960s [1]. The single optical fiber of data rate could be handling around 1300 at once voice channels. The system is operated at 90 Mb/s. Now, the system commonly operates at 10 Gb/s and beyond and over 130,000 at once voice channels [12]. Fiber optic is one of the important parts for the transmission to transfer time of light in the fiber and it is used to measure the strain and temperature by modifying a fiber. Additionally, with modifying the fiber the wavelength, phase,

intensity, polarization can be identified from transfer time of light in fiber. [2][3]. In future, sensor can be utilized in any applications. Sensors that emits, receives and convert the light energy into an electrical signal. Fiber optic is not only focused on in telecommunication for data transmission media.

A fiber optic sensor is one of the sensor uses an optical fiber either as the sensing element intrinsic sensors or extrinsic sensor. Intrinsic sensors carry a signal from a remote sensor to the electronics that process the signals of extrinsic sensors. [2].Fiber optic sensor used for variety of sensing for detects high-speed performance. Fiber optic easy to use because the criteria of fiber is small size, no power electric needed, or maybe the factor to sensor can multiplexed along the conversion of light wavelength for each sensor. Fiber optics carries light to sensing the light source over a long distance. One of the fiber optic uses in high heat resistance is temperature. Fiber optic sensor can used in high voltage electricity because this sensor do not conduct electricity and immune to electromagnetic for example is jet fuel or flammable for safer to handle the engine. This sensor can designed to withstand high temperature as well.

Petroleum come up the product for the engine for downstream. Downstream is the petroleum crude oil and process of raw natural gas. The product is one of the major of lubricants in our engine and machines. Lubricants are largely used for automobiles (for transportation facilities), heavy industries, small industries, and vessels. The benefits of lubricants reduced friction, cooling, load balancing, cleaning, sealing, and corrosion prevention. The important purposes is lubricate engine part. Lubricating oil is a blood for an engine. Without lubricants the engine might be happening friction and corrosion on the clashing surfaces. Choosing the right lubricants it might be reduces the friction surfaces. As a jet was introduced in 1950s, the evolution of lubricant is working properly even the temperature lower than 50 degrees below zero needed, resulting in appearance of synthetic oil and multi-purpose oil. Fully synthetic engine oil is one type of lubricants oil.

This fiber optic sensor is contributed for engine oil. In this project by using the fiber optic sensor would help the automotive industry to control the performance of fully synthetic for engine oil by using fiber optic sensors. Additional, fully synthetic engine oil is for the new automotive engine. So, to make sure the engine is not broke, the engine oil is always need to be exchanged when achieve the target point to be changes. Thus, the purpose of this project focused on fiber optic sensor that uses fully synthetic engine oil to detect the best performance with different concentration.

1.2 Project Objectives

The objectives of this project is :

a. To understand the concept of fiber optic sensor operation
b. To develop fiber optic sensor for different concentration of fully-Synthetic Engine Oil.
c. To analyze performance of fiber optic sensor for the concentration activity.

1.3 Project Scope

This project is developed fiber optic sensor are used in automotive engine oil. By using a fully synthetic engine oil with different concentration in order to analyzed this technique in a good performance before this technology is applied. A few research with a different concentration must be tested to known the capability of this application. To fulfill the project objective, some project scope were follows as outline :

a. Analyze on fiber optic sensor capability.
b. Design and develop the fiber optic sensor to detect the concentration of fully-synthetic engine oil.

c. Applying the various of engine oil concentration to obtain the result required which are closed to the theoretical results.
d. Analyze the data obtained and select the data that have optimum results.

1.4 Problem Statement

Nowadays, there are various type of synthetic oil which are focused on fully synthetic that is very useful for engine oil. Lubricant are known as synthetic oil to avoid and reduce friction and wear between two surfaces. The engine oil must be changing necessary to keep the engine running well. The main problem of this project is users don"t know when the expired date of synthetic oil must be changed. User detect the expired date of synthetic oil by tracing the date at the sticker supplied by workshop or the bottle label are stated. In the engine does not have sensors for detecting the level of fuel consumption has been achieved at the maximum level should be changed to the new oil. Therefore, by using the fiber optic sensor in fully synthetic engine oil some techniques are used through beam which a user can determine the performance of engine with different level of concentration. By producing fiber optic sensor it can indicate user to identified for a concentration of an oil that has been reached the limit to test the performance of engine. Fiber optic is used in this project because it is heat resistant. So it allows the data are tested to be accurate.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter consider the main purpose of this project to get information from the articles, reference books, magazines, journals, technical papers, web sites, gathering procedures and different source which are focus to a specific issue, region of research, or hypothesis and gives setting to an exposition by identifying past research. This research determine to ensure that this project are relevant between the other research.

2.1 Fiber Optic Communication

Everyone need to communicate with one another. The part of a communication channel is to carry the optical signal from transmitter to recipient without changing it. The basic optical transmitter is to change over the electrical input signal into modulated light for transmission over an optical fiber. Fiber optic system starting from transmitter consist modulator and circuitry that generate the carrier of a light beam that modulated by the digital pulses which turn on and off. While, the receiver part consists the detector that it will be senses the light pulses and converts an electrical signal as shown in **Figure 2.1** for the basic of fiber optic communication systems operations. The use of fiber-optic transmission is conceivable in any zone that requires exchange of data starting with one place then onto the next and widely for transmission data signal to form of light [4].

The most common devices used as the light source in optical transmitters are the light emitting diode (LED) and the laser diode (LD). Additionally, the range of region of fiber optic for the frequency spectrum of electromagnetic radiation is 660nm until 1550nm. The most popular wavelength of operation for transmitter are 850, 1300 or 1550 nanometers. Fiber optics have high bandwidth abilities and low attenuation is perhaps the important characteristics of the fiber make it ideal for gigabit transmission. In any case, mostly fiber optic communication system have been created generally for media transmission applications.

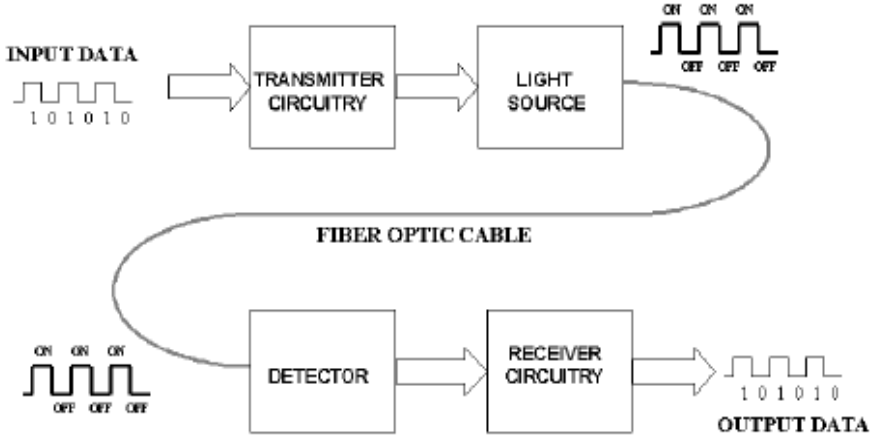

Figure 2.1 : *Basic Fiber Optic Communication*

2.2 Fiber Optic Cable Type

Optical fiber have concentric of three layer which are core, cladding, and coating or buffer and outer jacket. The basic structure of fiber optic is shown in **Figure 2.2**. The core is cylindrical rod of dielectric material. Core glass fiber is surrounded by cladding made from silica or doped silica, is a light transmitting propagates mainly along the region of the core of fiber and conducts no electric. Cladding is the second layer around the core. Cladding made from silica or plastic but not same structure with the glass core. This form an optical waveguide with index of refraction less than the core material. Coating is the