UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FIBER OPTIC SENSOR FOR SODIUM CHLORIDE CONCENTRATION DETECTION

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

by

RABIATUL ADAWIYAH BINTI MD SALLEH

B071310257

910601-14-5620

FACULTY OF ENGINEERING TECHNOLOGY

2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **FIBER OPTIC SENSOR FOR SODIUM CHLORIDE CONCENTRATION DETECTION**

SESI PENGAJIAN: **2016/17 Semester 1**

Saya **RABIATUL ADAWIYAH BINTI MD SALLEH**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

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

Disahkan oleh:

________________________ ________________________

Alamat Tetap:

A-04-08, Perumahan Awam Desa

Rejang, Persiaran Rejang,

53300 Setapak, Kuala Lumpur.

Cop Rasmi:

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

DECLARATION

I hereby, declared this report entitled "Fiber Optic Sensor for Sodium Chloride Concentration" is the results of my own research except as cited in references.

Signature :………………………

Name : **RABIATUL ADAWIYAH MD SALLEH**

Date : ………………………

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 (Telecommunication) (Hons.). The member of the supervisory is as follow:

……………………………….

(Md Ashadi bin Md Johari)

ABSTRACT

Fiber optic sensor for sodium chloride detection is a technology that sensing liquid using fiber optic cable. This research to develop the sensor that can detect parameter in liquid. This sensor has been test in 5 different percentage of concentration which is 20%, 40%, 60%, 80% and 100%, and also tested with 4 different wave length on sodium chloride concentration which is 850nm, 1300nm, 1310nm and 1550nm. The fiber optic sensor is immersed in the sodium chloride concentration within 1 hour and the data taken every 5 minutes. Finally the concentration of sodium chloride influencing the reaction of fiber optic sensor.

ABSTRAK

Fiber optik sensor untuk mengesan natrium klorida merupakan teknologi yang mengesan cecair menggunakan kabel gentian optik. Kajian ini untuk membangunkan sensor yang boleh mengesan parameter dalam cecair. Sensor ini telah ujian dalam 5 peratusan yang berbeza kepekatan iaitu 20%, 40%, 60%, 80% dan 100%, dan juga diuji dengan 4 panjang gelombang yang berbeza pada kepekatan natrium klorida yang 850nm, 1300nm, 1310nm dan 1550nm. Sensor gentian optik tenggelam dalam kepekatan natrium klorida dalam masa 1 jam dan data diambil setiap 5 minit. Akhirnya kepekatan natrium klorida mempengaruhi reaksi sensor gentian optik.

DEDICATIONS

To my beloved parents

To my kind lecturers

And not forgetting to all friends

For their

Love, Sacrifice, Encouragement, and Best Wishes

ACKNOWLEDGMENTS

In completing this project, I have received a lot of helps from my supervisor, lecturers, researchers and family members and fellow friends.

Firstly, I want to give my upmost thanks to my supervisor, Mr. Md Ashadi bin Md Johari who gave me an opportunity to do this project for guiding and assisting me through the completion of this project. Without her guidance and persistent help, this project would not have been successful.

I would like to express deepest appreciation to my parents in supporting me mentally and financially, for their encouragements and supports.

Secondly, it is also my duty to record my thankfulness to my fellow friends that gave advice at some points and lent me a hand in completing the project. Also to a friend that offered this private space for field test and analysis of the prototype.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

LIST OF SYMBOLS AND ABBREVIATIONS

FOS	=	Fiber Optic Sensor
COD	=	Coefficient of Determination
WDM	=	Wavelength-Division Multiplexing
ASE	=	Amplified Spontaneous Emission
OSA	=	Optical Spectrum Analyzer
IPA	=	Isopropyl Alcohol

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter will briefly discuss on the project background. This chapter also elaborates the problem statement, the objective, of this project, and the scope of this project.

1.1 Background

In this modern ages, speed data transmission is being given a prior for human being to perform well in their specific field of task. Speed of data transmitted is being concerned especially for medics and telecommunication, where it helps human being to perform well in their life.

Optical Fiber can be utilized as a medium for telecommunication and PC organizing on the grounds that it is adaptable and can be packaged as links. It is particularly favourable for long-remove interchanges, since light proliferates through the fiber with little weakening contrasted with electrical links. This permits long separations to be spread over with couple of repeaters. The use of fiber optics in this project is to expand the use of fiber optics in terms of the use of such sensors other than the data transmission. So from the fiber optic then modified into sensor and known as fiber optic sensor.

A fiber optic sensor is a sensor that utilizations optical fiber either as the detecting component ("intrinsic sensors"), or as a method for handing-off signs from a remote sensor to the hardware that procedure the signs ("extrinsic sensors"). Filaments have numerous utilizations in remote detecting. Contingent upon the application, fiber might be utilized as a result of its little size, or on the grounds that no electrical force is required at the remote area, or on the grounds that numerous sensors can be multiplexed along the length of a fiber by utilizing light wavelength shift for every sensor, or by detecting the time delay as light goes along the fiber through every sensor. While, intrinsic sensor the detection occurs in the fiber itself. Depending on the sensor when the optical properties of the fiber itself to change from one activity to the ecology of the light will pass through the bar. Here, one of the physical properties of light flags may be repeated, stage, polarization effect. The most useful elements of the natural fiber-optic sensor, it provides more separation detect delivered remotely.

Sodium chloride is the chemical name given to salt or table salt. It's a white crystalline mineral substance that's used as a seasoning in many foods, as well as in many workplace situations for a wide variety of purposes. Sodium chloride solutions are used medically to treat or prevent sodium loss caused by dehydration, excessive sweating, or other issues. These solutions are used in intravenous (IV) infusions and catheter flush injections. In the form of saline, sodium chloride is used to clean objects like contact lenses. So, this is the cause of sodium chloride were chose for concentration detection for fiber optic sensor.

This project is develop to study the capability of fiber to acts as a sensor for various sodium chloride concentration.

1.2 Problem Statement

A various kind of sensors has been developed nowadays for different type of usage. Nowadays, health is being priority for mankind to live well. Human health is being controlled and measured from many disease such as high blood pressure. Salt or in scientific called sodium chloride is one of the essential elements which act as an agent to enhance a better health. There are a lot of salt use salt used in technologies such as diet, health, and is sometimes used in therapy. Normally in laboratory use the salt concentration and not the percentage of the same concentration. Salt consumption varies even when using the same salt, but differences in concentration. So a fiber optic-built to impress each salt concentration. Then the final decision will indicate where the salt concentration of the most active and least active against cells of optical fiber. This would be additional information for fiber optic as high performance sensor and could be used in related fields such as biomedical.

1.3 Project Objectives

The objectives of this project are stated below:

1. To understand Fiber Optic Sensor operation.
2. To develop Fiber Optic Sensor for sodium chloride detection in different concentration.
3. To analyse performance Fiber Optic Sensor.

1.4 Project Scope

The concept of fiber optic connection to become a sensor needs special coordinated scope of work. As this project scope of the project to be determined so that the main objective can be achieved.

The scope of work in this project are given:

1. Study on the compatibility of fiber optic as sensor to identify the concentration of sodium chloride.
2. Analyzing the system establishment for fiber optic as sensor.
3. Data will be analyzed by the power loss of the fiber optic, where general hypothesis will be made.
4. Analysis will be conducted by varying the parameters which is the concentration of sodium chloride in order to obtain the experiment results which are closed to the theoretical result.
5. The result can be analyzed and studied.

1.5 Project Outline

This report is divided into three chapters. Chapter 1 is the introduction part which explain the project background, problem statement, project objectives and project scope. Chapter 2 which is literature review of the project is about references and understandings which are gained from various sources such as books, journals, Internet and previous projects. These materials are used as the main source for this entire project. Project methodology, methodology flowchart, software overview and process flow of the project are described in Chapter 3. The progress of PSM 1 and planning of PSM 2 will been state in Chapter 4 which preliminary result. While in Chapter 5 it will talk about conclusion that consists of discussion, suggestion and the conclusion of the project.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Literature review were carried out for the entire project and realizing the project. The main source for this project is the previous projects and other sources such as journals, articles, and books related to the project. This chapter also elaborates all the related research.

2.1 Fiber optic

Optical Fiber can be utilized as a medium for telecom and PC organizing on the grounds that it is adaptable and can be packaged as links. It is particularly favourable for long-remove interchanges, since light proliferates through the fiber with little weakening contrasted with electrical links. This permits long separations to be spread over with couple of repeaters.

The per-direct light flags spreading in the fiber have been tweaked at rates as high as 111 gigabits for each second (Gbit/s) by NTT, despite the fact that 10 or 40 Gbit/s is regular in conveyed systems. In June 2013, specialists exhibited transmission of 400 Gbit/s over a solitary channel utilizing 4-mode orbital precise force multiplexing.

Every fiber can convey numerous free channels, every utilizing an alternate wavelength of light (wavelength-division multiplexing (WDM)). The net information rate (information rate without overhead bytes) per fiber is the per-channel information rate diminished by the FEC overhead, increased by the quantity of channels (as a rule up to eighty in business thick WDM frameworks starting 2008). Starting 2011 the record for transfer speed on a solitary center was 101 Tbit/s (370 channels at 273 Gbit/s each).The record for a multi-main element as of January 2013 was 1.05 petabits for every second. [35] In 2009, Bell Labs broke the 100 (petabit per second) × kilometer obstruction (15.5 Tbit/s over a solitary 7,000 km fiber).

For short separation application, for example, a system in an office building, fiber-optic cabling can spare space in link conduits. This is on account of a solitary fiber can convey a great deal more information than electrical links, for example, standard class 5 Ethernet cabling, which ordinarily keeps running at 100 Mbit/s or 1 Gbit/s speeds. Fiber is additionally invulnerable to electrical obstruction; there is no cross-talk between signs in various links, and no pickup of ecological commotion. Non-defensively covered fiber links don't direct power, which makes fiber a decent answer for securing correspondences gear in high voltage situations, for example, power era offices, or metal correspondence structures inclined to lightning strikes. They can likewise be utilized as a part of situations where unstable exhaust are available, without threat of ignition. Wiretapping (for this situation, fiber tapping) is more troublesome contrasted with electrical associations, and there are concentric double central elements that are said to be tap-proof.

Strands are regularly likewise utilized for short-remove associations between gadgets. For instance, most top notch TVs offer an advanced sound optical association. This permits the gushing of sound over light, utilizing the TOSLINK convention.

2.1.1 Anatomy of a Fiber Optic

The two principle components of an optical fiber are its center and cladding. The "center", or the hub part of the optical fiber made of silica glass, is the light transmission range of the fiber. It might at times be treated with a "doping" component to change its refractive file and in this manner the speed of light down the fiber. The "cladding" is the layer totally encompassing the center. The distinction in refractive record between the center and cladding is under 0.5 percent. The refractive file of the center is higher than that of the cladding, so that light in the center hits the interface with the cladding at a bobbing point, gets caught in the center by aggregate inward reflection, and continues going in the appropriate heading down the length of the fiber to its destination.

Encompassing the cladding is normally another layer, called a "covering," which commonly comprises of defensive polymer layers connected amid the fiber drawing process, before the fiber contacts any surface. "Supports" are further defensive layers connected on top of the covering.

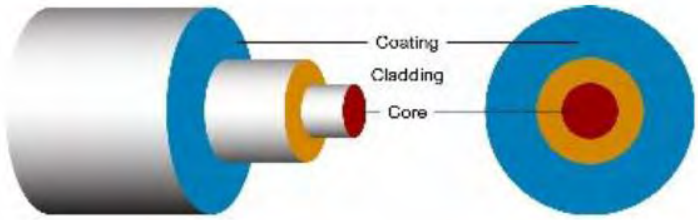

Figure 2.1: Basic view of an optical fiber

2.1.2 Types of Fiber Optic

1. Single-mode Fiber

Single-mode fiber takes into account a higher ability to transmit data since it can hold the devotion of every light heartbeat over longer separations, and it displays no scattering brought about by different modes. Single-mode fiber additionally appreciates lower fiber weakening than multimode fiber. Accordingly, more data can be transmitted per unit of time. Like multimode fiber, early single-mode fiber was for the most part described as step-file fiber meaning the refractive file of the fiber center is a stage over that of the cladding as opposed to graduate as it is in reviewed record fiber. Current single-mode strands have developed into more perplexing outlines, for example, coordinated clad, discouraged clad and other extraordinary structures.

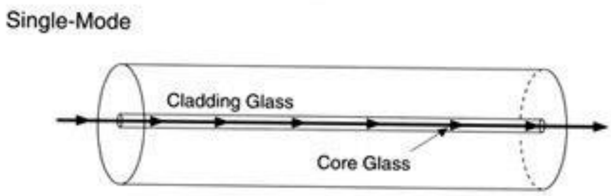

Figure 2.2: Single Mode of Fiber Optic

2. Multi-mode Fiber

Multimode fiber, the first to be produced and popularized, just alludes to the way that various modes or light beams are helped at the same time through the waveguide. Modes result from the way that light will just spread in the fiber center at discrete edges inside the cone of acknowledgment. This fiber sort has a much bigger center distance across, contrasted with single-mode fiber, taking into consideration the bigger number of modes, and multimode fiber is less demanding to couple than single-mode optical fiber. Multimode fiber might be classified as step-file or evaluated list fiber. Multimode Step-file Fiber.

Figure 2.3 demonstrates how the standard of aggregate inward reflection applies to multimode step-file fiber. Since the center's record of refraction is higher than the cladding's list of refraction, the light that enters at not exactly the basic point is guided along the fiber.

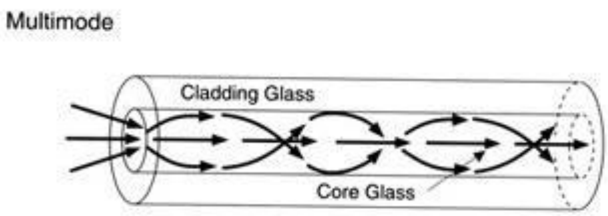

Figure 2.3: Multi Mode of Fiber Optic

2.1.3 Advantage of Fiber Optic

The advantages of optical fiber communication with respect to copper wire systems are:

1. Lower cost in the long run.
2. Low loss of signal (typically less than 0.3 dB/km), so repeater-less transmission over long distances is possible.
3. Large data-carrying capacity (thousands of times greater, reaching speeds of up to 1.6 Tb/s in field deployed systems and up to 10 Tb/s in lab systems).
4. Immunity to electromagnetic interference, including nuclear electromagnetic pulses (but can be damaged by alpha and beta radiation).
5. No electromagnetic radiation; difficult to eavesdrop.
6. High electrical resistance, so safe to use near high-voltage equipment or between areas with different earth potentials.
7. Low weight.
8. Signals contain very little power.
9. No crosstalk between cables.
10. No sparks (e.g. in automobile applications).
11. Difficult to place a tap or listening device on the line, providing better physical network security.

2.1.4 Disadvantage of Fiber Optic

1. High investment cost.
2. Need for more expensive optical transmitters and receivers.
3. More difficult and expensive to splice than wires.
4. At higher optical powers, is susceptible to "fiber fuse" wherein a bit too much light meeting with an imperfection can destroy as much as 1.5 kilometers of wire at several metres per second. A "Fiber fuse"