UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A FIBER OPTIC SENSOR ON ACIDIC LEVEL DETECTION USING BEAM-THROUGH TECHNIQUE

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

by

NURFARIHAH NATASHA BINTI MOHD NIZAM

B071410224

940411-02-5190

FACULTY OF ENGINEERING TECHNOLOGY

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **A Fiber Optic Sensor On Acidic Level Detection Using Beam-Through Technique**

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

Saya **NURFARIHAH NATASHA BINTI MOHD NIZAM** 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 yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐ TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐ TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:

No 42 A, Kampung Padang Kandang,
mukim Padang Matsirat, 07100
Langkawi, Kedah.

Cop Rasmi:

Tarikh: _____ Tarikh: _____

*** 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"A Fiber Optic Sensor On Acidic Level Detection Using Beam-Through Technique" is the results of my own research except as cited in references.

Signature : ……

Author's Name: NURFARIHAH NATASHA BINTI MOHD NIZAM

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 the degree of Bachelor of Engineering Technology Electronic Telecommunication with Honours. The member of the supervisory is as follow:

.....

(MD ASHADI B. MD JOHARI)

ABSTRAK

Penyelidikan mengenai sensor gentian optik telah berkembang lama dahulu dan penyelidik terus membuat kajian mengenai gentian optik sebagai sensor. Julat aplikasi yang melibatkan serat optik telah dilanjutkan. Kini hari, banyak organisasi menggunakan sensor gentian optik sebagai sensor. Teknologi kini telah matang ke titik di mana sistem sensor tersedia secara komersil dari beberapa syarikat. Kemudian, banyak syarikat dan pertubuhan penyelidikan yang lain terlibat secara aktif dalam pengujian bidang sistem sensor prototaip. Projek ini akan menganalisis jenis sensor yang sesuai digunakan oleh sensor gentian optik pada pengesanan paras asid menggunakan teknik pencahayaan. Analisis ini amat berguna untuk industri farmaseutikal. Analisis ini akan dianalisis dengan menggunakan teknik statistik untuk mendapatkan ketepatan keputusan yang lebih baik.

ABSTRACT

The research about the fiber optic sensor have been develop long time ago and the researcher keep going on research about the fiber optic as a sensor. Range of the application that involve in fiber optic have been extended. Now days, many organization use fiber optic as a sensor. The technology has now matured to the point where the sensor systems are commercially available from a number of companies. Then, many other companies and research establishments are actively involved in the field-testing of prototype sensors systems. This project was about to analyze the suitable of fiber optic sensor type on acidic level detection using beam-through techniques. This analysis was very useful to pharmaceutical industry. The analysis was analyze by using statistical technique to get better accuracy of the results.

DEDICATION

All the effort is dedicated to my beloved parents, family lecturers and friends, whose love can never be forgotten for their support, guidance and encouragement upon completing this project and report.

Special dedication to my parents

MOHD NIZAM BIN MD ZAIN
ROHANI BINTI BAHARI

ACKNOWLEDGEMENT

In the name of Allah S.W.T, The Most Merciful and The Most Passionate, I am thankful to Allah for allowing me to complete this report. First of all, I would like to thanks Mr. Md Ashadi bin Md Johari as my supervisor, lecturer of Faculty Technology Engineering for giving me a full cooperation and supervision during the making of this final year report. Thank you also to my family and friends for contributing their ideas and also encouraging me by giving moral support for me to complete this report. Last but not least, I want to give my deepest gratitude to all that part in directly or indirectly that helps me to complete my project.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLE

CHAPTER 1
INTRODUCTION

1.1 Project Background

Fiber optic sensors are supreme for exacting situations, with noise, high number of vibration, and extreme heat, and insecure situations. These sensors can without quite a bit of an extend fit in little zones and can be arranged viably wherever versatile strands are required. The wavelength move can be figured using a contraption, optical repeat zone Reflectrometry. The wavelength of the fiber optic sensors can be picked using a gadget, for instance, an optical time-space Reflectometer. Amid 1930, unique considerations were delivered with this fiber optic, for instance, transmitting pictures through a fiber. In the midst of the 1960s, Lasers were displayed as compelling light sources. In 1970s all glass filaments experienced unnecessary optical mishap, the loss of the light flags as it dared to all aspects of the fiber controlling diffusion remove. This induced the technologists to make glass filaments that join a disconnecting glass covering. The most profound area was used to transfer the light, and the glass covering shielded the light since spilling out of the middle by imitating the light inside the points of confinement of the inside.

A corrosive (acid) was a compound types that provides protons or hydrogen particles and also accepts electrons. Acids have a hydrogen molecule fortified that able to release (partitioned) to produce a positive and negative charges in water. The greater the combination of hydrogen particles made by a destructive, the greater its corrosiveness and the lesser the pH of the fluid. Everything needs to do with hydrogen particles (truncated with the synthetic image H+). In water (H2O), few the atoms separate (split up). A ration

of the water atoms miss a hydrogen and get to be hydroxide elements (OH−). The "lost" hydrogen particles collaborate with water atoms to frame hydronium particles (H3O+). For effortlessness, hydronium particles are referred to as hydrogen particles H+. In water, there are an equivalent number of hydrogen particles and hydroxide particles.

Acids in water concentration display the accompanying regular things: acid taste acrid; changing on litmus paper; and respond with specific metals. Then, this project focuses on Fiber Optic Sensor (FOS) that uses acidic solution beyond on different time and to shows the performances of each pH levels of acids on certain time. The FOS are more different because they have many advantages such as the simple in optic design, sensor accuracy, good range, and the low price of manufacture are advantageous attributes of the sensor and give advantages for real applications. This project is useful in pharmaceuticals industry.

1.2 Problem Statement

Recently to differentiate acid level in the lab is by using litmus paper or pH sensor. (Recent method). This project introduce new method to differentiate acid level using fiber optic sensor. This new method (using fiber optic sensor) could replacing the old method to test acid pH level. The usage of fiber optic as a sensor is choose based on various advantageous of fiber in sensing activities rather than other sensor (litmus and normal pH sensor). pH sensor replace the litmus paper as we know litmus paper was used to check the acidity or based for the solutions. pH sensor can give the correct acids level but in this research by using the fiber optic sensor the pH level for acid also can be checked. Purpose of the research is want to check the relation between the acids level with time. Which time is the most suitable for each pH levels of acids will be testing by using optical technology. This was a latest technology compared to the previous way which is by using the pH sensor and litmus paper. As a result of it unprecedented qualities as far as qualities to the extent precision, offer ease, negligible exertion and non-contact sort detecting which ready to perform without reaching the samples. Besides the outline, development and trial of a

sensor for identifying the nearness of acid as an element of position along an optical fiber length.

1.3 Objectives

Regarding on the problem statement mention before, there was an objective of this project:

1. To understand and study regarding fiber optic sensor.

2. To develop fiber optic sensor for acid medium in different time.

3.To analyses performance of fiber optic technology by using statistical techniques.

1.4 Scopes

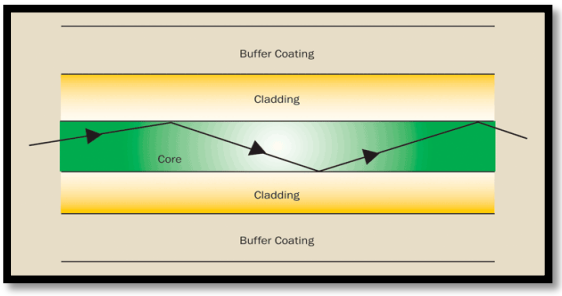
The scopes for the project including the following ranges, learning and understanding of fiber optic sensor in measuring acidity. Then, making the project by using fiber optic to check acidity in different time. After that, find the true result of measurement to prove the performance of acid. Beside that analysis of the result using statistical technique. Last but not least, improving the robustness of the design or process to variation

CHAPTER 2
LITERATURE REVIEW

2.1 Overview for Fiber Optic

On a basic level, a fiber optics alludes to the advancement of transferring light down tinny threads of profoundly straightforward material, for the most part glass however now and again plastic. Fiber optics is used piece of interchanges, light, medical, optical checks and as a radars. The fiber is a filament of silica based glass a hair, incorporated via a straightforward cladding. Light able be transferring to the fiber above awesome separation. Excessive data level capacities, clamor dismissal and electrical separation are the features that create fiber optic advancement perfect use for mechanical and business framework.[5]

Habitually utilized for indicate point associations, fiber optic connections are used to open up the separation impediments of RS-232, RS-422/485 and Ethernet structures although confirming great records amounts and limiting electrical check. Routine electricity data signal will changed into a controlled lighting bar, bring to the fiber and conveyed complete a little estimation glass to a gatherer that progressions of the light yet again into electricity signals. Fiber capacity to pass on the light flag, along through the little hardships, relies upon a pivotal substantial learning associated with the bending and impression of light.



Figures 2.1a: Travelling of light in the fiber optic

Fiber optic permit data signs to degree through the fiber by ensuring that the light flag arrives the fiber at an advantage more obvious than the fundamental reason for the boundary among two glass. As showed up in Figure 2.1, optical fiber is genuinely included three fragments. Within focus is made out of perfect glass. The wrapping glass, called cladding, is a conceivably less incorporating glass.

2.1.1 Fiber Optic Categories

Optical fibers types:

1. The Step Index Multimode Fiber
2. The Graded Index Multimode Fiber
3. The Single-mode Fiber

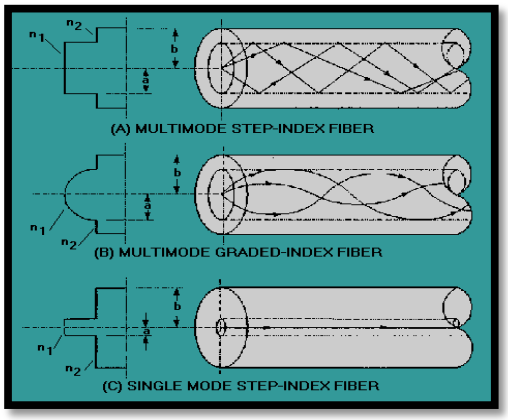


Figure 2.1b: Different categories of fiber optics.

An optical fiber is a tinny cylinder of dielectric substantial to transference light. The shaft propelled in the fiber is proliferated by internal reflection. A straightforward thin barrel of glass goes about as an optical fiber, be that as it may it is outrageous delicate and breaks effortlessly by applying a little curve. An approach to decrease this delicacy is to coat the pole with a smooth material like acrylic, silicon or polyimide. The fiber is presently considerably more strong and adaptable. Be that as it may, the light do not transfer in the fiber in view that these protective coats have reasonable or better refraction report than the bar and on this way no longer any more internal reflection occurs to take care of this matter, the bar (it'll come to be being the middle of the fiber) is encompassed by using a layer of glass (called cladding) with a little refraction list to allow add as much as inward reflection. The refraction listing difference among the center and the clad characterizes the brink (numerical beginning) at which the light can go into the fiber. The middle measurement stages from couple of microns as much as couple of millimeters. The length may additionally achieve kilometers as because of broadcast communications applications. For cosmic functions the lengths are typically littler than 100m.

Step Index Multimode Fiber has a large middle, as much as 100 microns in distance across [5]. Accordingly, a ration of the light rays that create up the superior heartbeat may also travel a right away route, although others crisscross as they pass off the cladding. These option paths purpose the various groupings of light beams, alluded to

as modes, to reach independently at a receiving point. The beat, a complete of various modes, begins to spread out, dropping its very a whole lot characterized form.

Graded Index Multimode Fiber consists of a middle wherein the refractive listing lessens little by little from the center hub out closer to the cladding. The higher refractive record on the center makes the light beams moving down the hub propel more steadily than those near the cladding [5]. Likewise, alternatively of crisscrossing off the cladding, light in the middle bends helically as a consequence of the evaluated list, lessening its journey separate. The abbreviated manner and the better speed permit light at the perimeter to touch base at a beneficiary at about an indistinguishable time from the moderate but straight beams within the center hub.

Single-Mode Fiber was narrow middle and the file of bending among the middle and the layer deviations quick of what it achieves for multimode threads [5]. Light on this manner makes a ride equivalent to the axis, and make a little heartbeat scattering. Telephone and digital telecom companies present a notable many kilometers of this fiber always.

2.1.2 Light Scattering

In optical fiber spreads, dispersing is the loss of flag conveyed on by the dissemination light bar, where the dispersion created by tiny selections in the diffusion standard. Dissipating ordinarily occur if a light flag get in touch in a contamination into fiber. Light disseminating is a type of dissipating in which light through spreading vitality is spread. Light diffusing considered as the avoidance of a beam from a straightforward pathway, for instance by abnormalities in the spread intermediate, elements, or in the boundary between two media. At the point when these abnormalities are thought to be arbitrary and sufficiently thick that impacts normal out, this sort of spread reflection is generally alluded to as diffuse reflection. The diffusion of different rates of light is fundamental for uses extending from glass to fiber optic transmission cables and infrared

(IR) warm looking for rocket recognition frameworks. Light proliferating through an optical framework can be constricted by ingestion, reflector and dispersing. [6]

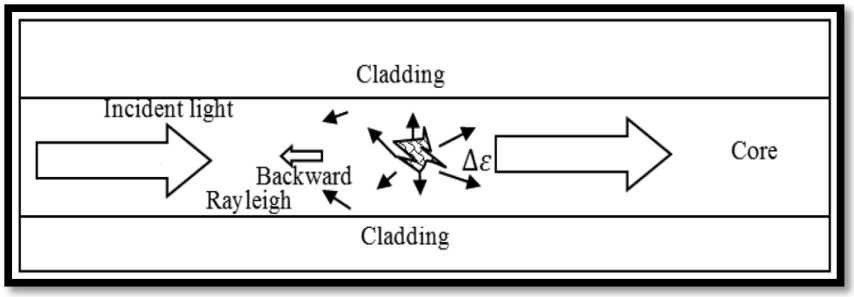


Figure 2.1c: Scattering in an optical fiber

2.1.3 Merits and Demerits of Fiber Optics

An optical fiber correspondence framework comprises of three segments: optical transmitter, fiber optic cable, and optical beneficiary. The optical transmitter changes over electrical flag to optical flag; the fiber optic cable conveys the optical flag from the optical transmitter to the optical recipient; and the optical collector reconverts the optical flag to electrical flag. Most optical fibers are made of silica or sand, crude material rich contrasted and copper. With only a couple pounds of glass, roughly 43 km of optical fiber can be delivered. Optical strands was utilized as a medium for media transmission and organizations management since it is flexible then be bundled as cables [5]. It is useful for long-remove transactions, since light engenders over the fiber with slight constriction compared with electrical copper cables. The fiber optics is better than metallic directors as a T/N line for signs on account of its high transfer speed, low weakening, obstruction, low bunks and light in weight [5]. Because of these preferences it is utilized as a part of field of media transmission. In this instructional exercise, we exhibit the points of interest and inconveniences of fiber optic transmission innovation.

To begin with data transmission size. Optical fiber cables have a substantially more important transfer speed than cables [5]. The measure of info that can be transferred per unit time of fiber over other diffusion media is its most basic favored viewpoint. An

optical fiber offers little impact occurrence. This thinks about longer diffusion detachments. Interestingly with copper; in a outline, the longest suggested copper partition is 100m while with fiber, it is 2000m. by then, the impedance. Fiber optic links are immune to electromagnetic obstacle. It can moreover be continue consecutively in electricity uproarious circumstances without stress as electrical noise won't impact fiber.. In contrast with copper, a fiber optic link has around 4.5 conditions as much cutoff as the wire link as and a cross sectional zone that is 30 times less. Close to that was the fiber optic weight. Fiber optic links are essentially more slim and lighter than metal wires.

Next, fiber was dielectric, it do not present a begin peril. Optical fibers are difficult to tap. As fiber do not exude electromagnetic imperativeness, releases could not be caught. Tapping the fiber takes phenomenal capacity to do hidden, fiber is the most secure medium available for passing on delicate data. Other than that is fiber optic adaptability. An optical fiber needs more vital inflexibility compared to copper or steel filaments of a comparable expansiveness. It is versatile, bends easily and restricts most dangerous parts that strike copper link. At long last is cost. The rough resources for glass are bounteous, not under any condition like copper. This suggests glass can be made more reasonably than copper. [5][1]

In any case Impediments was the cost of the link. Links are costly to present yet last longer than copper links. Next, transmission on optical fiber needs reiterating at detachment intervals. Fiber optic is Delicate. Filaments can be cracked or have diffusion loses when wrapped around curves of only several centimeters clear. Nevertheless by covering strands in a plastic cover, it is hard to contort the link into an adequately little traverse to break the fiber. Optical filaments require more protection around the link appeared.

2.2 Introduction of Fiber Optic Sensor

Figure 2.2a: Optical fiber sensor

A fiber optic sensor is a detecting equipment which utilizations fiber optic innovation for measuring physical amounts, for example, temperature, weight, strain, voltages and increasing speed. [1][9] Specifically, it utilizes an optical fiber as the detecting component, called an inherent sensor, or utilizations it to transport signals from the remote sensor to the flag preparing module (outward sensor). Fiber optic sensors are invulnerable to electromagnetic impedance and can deal with outrageous conditions, so they are picking up prevalence as the sensor of decision for some businesses.

Another reason, in any case, is that many devices can be multiplexed through the size of the fiber by developing an alternate light wavelength transfer for each sensor or by detecting the time it takes for light to go through the fiber through each extraordinary sensor. On the off chance that wavelength move is utilized, this can be detected and computed with the utilization of an instrument that actualizes optical recurrence area reflectometry. To make a fiber optic Ph sensor, an optical fiber with a transitory misfortune property that differs alongside time is utilized or the Raman disseminating created in the fiber by the time. To quantify electrical voltages, nonlinear optical impacts are detected in exceptionally doped fiber that changes its light polarization as a component of the electrical field.

2.2.1 Merits of Optical Fiber Sensor

Now, the inventive work of optical fiber sensor devices has many applications to various automated fields, including the therapeutic, compound, and broadcast communications researchs. Optical fiber sensors been delivered to measure a widespread arrangement of physical belongings, such as, substance variations, straining, electricity and attractive fields, temperature, weight, revolution, uprooting, radioactivity, stream, fluid level, vibrations, light force, and shading. Optical fiber sensors are contraptions that can be implemented in challenging circumstances where standard electricity and electronic radars encounter problems. In correlation with alternate sorts of sensors, fiber optic sensors show various points of interest: [2]

a) Not electricity gadgets

b) Need little cable measurements

c) Allow little sensor sizes

d) Often don't require contact

e) Permit remote detecting

f) Do not debase their environment and are not subject to consumption

g) Provide high affectability, determination and element extend

h) Allow access into ordinarily distant ranges

i) Offer affectability to different ecological parameters

j) Can be interfaced with information correspondence frameworks

k) Offer insusceptibility to radio recurrence impedance (RFI) and electromagnetic obstruction (EMI)