UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF FIBER OPTIC LIQUID SENSOR ON LIQUID PARACETAMOL CONCENTRATION DETECTION FOR PHARMACEUTICAL INDUSTRY

This report is submitted in partial fulfilment of the requirements of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Electronic (Telecommunication) Technology Engineering with Honours

by

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ABSTRAK

Kajian dalam bidang fiber optik sensor telah diperkenalkan dalam teknologi masa kini di mana untuk mencapai satu tujuan merealisasikan pelbagai aplikasi yang luas dalam teknologi fiber optik untuk digunakan oleh pengguna di serata dunia. Selain itu, teknologi fiber optic juga berkembang pada setiap syarikat yang mana bukan sahaja untuk bidang telekomunikasi. Malah, ia turut boleh digunakan untuk bidang lain dalam teknologi fiber optik. Tambahan pula, banyak syarikat yang menggunakan teknologi fiber optik dijadikan sebagai sensor dalam kajian untuk sistem sensor. Kajian ini dilaksanakan untuk menganalisis dan mengesan sensitiviti pada fiber optik sensor dengan menggunakan kepekatan cecair Paracetamol. Analisis ini juga berguna untuk teknologi masa hadapan dan boleh dijadikan sebagai maklumat yang penting untuk industri farmaseutikal dan perubatan. Kajian ini dapat membangunkan sensor yang boleh mengesan cecair. Sensor ini akan menumpukan pada lima jenis peratusan kepekatan yang berbeza dan diuji dengan empat jenis panjang gelombang yang berbeza pada kepekatan cecair Paracetamol. Tempoh untuk pengumpulan data dalam kepekatan cecair Paracetamol dalam setiap 5 minit untuk tempoh satu jam. Akhirnya kepekatan cecair Paracetamol boleh mempengaruhi reaksi fiber optik sensor.

ABSTRACT

The research in the field of fiber optic sensors have been introduced in the current technology where to achieve one goal the realization of various applications in fiber optic technology for use by users around the world. Besides that, fiber optic technology evolved at each company in which not only to the field of telecommunications. In fact, it can also be used for other filed in fiber optic technology. In addition, many companies use fiber optic technology serves as the sensor in the sensor system to research. This research was performed to analyze and detect sensitivity in fiber optic sensors using the concentration of liquid Paracetamol. This analysis is also useful for future technology and can be used as information important to the pharmaceutical and medical industry. This research was unable to develop sensors that can detect the liquid. This sensor will focus on five different types of the percentage concentration and tested with four types of different wavelengths at the concentration of liquid Paracetamol. Period for data collection in the concentration of liquid Paracetamol in every 5 minutes for a period of one hour. Eventually the concentration of liquid Paracetamol can influence the reaction of fiber optic sensor.

DEDICATION

This thesis is dedicated to my family for their endless love, support and encouragement.

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LIST OF SYMBOLS AND ABBREVIATIONS

FOS	Fiber Optic Sensor
COD	Coefficient of Determination
ASE	Amplified Spontaneous Emission
OSA	Optical Spectrum Analyzer
dB	Decibel
FTTO	Fiber to the office
FTTS	Fiber to the street
FTTC	Fiber to the curb
FTTH	Fiber to the home
FTTZ	Fiber to the zone
EMI	Electromagnetic Interference
PVC	Polymerizing Vinyl Chloride
LED	Light-Emitting Diode
COX	Cyclooxygenase

CHAPTER I

INTRODUCTION

1.1. Introduction

This chapter will briefly discuss in the project background. This chapter also explains about the problem statement, the objectives of this project and the scope of this project.

1.2. Project Background

Advances in optical technologies are very fast compared with other technologies. At present, the involvement of other optical technology is of potential has grown enormously. The wide spectrum of optical device applications provides an overview of the importance of this emerging field. Fiber optic has an important role not only in communication but also in the development of various types of sensors. Fiber optic sensor can form a large part of its contribution to the overall optical technology. Sensing the fiber optic is supported by the main features, which can make it stand out among other sensing methods. In the bio – medical, fiber optic sensors have become an indispensable tool for biomedical research because there are unique characteristics such as high sensitivity, small footprint and compatibility endoscopic, and immunity from electromagnetic interference.

There are two important scientific advances made in 1960, namely laser in 1960 and modern low-loss fiber optic in 1966. Both equally had origins in work in the previous decades to the microwave predecessor of the laser (the maser) and the short-length low transparency fibers used in early endoscopes for medical and

industrial applications. Therefore, some of the first experiments on low-loss fiber optic used in early 1970, not for telecommunication has become the main impetus for development but is aimed at sensor. This field continues to progress and has been growing rapidly. The main thing in research today is to produce fiber optic network based techniques that are used for various purposes of different sensors and provide the basis for an effective measurement technology. Here are recipes for success fiber optic sensor.

Paracetamol is a safe and effective medicine for lowering high temperature due to fever if taken as recommended on the label paracetamol. However, paracetamol can be harmful to the body if taken in excessive quantities. Paracetamol is also effective to control pain from moderate to light, for example pains caused by osteoarthritis, migraines or headaches. However, patients should seek advice from your doctor if you are using paracetamol for a long time. Paracetamol can able found in combination with other therapeutic agents such as an antihistamine that provides relief in fever and flu. In Malaysia, paracetamol can also be easily found in any store, especially pharmaceuticals.

This project to analyze concentration and performance of fiber optic sensor using liquid Panadol paracetamol. Therefore, this project is to develop a fiber optic sensor to detect the concentration of the liquid paracetamol. The best concentration will provide the high sensitivity of the fiber optic sensor. Faster transmission and higher sensitivity of the sensor fiber optic can help in increasing the efficiency of liquid paracetamol concentration analysis. This research can be a useful technology for use in pharmaceutical industry.

1.3. Problem Statement

Fiber optic sensors have been introduced in the form of medical and industrial applications. Currently, fiber optic sensors have been developed not only in the form of communication, even fiber optic sensor used in the form of infrastructure, pipelines, process control, oil, gas, and others. In this project, fiber optic sensors are used to detect the concentration of liquid paracetamol. In this modern era, there is no fiber optic sensor that shows how much concentration to be

taken by children to help the system of the child's body. By creating a fiber optic sensor, it can detect concentrations given in children or in enough. Production of this sensor can help either dose administered in children able to recover or affect the health of children. Therefore, any results or answers about the concentration detection of liquid paracetamol can help pharmaceutical and medical industry to find out how a given amount or rate in children. Furthermore, this research will prove the ability of the sensitivity of the fiber optic sensor on liquid paracetamol.

1.4. Project Objectives

There are three main objectives for this research which can bring this project successful.

- To understand the fiber optic sensor operation.
- To develop fiber optic sensor for liquid paracetamol concentration detection.
- To analyze the performance of fiber optic sensor.

1.5. Project Scope

The scope of this project is to study and develop a fiber optic sensor for detection of liquid paracetamol concentration. This project is to ensure that this task in the right direction to achieve its objectives. The scope of this project is to investigate and detect the concentration of the liquid paracetamol. Any study of the concentration detection of liquid paracetamol will help pharmaceutical and medical industry as important information in making medicines for children.

CHAPTER II

LITERATURE REVIEW

2.1. Introduction

This section will present the literature review. It's very important to understand the concept of fiber optic and fiber optic how it works before designing and analyzing the fiber optic sensor to detect the concentration of liquid paracetamol. The concept of fiber optic will be described in more detail in the literature review.

2.2. Fiber Optic

Fiber optic can be used as an intermediate (medium) for the telecommunications and computer networks because it is very flexible and can be fastened to the cable. Although fibers can be made of transparent plastic or glass fibers used in long-distance telecommunications almost always use glass, because optical absorption is lower. The light emitted by the fiber saved due to total internal reflection (total internal reflection) in the material. This is important features that eliminates cross signals between fibers in the cable and allow the installation of cables with curves and turns. The use of telecommunications, the light used usually infrared light, the light waves approaching the minimum absorption wavelength for the fiber used.

Fiber optic is the newest and most of the media transmission to almost all forms of digital and data communication applications including local area networks, metropolitan, and wide area networks. With fiber optics, electromagnetic waves are guided through media consisting of transparent materials without the use of electrical current flow. With fiber optics, electromagnetic light waves propagate through media

in much the same ways that radio signals propagate through the Earth's atmosphere. (Tomasi, 2004)

Basically, the optical communication system is one that has used light as an information carrier. Spread the light waves to enter the Earth's atmosphere is difficult and impractical. Thus, the fiber optic communication system using glass or plastic fiber is able to "contain" and guiding light waves in a similar way or with electromagnetic wave transmission medium is guided through the metal. (Tomasi, 2004)

The information – carrying capacity of any electronic communication system is directly proportional to the bandwidth. Fiber optic cables have, for practical purposes, an unlimited bandwidth. Therefore, the ability to carry more information than metal or, in this case, although the wireless communication system is the most advanced. (Tomasi, 2004)

2.2.1. Structure of Fiber Optic

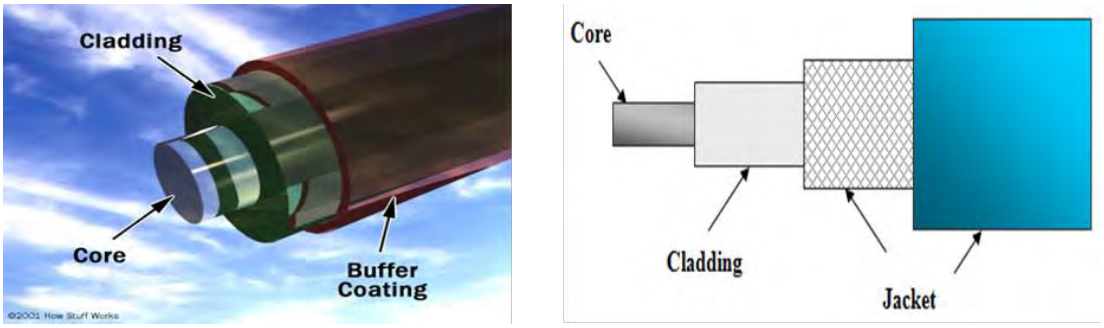

Figure 2.2.1: Structure of Fiber Optic

- **Layer 1**: Core – The thin glass fiber optic which the light travels
- **Layer 2**: Cladding – The part which surrounds the core layer that reflects light back to the core and avoid the light source go outside the core.
- **Layer 3**: Buffer Coating – Plastic coating that protects the fiber optic from damage and moisture
- **Layer 4**: In one cable, there are hundreds or thousands of fiber optic which covered a layer known as Jacket.

2.2.2. Fiber Optic Construction

The use of telecommunications, the light used usually infrared light, the light waves approaching the minimum absorption wavelength for the fiber used. The fibers are usually used in pairs with one fiber carries one-way traffic. (Tomasi, 2004)

Every single element in the fiber optic cable has its own functions beneficial. The cable jacket is an outer layer in any cables. Most of the fiber optic cable has an orange jacket even though there are several types of cable in black or yellow. Next, the function of the fiber optic cable is to help protect the core of the damage that will occur such as animal bites, natural disasters and so on. How important is the cable jacket protects the core as the core is made of glass and is very sensitive. The coating is a plastic coating that surrounds the core and cladding to strengthen and protect the fiber optic core. Then, the coating is a thin layer that surrounds the core and serves as a border with light waves and cause refraction and allows data to follow the course of the entire length of the fiber optic segment. Finally, the core is a form of physical carrying optical data signal from a light source attached to the receiving device. The terrace is a single continuous piece of glass or plastic, which is measured in microns (μ) by size in outer diameter. The more light that cable can carry, the greater its core. (Tomasi, 2004)

2.2.3. Type the Use of Fiber Optic

Type in the use of fiber optic communication system is

i. **Fiber to the office (FTTO)**
   - Normally, the cabinets are placed in a building and have their own room. The rooms are equipped with air conditioning to avoid system down.
   - In addition, also provided the krone and some wires for connection to the customer.

- FTTO system is limited to only a few customers and the fiber optic is terminated directly to the customer.

ii. **Fiber to the street (FTTS)**

- FTTS cabinet is usually found near the road or by the roadside.
- Cable distribution is still in the form of copper and fiber optic is terminated in a circuit card slot.
- Line capacity that can be brought only 480 line.

iii. **Fiber to the curb (FTTC)**

- This fiber optic will through the copper and its position is closer to the customer with guesses distance of 100 m.
- The equipment is placed in the control site or pole mounted with a maximum capacity of 30 circuits.

iv. **Fiber to the home (FTTH)**

- FTTH fiber types will be connected directly to the customer. It is the last terminal for online access to customers.

v. **Fiber to the zone (FTTZ)**

- FTTZ fiber types are used if there is a new operation system and also the transfer of the fiber optic into a new area.

2.2.4. Types of Fiber Optic Cable

There are several types of fiber optic cable commonly used. Among them are:

i. Loose Tube Fiber Cable
ii. Slot Tube Fiber Cable
iii. Ribbon Fiber Cable

Figure 2.2.4 (i): Loose Tube Fiber Cable

Figure 2.2.4 (ii): Slot Tube Fiber Cable

Figure 2.2.4 (iii): Ribbon Fiber Cable

2.2.5. Mode of Propagations

In fiber optic terminology, the word mode simply mean path. If there is only one path for light rays to take down a cable, it is called single mode. If there is more than one path, it is called multimode. As shown in **Figure 2.2.5 (a)**, with single – mode propagation, there is only one path for light rays to take, which is directly down the center of the cable. However, as **Figure 2.2.5 (b)** shows, with multimode propagation there are many higher – order mode possible, and light rays propagate down the cable in a zigzag fashion following several paths. (Tomasi, 2004)

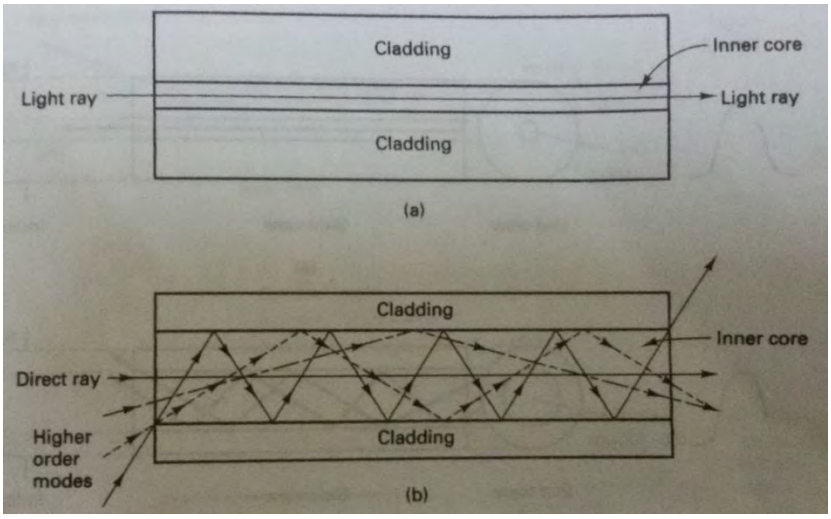

Figure 2.2.5 (a) single - mode; (b) multimode for Mode of Propagations

2.2.6. Fiber Optic Classifications

Propagation modes can be categorized as either multimode or single mode, and then multimode can be further subdivided into step index or graded index. Although there are a wide variety of combinations of modes and indexes, there are only three practical types of operation fiber configurations: single mode step – index, multimode step – index and multimode graded index. Every fiber optic have a refractive index. It has a central core in which the light is guided and higher refractive index (N1). Besides that, the core was embedded in an outer cladding of slightly lower refractive index (N2). Light rays incident on the core – cladding boundary at angles greater than the critical angle undergo total internal