PHOTOBIODEGRADATION OF REACTIVE BLACK 5 (RB5) USING *ASPERGILLUS NIGER* AND N,S-TiO_2 UNDER VISIBLE LIGHT

NURWANIM BINTI BORHAN

FACULTY OF CHEMICAL ENGINEERING
UNIVERSITI TEKNOLOGI MARA
SHAH ALAM

2016

ACKNOWLEDGEMENT

All praises be to Allah SWT for His infinite bounties, all the knowledge and the guidance for the vicegerents and love. Peace be upon Prophet Muhammad SAW, his family, his companions and the people who follow his path.

I would like to thank to my dearest supervisor Mr. Mohamad Sufian So'aib who has guided and helped me a lot upon completing this project. Thank you for the knowledge and the inspirations he gave me from the beginning of the project until it comes to end.Also countless appreciation to all my classmate who always there to motivated and helped me for this project. To lab technician and master students, thanks for helping me for all lab protocol and all the discussion and relevance idea for the experiment.

Last but not least, a great thank to my family members who always give me moral support and advice in completing this project, encourage in every stage of the project, and who always want me to complete and enjoy all the things I put effort into. May Allah reward all of your efforts with His blessing and forgiveness. In Sha Allah.

ABSTRACT

The rate of photodegradation, biodegradation and combined photobiodegradation on reactive black 5 (RB5) using N,S-TiO_2 and *Aspergillus niger* under visible light has been investigated. Various reaction parameters such as dopant concentration and catalyst loading of N,S-TiO_2 and, inoculum size of *Aspergillus niger* were investigated. The photocatalyst samples were prepared using solgel method with titanium tetraisopropoxide as precursor of titania. Three different dopant concentrations were investigated; 0.5%, 0.75% and 1.0% while the catalyst loading were varied from 1 g/L, 2 g/L and 3 g/L to determine the optimum condition for the photodegradation of Reactive Black 5. The rate of biodegradation of Reactive Black 5 also was investigated by using *Aspergillus niger* by varying the inoculum size from 5 ml, 10 ml and 15 ml. From these batch experiment, the optimum dopant concentration 0.75% N,S-TiO_2, catalyst loading 3 g/l and 10 ml of inoculum size were used to investigate the combination of photobiodegradation experiment. In photobiodegradation experiment, the initial Reactive Black 5 concentration was varied; 10 ppm, 25 ppm and 50 ppm to investigate the rate of photobiodegradation with time. The finding shows that the combined photobiodegradation took only 6 hours to degrade 90% of the Reactive Black 5, whereas photodegradation took 7 hours and biodegradation took 72 hours to degrade the Reactive Black 5. This can be concluded that photobiodegradation processes can save more time to degrade the Reactive Black 5.

TABLE OF CONTENTS

DECLARATION iii
SUPERVISOR'S CERTIFICATION iv
ACKNOWLEDGEMENT vi
ABSTRACT vii
TABLE OF CONTENTS viii
LIST OF FIGURES x
LIST OF TABLES xi
LIST OF ABBREVIATIONS xii
LIST OF SYMBOLS xiii
CHAPTER 1 1
INTRODUCTION 1
1.1 Background 1
1.2 Problem Statement 7
1.3 Objective 7
1.4 Scope of Research 7
CHAPTER 2 8
LITERATURE REVIEW 8
2.1 Photodegradation and Biodegradation 8
2.2 Reactive Azo Dyes 9
2.3 Different methods of textile wastewater treatment 11
2.3.1 Biological treatment of dyes 16
2.3.2 Biodegradation kinetics using Monod Kinetic Model 18
2.4 Heterogeneous photocatalyst 19
2.4.1 Background 19
2.4.2 Titanium dioxide (TiO_2) structures and properties 20
2.4.3 Electronic processes in TiO_2 photocatalysis 21
2.4.4 Kinetics of photocatalytic degradation 23
2.4.5 Modified Titanium Dioxide (TiO_2) 23

CHAPTER 1

INTRODUCTION

1.1 Background

Water is basic necessity for life and sufficient water supply in both quality and quantity is vital for human being, animal and plants in order to carry out their normal life. Water occupies three quarters of the earth surface but only 2.5% is non salty. Only less than 1% of this 2.5% world's fresh water is readily available for human use but unfortunately is unevenly distributed.

Annual global water consumption is about 10^4 km^3. At present, the amount of accessible potential drinking water for every year is between 10 and 30 x 103 km^3 (UNESCO, 2002). Therefore, even a small shortage of water might turn into a danger for humankind. It is estimated that (WHO, 2002; UNESCO, 2002;UNICEF, 2002):

(a) 2.2 million people in developing countries die every year from illness associated with lack of safe drinking water.

(b) 1.2 billions of people are lacking safe drinking water (one quarter of the world population)

(c) More than 80 countries are suffering from a lack of water (>40% of the world population).

Unfortunately, our biosphere is undergoing tremendous development so there are many threats to the environment which come from water pollution and air pollution. There are many kinds of activities that affect the environment in terms of water, air or land. Industrial, agriculture, shipping, radio-active, aquaculture wastes are the examples of activities that affect water while air are affected by the mobile combustion, burning of fuels, industrial pollutants, suspended particulate matter, ionization radiation; and on land by domestic wastes, industrial wastes, agricultural chemicals and fertilizers, acid rain, and animal waste have bad effects over biotic and abiotic components on different natural eco-systems.