# PHOTOBIODEGRADATION OF REACTIVE BLACK 5 USING MIXED MICROBIAL CULTURE AND N-S-TiO2 UNDER VISIBLE LIGHT

AINUL JAMILAH BINTI AZMAN

BACHELOR OF ENGINEERING (Hons)

CHEMICAL AND BIOPROCESS

FACULTY OF CHEMICAL ENGINEERING

UNIVERSITI TEKNOLOGI MARA

JULY 2016

## Abstract

The photobiodegradation of reactive black five (RB5) by using N-S-TiO2 and mixed cultured under visible light was studied. The effect of several parameters such as dopant concentration, catalyst loading, inoculum size and initial concentration of RB5 were investigated. To study the kinetic of degradation, Langmuir-Hinshelwood mechanism was used for photodegradation meanwhile, for biodegradation, Monod equation was used. Thus, the rate of degradation was measured by using spectrophotometer. Two experiments with the purpose to study the kinetics of photodegradation were conducted by using parameters such as dopant concentration and catalyst loading. Optimum dopant concentration recorded was 0.75 % meanwhile, optimum catalyst loading was 1 g/L. biodegradation experiment shows the optimum inoculum size recorded was 5 mL. Based on combine photodegradation study, the rate of degradation of RB5 was faster compare to photodegradation and biodegradation.

**CONTENT**

**CONTENT …… i**
**LIST OF TABLES …….. ii**
**LIST OF FIGURES ……. ii**
**NOTATIONS …… iii**
**ABSTRACT …….. iv**
**Chapter 1: Introduction**
**1.1 Dyes classification …….. 1**
**1.2 Effect of azo dyes to the environmental and living things ……. 3**
**1.3 Problem statement …….. 4**
**1.4 Objectives …… 5**
**1.5 Scope of research …… 6**
**1.6 Conclusions ……. 7**

**Chapter 2: Literature review**
**2.1 Definition of dyeing …….. 8**
**2.2 Dyeing techniques ……. 9**
**2.3 Theory of photocatalytic process …… 10**
**2.4 Synthesis of reactive black 5 …… 11**
**2.5 Reaction of reactive black 5 ……. 13**
**2.6 Photocatalysis of reactive black 5 ……..... 13**
**2.7 Kinetics study of doping $TiO_2$ catalyst …… 14**
**2.8 Dyes techniques removal …… 15**
**2.9 Possible enzyme within waste water effluent …… 19**
**2.10 textile-dye degradation systems ……. 21**

**Chapter 3: Research methodology**
**3.1 Photodegradation of RB5 …… 24**
**3.2 Biodegradation of RB5 ……. 25**
**3.2 Photo-biodegradation of RB5……26**

**Chapter 4: Results and discussions**

**4.1 Photocatalytic activity of RB5 …… 27**

**4.2 Photocatalytic degradation of RB5 ……..**

**27**

**4.3 Biodegradation of RB5 ……..**

**29**

**4.4 Photo-biodegradation of RB5 ……**

**32**

**Chapter 5: Conclusions …….**

**34**

**Reference ……..**

# CHAPTER 1

# INTRODUCTION

## 1.1 Dyes classification

A dye can be classified as colour substance that has affinity when it is apply to the substrate. Generally, the dye applied in the liquid form where high technology may be used to improve the effectiveness and give the high performance of the specific dye. A mordant term used widely in the dye industry which can be define as materials or reagents that used to set and fixed specific dyes to cells, tissues, textile or materials by forming coordination complex between both of them. Dyes can be classified according to their nature and all of them can be categorized into 20 groups based on the chemical structure.

| | Group | Uses |
|---|---|---|
| **Category:** | Acridine dyes, derivatives of acridine >C=N-and>C=C | Textiles, leather |
| **Category:** | Anthraquinone dyes, derivatives of anthraquinone >C=O and>C=C | Textiles |
| **Category:** | Arylmethane dyes<br>• Diarylmethane dyes, based on diphenyl methane<br>• Triarylmethane dyes, based on triphenyl methane | |
| **Category:** | Azo dyes, based on a -N=N- azo structure | |
| **Category:** | Cyanine dyes, derivatives of phthalocyanine | |
| **Category:** | Diazonium dyes, based on diazonium salts | |
| **Category:** | Nitro dyes, based on the -NO2 nitro functional group | |
| **Category:** | Nitroso dyes, are based on a -N=O nitroso functional | |
| **Category:** | Phthalocyanine dyes, derivatives of phthalocyanine >C=N | Paper |
| **Category:** | Quinone-imine dyes, derivatives of quinone | Wool and paper |
| **Category:** | Azin dyes<br>• Eurhodin dyes<br>• Safranin dyes, derivatives of safranin -C-N=C- -C-N-C | Leather and textile |
| **Category:** | Xanthene dyes, derived from xanthene -O-C6H4-0 | Cotton, Silk and Wool |
| **Category:** | Indophenol dyes, derivatives of indophenol >C=N-and>C=O | Color photography |
| **Category:** | Oxazin dyes, derivatives of oxazin -C-N=C =C-O-C= | Calico printing |
| **Category:** | Oxazone dyes, derivatives of oxazone | |
| **Category:** | Thiazin dyes, derivatives of thiazin | |
| **Category:** | Thiazole dyes, derivatives of thiazole >C=N-and-S-0= | Intermediate |
| **Category:** | Fluorene dyes, derivatives of fluorene | |
| **Category:** | Rhodamine dyes, derivatives of rhodamine | |
| **Category:** | Pyronin dyes | |

Figure 1.1.1 Classifications of dyes (source: [http://www.dyes-pigments.com])