



**UNIVERSITI PUTRA MALAYSIA**

**REMOVAL OF COLOUR AND ORGANIC POLLUTANTS FROM TEXTILE  
WASTEWATER USING INTEGRATED BIOLOGICAL AND ADVANCED OXIDATION  
PROCESS**

**ADEL MOHAMED AHMED**

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AND ADVANCED OXIDATION PROCESS**

**By**

**ADEL MOHAMED AHMED**

**Thesis Submitted to the School of Graduate Studies, Universiti  
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Degree of Doctor of Philosophy**

**June 2007**



*To the soul of my father.  
A father who shows me his support from the day of  
my cradle till the day he dies.  
And to all faithful Muslims in the world.*



Abstract of the thesis presented to the Senate of Universiti Putra  
Malaysia in fulfilment of requirement for the degree of Doctor of  
Philosophy

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TEXTILE WASTEWATER USING INTEGRATED BIOLOGICAL  
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**June 2007**

**Chairman: Professor Azni Idris, PhD**

**Faculty : Engineering**

Textile industrial wastewater effluent varies greatly in characteristics within a plant and even from the same process from time to time. Removal of pollutants such as colour and organics by conventional techniques has been difficult and could not reach the level of required discharge. In this study, colour and organic removals from textile wastewater in a continuous process using an integrated system of activated sludge and advanced oxidation process was studied. The primary objective was to reduce colour to 50 PtCo; the total organic carbon (TOC), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total suspended solid (TSS) to less than 20, 50, 20 and 20 mg/l, respectively; and to remove oil and grease (O&G). Activated sludge was satisfactory in terms of removing TOC, COD, BOD, O&G and TSS. At 36 h



retention time, the removal of TOC, COD, BOD, O&G and TSS were 80, 78, 79, 53 and 61%, respectively. However, the colour removal was only 37%.

With equalization tank, combining of 50 mg/l O<sub>3</sub> with 1 ml/l H<sub>2</sub>O<sub>2</sub> and UV was proven capable of reducing the colour, TOC, COD, BOD, O&G and TSS after 60 min by 97, 60, 64, 62, 90 and 36%, respectively.

Without equalization tank, activated sludge treatment was efficient in terms of removing TOC, COD, BOD, O&G and TSS from the different strengths of textile wastewater samples. Removals of TOC, COD, BOD, O&G and TSS were 76-86, 77-84, 78-82, 34-61 and 65-74%, respectively. However, colour removal was from 17 to 34%. This means that activated sludge was satisfactory in removing only organics pollutants.

Having different, easy control and successful processes that treat different strengths of textile wastewater is the best formulation of process treatment options to ensure appreciable removals of colour and organic pollutants from any strength of textile wastewater.

A software called TexTreat was successfully developed. It can determine the required process treatment option of AOP<sub>s</sub> for any existing textile treatment plant and predict the characteristics of the final discharge using different retention times. The validation of the process treatment options using TexTreat shows their applicability with different textile wastewater plants.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra  
Malaysia sebagai memenuhi keperluan untuk ijazah Doktor  
Falsafah

**PENYINGKIRAN WARNA DAN BAHAN PENCEMAR ORGANIK  
DARIPADA AIR SISA BUANGAN TEKSTIL MELALUL PROSES  
BERSEPADU BIOLOGIKAL DAN PENGOKSIDAAN TERMAJU**

Oleh

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Ciri-ciri air sisa buangan industri tekstil adalah berbeza bagi setiap kilang malah juga berbeza walaupun ia melalui proses yang sama dari semasa ke semasa.

Penyingkiran bahan cemar seperti warna dan organik melalui teknik konvensional adalah sukar dan tidak dapat mencapai tahap pembuangan. Oleh itu, kajian penyingkiran warna dan organik daripada sisa buangan tekstil sebenar melalui proses berterusan menggunakan sistem bersepadu enapcemar teraktif dan proses pengoksidaan termaju dijalankan. Objektif utama kajian adalah untuk mengurangkan bahan cemar warna kepada 50 PtCo dan Jumlah Karbon Organik (TOC), Keperluan Oksigen Kimia (COD), Keperluan Oksigen Biokimia (BOD), dan Jumlah Pepejal Terampai (TSS) kepada nilai kurang daripada 50 mg/l serta penyingkiran Minyak dan Lemak (O&G).



Enapcemar teraktif berkesan dalam menyingkirkan TOC, COD, BOD, O&G dan TSS. Selepas 36 jam masa penahanan, penyingkiran TOC, BOD, O&G dan TSS adalah sebanyak 80, 78, 79, 53 dan 61%. Walaubagaimanapun, penyingkiran warna hanya sekadar 37% yang berkemungkinan disebabkan oleh kehadiran bahan organik tak berwarna dalam air sisa buangan tekstil dan kadar larut pewarna biodegradasi yang rendah.

Kombinasi 50mg/l  $O_3$  dengan 1ml/l  $H_2O_2$  dan UV dalam tangki penyamaan berupaya mengurangkan kadar warna TOC, COD, BOD, O&G dan TSS kepada 97, 60, 64, 62, 90 dan 36 %. Tanpa tangki penyamaan, rawatan ke atas enapcemar teraktif sangat berkesan dalam menyingkirkan TOC, COD, BOD, O&G dan TSS daripada sampel air sisa buangan tekstil yang mempunyai keupayaan yang berbeza. Nilai penyingkiran TOC, COD, BOD, O&G dan TSS adalah sebanyak 76-86, 77-84, 78-82, 34-61 dan 65-74%. Walaubagaimanapun, penyingkiran warna adalah dari 17 kepada 34%. Ini bermakna enapcemar teraktif hanya berkesan dalam menyingkirkan bahan cemar organik sahaja.

Oleh yang demikian, kawalan yang mudah dan proses yang berjaya dalam kepelbagaian keupayaan air sisa buangan tekstil merupakan strategi rawatan terbaik dalam memastikan penyingkiran lebih berkesan terhadap bahan cemar warna dan organik daripada semua jenis keupayaan air sisa buangan tekstil.

Proses regressi yang berkaitan dengan formulasi rawatan telah dibangunkan dalam kod perisian (TexTreat). Penilaian terhadap strategi rawatan dan juga TexTreat menunjukkan keupayaannya terhadap kepelbagaian air sisa buangan kilang tekstil.



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I certify that an Examination Committee has met on 21 June 2007 to conduct the final examination of Adel Mohamed Ahmed on his Doctor of Philosophy thesis entitled “Removal of Colour and Organic Pollutants From Textile Wastewater Using Integrated Biological and Advanced Oxidation Process” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

---

**ADEL MOHAMED AHMED**

Date: 25 September 2007

## TABLE OF CONTENTS

	<b>Page</b>
<b>DEDICATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	v
<b>ACKNOWLEDGEMENTS</b>	viii
<b>APPROVAL</b>	x
<b>DECLARATION</b>	xii
<b>LIST OF TABLES</b>	xvii
<b>LIST OF FIGURES</b>	xix
<b>LIST OF ABBREVIATIONS</b>	xxviii
 <b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Introduction	1
1.2 Waste Problem in the Textile Industry	2
1.3 Textile Industry in Malaysia	4
1.4 Methods of Treating Textile Wastewater	5
1.5 Problem Statement	9
1.5.1 Suggestion of Sample and Treatment Process	11
1.6 Aim of the research	12
1.7 The Objective	12
1.8 Organization of Thesis	14
<b>2 LITERATURE REVIEW</b>	<b>15</b>
2.1 Textile Wastewater	15
2.2 Dyes Classification	15
2.3 Major Dyes Use and Estimated Degree of Fixation and Loss	25
2.4 Characteristics of Textile Wastewater Effluent	26
2.5 Biological Treatment	29
2.5.1 Objective	29
2.5.2 The Mechanisms	29
2.5.3 Types	30
2.5.4 Activated Sludge Process	31
2.5.5 Previous Studies on Aerobic Biological Treatment for Textile Wastewater Treatment	40
2.6 Advanced Oxidation Process	44
2.6.1 Theory	44
2.6.2 Technologies Used to Produce Hydroxyl Radical (OH.)	45
2.6.3 Oxidation of Refractory Organic Compounds	46
2.6.4 Ozone	48
2.6.5 H <sub>2</sub> O <sub>2</sub> As Single Reagent	56



2.6.6	H <sub>2</sub> O <sub>2</sub> /O <sub>3</sub> (Peroxone)	56
2.6.7	Ultraviolet System	59
2.6.8	O <sub>3</sub> /UV	61
2.6.9	H <sub>2</sub> O <sub>2</sub> /UV	64
2.6.10	O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> /UV	72
2.7	Advanced Oxidation Process Status	73
2.8	Cost and Economic of Advanced Oxidation Process	77
2.9	Malaysian Textile Manufacturing	80
2.9.1	Overview	80
2.9.2	Textile Manufacturing Process	82
2.9.3	Sources of Pollution	82
2.10	Summary	85
2.10.1	Overview	85
2.10.2	Type of Sample and the Sequences Treatment Process	85
<b>3</b>	<b>METHODOLOGY</b>	<b>88</b>
3.1	Frame Work of Study	88
3.2	Development of a New Integrated System of Biological and Advanced Oxidation Process	90
3.2.1	Background Leading to the System Development	90
3.2.2	The Integrated System Development	91
3.3	Determination of the Best Retention Time for Biological Treatment	109
3.3.1	Biological Treatment	109
3.3.2	Determination the Best Method of Chemical Oxidation	113
3.4	Formulations of Process Treatment Options	119
3.4.1	Evaluation of the Performance of Biological Treatment	119
3.4.2	Categorization of the Biotreated Textile Wastewater	119
3.4.3	Determination of Best Processes	120
3.5	The Software Development and validation	122
3.5.1	The Software Development	122
3.5.2	The TexTreat and the Formulation Process Treatment Options Validation	130
3.6	Analytical Measurements	132
3.6.1	Food to Microorganism Ratio (F/M ratio)	132
3.6.2	Sludge Volume Index (SVI)	133
3.6.3	pH	134
3.6.4	Colour	135
3.6.5	Total Organic Carbon (TOC)	136
3.6.6	Biochemical Oxygen Demand (BOD)	137
3.6.7	Chemical Oxygen Demand (COD)	138
3.6.8	Oil and grease	139

3.6.9	Total Suspended Solids (TSS)	139
3.6.10	Volatile Solids (VS) at 550°C	140
3.7	Statistical Analysis	141
<b>4</b>	<b>DETERMINATION THE BEST METHOD OF ADVANCED OXIDATION PROCESS</b>	<b>142</b>
4.1	Biological Treatment	142
4.1.1	Overview	142
4.1.2	Initial Textile Wastewater Collection and Characteristic	142
4.1.3	Performance of Activated Sludge Process	143
4.1.4	Bacteria Identification	147
4.2	Advanced Oxidation Processes Treatment	151
4.2.1	Overview	151
4.2.2	Performance of Ozonation	151
4.2.3	Performance of H <sub>2</sub> O <sub>2</sub> Process	163
4.2.4	Performance of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> (peroxone)	170
4.2.5	Performance of UV Process	190
	<b>defined.</b>	191
4.2.6	Performance of O <sub>3</sub> /UV	198
4.2.7	Efficiency of H <sub>2</sub> O <sub>2</sub> /UV process	206
4.2.8	Performance of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> /UV	206
4.3	Conclusion	209
4.3.1	Biological Treatment	209
4.3.2	Advanced Oxidation Processes Treatment	210
<b>5</b>	<b>FORMULATION OF PROCESS TREATMENT OPTIONS</b>	<b>213</b>
5.1	Overview	213
5.2	Evaluation of the Performance of Biological Treatment System	214
5.3	Categorization of the Biotreated Textile Wastewater	218
5.4	Determination of the Best Method using Advanced Oxidation	219
5.4.1	First Category	220
5.4.2	Second categories	225
5.4.3	Fourth Category	229
5.4.4	Third Category	234
5.5	Categorization and Selection of Textreat Options	236
5.6	Conclusion	237
<b>6</b>	<b>THE TEXTREAT DEVELOPMENT</b>	<b>239</b>
6.1	Software Development	239
6.1.1	Overview	6.1
6.1.2	Determination of the Reaction Order and Rate Constant	240
6.1.3	Determination of the Best Fitting Regression Equation	249



6.1.4	Formulation of Computer Algorithm	
	Conclusion	257
6.2	The TexTreat and the Process Treatment Options Validation	
	6.2.1 Sample Collection	259
	6.2.2 Kim Fashion Knitwear	259
	6.2.3 Pacific Peninsula Textile	260
	6.2.4 Ramatex Textiles Industrial	262
	Conclusion	264
6.3	6.3.1 Software Development	267
	6.3.2 The TexTreat and the Process Treatment Options Validation	267
		268
<b>7</b>	<b>CONCLUSIONS AND RECOMMENDATIONS</b>	<b>269</b>
7.1	Conclusions	269
	7.1.1 Bio-Photochemical System	269
	7.1.2 The Best Method of Advanced Oxidation Process	
	7.1.3 The Formulation of Process Options Treatment	269
	7.1.4 Software Development and Validation	
	7.1.5 Overall	271
	Recommendations	271
		272
7.2		273
	<b>REFERENCES</b>	274
	<b>APPENDICES</b>	288
	<b>BIODATA OF THE AUTHOR</b>	292

## LIST OF TABLES

<b>Table</b>		<b>Page</b>
2.1	Chemical Classification of Dyes	17
2.2	Estimated Degree of Fixation and Loss for Different Dye Combinations	26
2.3	Characteristic of Composite Textile Wastewater	28
2.4	Summaries of The Studies on Using Aerobic Biological Treatment for Textile Wastewater	41
2.5	Oxidizing Potential for Conventional Oxidizing Agents	45
2.6	Technologies Used to Produce The Free Radical Hydroxyl	46
2.7	Properties of Ozone	48
2.8	Summary of Ozonation Studies for Textile Wastewater Treatment	51
2.9	Summary of Previous Studies of Using H <sub>2</sub> O <sub>2</sub> /UV Processes	66
2.10	EE/O Comparison for Textile Dyes Removal with AOPs	79
2.11	Power Needed For 95% Removal of Six Azo Dyes	80
2.12	Malaysian Export of Textile, Apparel and Footwear	81
2.13	Wastewater Generation in Textile Manufacturing Process	84
2.14	Production Performance Spinning, Weaving and Finishing of Textile	84
3.15	Wet Process and Generation Wastewater	84
4.1	The Constant Parameters during Study	93
4.2	Distance of Effluent Discharge Points in Advanced Oxidation Reactor	95
4.3	Characteristic of Ultraviolet Lamp	108

<b>Table</b>	<b>Page</b>
4.1 Design Parameter of Activated Sludge (Extended Aeration)	112
4.1 Textile Wastewater Characteristics before Treatment	143
4.2 Operating Condition for Activated Sludge	144
4.3 Characteristic of Samples before and after Biological Treatment	145
4.4 Pollutants Removal Efficiency of Activated Sludge (Extended Aeration) Process for Textile Wastewater Treatment	145
4.5 Biochemical and Morphology Characteristics of <i>Aeromonas Caviae</i>	150
4.6 Actual O <sub>3</sub> Production and Applied O <sub>3</sub> Concentration	153
4.7 Methods Used for Removal of H <sub>2</sub> O <sub>2</sub> Residual From Sample before COD Measurement	164
5.1 Textile Wastewater Characteristics before Treatment	214
5.2 Descriptive Statistics for Biotreated Samples	217
5.3 The Characteristic of The Categories	219
5.4 Summary of Categories of Biotreated Textile Wastewater and Selected Methods of Advanced Oxidation	237
6.1 Rate Constants for Colour Removal at Different Retention Times	243
6.2 Rate Constants for TOC and COD Removals	248
6.3 Regression Equations	252
6.4 The Characteristics of Raw and Biotreated Wastewater for The Validation Purpose	259

## LIST OF FIGURES

<b>Figure</b>		<b>Page</b>
2.1	Proposed Mechanism for Reduction of Azo Dyes by Whole Bacterial Cells	39
2.2	Schematic Detail of Ozone Generation	49
3.1	Framework of Study	89
3.2	The Flow Diagram of Treatment Process	91
3.3	Main Chassis of Bio-Photochemical Reactor	96
3.4	Design configuration of Bio-Photochemical Reactor	97
3.5	The Design Drawing of Experimental Set-Up (Bio-Photochemical Reactor)	98
3.6	Experimental Set-Up (Bio-Photochemical Reactor)	99
3.7	Feeding Tank (Right), Aeration Tank (Left).	100
3.8	Aeration Tank	101
3.9	Settling Tank (Front View)	102
3.10	Settling Tank (Plan View)	103
3.11	The Photograph of the Photochemical Reactor	105
3.12	The Schematic of the Photochemical Reactor	105
3.13	The Picture of the Photochemical Reactor	106
3.14	The Intensity of the UV Radiation at Different Distance from Lamp Axis	107
3.15	The Ultraviolet Lamp and Quartz	105
3.16	A Laboratory Ozone Generator	109
3.17	Equalization Tank of Treatment Plant	110
3.18	Design Experiment for Advanced Oxidation Process	114

<b>Figure</b>	<b>Page</b>
3.19 Ozone Generator Test	116
3.20 Flowchart of Producing the Formulation of Process Treatment Options	121
3.21 Flowchart of the TexTreat Development	124
3.22 The Main and Submenus Interfaces	126
3.23 The Decision Support Interface	127
3.24 Flowchart of Instructions of Using the TexTreat	128
3.25 Flow Diagram of the TexTreat Algorithm	129
3.26 The Equalization Tank of Kim Fashion Knitwear	131
3.27 The Equalization Tank of Pacific Peninsula Textile	131
3.28 The Equalization Tank of Ramatex Textiles Industrial	131
3.29 Flowchart of the TexTreat and the Formulation of Process Treatment Options Validation	132
3.30 Determining Sludge Volume Index (SVI)	134
3.31 pH meter	135
3.32 Spectrophotometer	136
3.33 Total Organic Carbon (TOC) Analyzer	137
3.34 BOD Incubator	138
3.35 COD Reactor	139
3.36 Oven	140
3.37 Muffle Furnace	141
4.1 Colour Removal Efficiency of Activated Sludge at Different Retention Time	146
4.2 Cellular Morphology of Aeromonas caviae Strain on a Nutrient Agar Plate	149

<b>Figure</b>	<b>Page</b>
4.3 Gram Staining of <i>Aeromonas caviae</i> Strain.	149
4.4 The Calibration of Ozone Production	152
4.5 Effect of O <sub>3</sub> (183 mg/l) Application on Colour, TOC and COD Removals before and after Modification of System	155
4.6 Effect of O <sub>3</sub> Concentration on Colour, TOC and COD Removal at 15 Min	155
4.7 Effect of O <sub>3</sub> Concentration on Colour Removal	157
4.8 Effect of O <sub>3</sub> Concentration on TOC Removal	157
4.9 Effect of O <sub>3</sub> Concentration on COD Removal	158
4.10 Effect of O <sub>3</sub> Concentration on BOD Removal	160
4.11 Effect of O <sub>3</sub> Concentration on O&G Removal	160
4.12 Effect of O <sub>3</sub> Concentration on TSS Removal	161
4.13 Effect Concentration of H <sub>2</sub> O <sub>2</sub> on COD Values in Sample before and after Removal of H <sub>2</sub> O <sub>2</sub> Residual	165
4.14 Effect of H <sub>2</sub> O <sub>2</sub> Different Concentration on Colour Removal	166
4.15 Effect of H <sub>2</sub> O <sub>2</sub> Concentration on TOC Removal	167
4.16 Effect of H <sub>2</sub> O <sub>2</sub> Concentration on COD Removal	168
4.17 Effect of H <sub>2</sub> O <sub>2</sub> Concentration on BOD Removal	169
4.18 Effect of H <sub>2</sub> O <sub>2</sub> Concentration on TSS Removal	169
4.19 Colour Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	172
4.20 TOC Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	173
4.21 COD Removal Efficiency O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	174
4.22 BOD Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	174
4.23 O&G Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	176

<b>Figure</b>	<b>Page</b>
4.24 TSS Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	176
4.25 Colour Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	177
4.26 TOC Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	179
4.27 COD Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	179
4.28 BOD Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	180
4.29 O&G Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	181
4.30 TSS Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	181
4.31 Colour Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	184
4.32 TOC Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	184
4.33 COD Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	185
4.34 BOD Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	185
4.35 O&G Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	187
4.36 TSS Removal Efficiency of O <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Processes	187
4.37 Effect of UV on the Parameters Removals	191
4.38 Colour Removal Efficiency of /O <sub>3</sub> /UV Processes	192
4.39 TOC Removal Efficiency of O <sub>3</sub> /UV Processes	193
4.40 COD Removal Efficiency of O <sub>3</sub> /UV Processes	194
4.41 BOD Removal Efficiency of O <sub>3</sub> /UV Processes	195
4.42 O&G Removal Efficiency of O <sub>3</sub> /UV Processes	196
4.43 TSS Removal Efficiency of O <sub>3</sub> /UV Processes	196
4.44 Effect of Different Concentration of H <sub>2</sub> O <sub>2</sub> /UV on Colour Removal	199
4.45 Effect of Different Concentration of H <sub>2</sub> O <sub>2</sub> /UV on TOC Removal	200

<b>Figure</b>	<b>Page</b>
4.46 Effect of Different Concentration of H <sub>2</sub> O <sub>2</sub> /UV on COD Removal	201
4.47 Effect of Different concentration of H <sub>2</sub> O <sub>2</sub> /UV on BOD Removal	202
4.48 Effect of Different Concentration of H <sub>2</sub> O <sub>2</sub> /UV on O&G Removal	203
4.49 Effect of Different Concentration of H <sub>2</sub> O <sub>2</sub> /UV on TSS Removal	204
4.50 Effect of O <sub>3</sub> /UV/H <sub>2</sub> O <sub>2</sub> on the Parameters Removals	207
4.51 Colour Removal with Different Combination of Advanced Oxidation	211
4.52 TOC Removal with Different Combination of Advanced Oxidation	211
4.53 COD Removal with Different Combination of Advanced Oxidation	212
5.1 The Efficiency of Biological Treatment in Removing Pollutants	215
5.2 Colour Concentration after Biological Treatment	217
5.3 Organic Pollutants Concentration after Biological Treatment	218
5.4 Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on Colour Removal for the Different Samples	221
5.5 Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on TOC Removal for the Different Samples	222
5.6 Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on COD Removal for the Different Samples	222
5.7 Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on BOD Removal for the Different Samples	223
5.8 Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on O&G Removal for the Different Samples	223



<b>Figure</b>	<b>Page</b>
5.9	Effect of 0.25 ml/l H <sub>2</sub> O <sub>2</sub> /UV on TSS Removal for the Different Samples 224
5.10	Samples Before and after Biological and Advanced Oxidation for Category 1 224
5.11	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/ 50 mg/l O <sub>3</sub> on Colour Removal for the Different Samples 226
5.12	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/50 mg/l O <sub>3</sub> on TOC Removal for the Different Samples 226
5.13	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/50 mg/l O <sub>3</sub> on COD Removal for the Different Samples 227
5.14	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/50 mg/l O <sub>3</sub> on BOD Removal for the Different Samples 227
5.15	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/50 mg/l O <sub>3</sub> on O&G Removal for the Different Samples 228
5.16	Effect of 0.75 ml/l H <sub>2</sub> O <sub>2</sub> /UV/50 mg/l O <sub>3</sub> on TSS Removal for the Different Samples 228
5.17	Samples Before and After the Biological and Advanced Oxidation for Category 2 229
5.18	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on Colour Removal for the Different Samples 230
5.19	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on TOC Removal for the Different Samples 231
5.20	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on COD Removal for the Different Samples 231
5.21	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on BOD Removal for the Different Samples 232
5.22	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on O&G Removal for the Different Samples 232
5.23	Effect of 1.5 ml/l H <sub>2</sub> O <sub>2</sub> /UV/134 mg/l O <sub>3</sub> on TSS Removal for the Different Samples 233