

Table of Contents

		Page
Abstract		i
Acknowledgements		iii
List of Tables		vii
List of Figures		viii
Chapter One	1.0	Introduction 1
Chapter Two	2.0	Literature Review 3
	2.1	Wastewater in Malaysia 3
	2.2	Soap and Detergent Wastewater in Malaysia 3
	2.3	Physio-Chemical Methods of Treatment 4
	2.3.1	Coagulation Characterization 4
	2.3.1.1	Mechanism of Coagulation 9
	2.3.1.2	Chemistry of Metal Coagulants 10
	2.3.2	Flocculation 13
	2.3.2.1	Mechanism of Floc Formation 14
	2.3.3	Coagulant Aids 16
	2.3.3.1	Types of Polymeric Flocculants 16
	2.3.3.2	Polymer Properties and Mechanism 18
	2.3.3.3	Polymers as Primary Coagulants 21
	2.3.4	Stability of Colloidal Suspension 23

	2.3.4.1	Stability Forces	24
	2.3.4.2	Instability Forces	28
	2.3.5	Factors Influencing Coagulation	30
	2.3.5.1	Effect of Coagulant	30
	2.3.5.2	Effect of Mixing	31
	2.3.5.3	Effect of pH	32
	2.4	Adsorption in Wastewater Treatment	32
	2.4.1	Adsorption in Color Removal	32
	2.4.2	Adsorption in Surfactant Removal	33
Chapter Three	3.0	Experimental Studies	34
	3.1	Materials	34
	3.2	Methods	35
	3.2.1	Wastewater Characterization	35
	3.2.2	Studies on Factors Influencing the Coagulation and Flocculation Process During Treatment of Wastewater	36
	3.2.2.1	Determination of the Type of Coagulant and Optimal Coagulant Dosage	37
	3.2.2.2	Determination of Optimum pH	38
	3.2.2.3	Determination of Optimum Mixing Time	38
	3.2.2.4	Determination of Optimum Mixing Intensity	39
	3.2.2.5	Determination of Optimum Settling Time	39

List Of Tables

	3.2.2.6	Evaluation of Optimum Conditions	40
	3.2.2.7	Double Chemical Treatment	40
	3.3	Adsorption Studies	41
Chapter Four	4.0	Results and Discussion	42
	4.1	Characterization Studies	42
	4.2	Determination of Optimal Conditions Influencing the Coagulation and Flocculation Process During the Treatment of Wastewater	43
	4.2.1	Determination of Optimum Type and Coagulant Dose	43
	4.2.2.	Determination of Optimum pH	60
	4.2.3	Determination of Optimum Mixing Time	70
	4.2.4	Determination of Optimum Mixing Intensity	77
	4.2.5	Determination of Optimum Settling Time	84
	4.2.6	Evaluation of Optimal Conditions	90
	4.2.7	Double Chemical Treatment	92
	4.3	Adsorption Studies	94
Chapter Five	5.0	Conclusions	99
Chapter Six	6.0	References	101

List Of Tables

		Page
Table 2.1:	Environmental Quality Act 1974, Environmental Quality (Sewage and Industrial Effluents) Regulations 1979. Parameter limits of Effluent Standard A and B	5
Table 2.2	Wastewater Characteristics	6
Table 2.3	Effect of Decreasing Size of Spheres	8
Table 2.4	Classification of Flocculants	17
Table 2.5	Advantages and Disadvantages of Polymeric Flocculation in Water Treatment.	22
Table 3.1	List of Chemicals.	34
Table 3.2	Jar Test Conditions to Determine Type of Coagulant and Optimal Coagulant Dosage.	37
Table 4.1	Wastewater Characteristics.	43
Table 4.2	Evaluation Results of Wastewater Treated with Alum and Ferric Sulfate at Optimal Conditions.	91
Table 4.3	Results after Double Chemical Treatment of Wastewater.	93
Figure 4.7	Variation of Percentage of Turbidity Removal with Ferric Sulfate Dosage.	51
Figure 4.8	Variation of Percentage of Turbidity Removal with Polyethylamine Dosage.	53
Figure 4.9	Variation of Sludge Volume with Alum Dosage.	55
Figure 4.10	Variation of Sludge Volume with Ferric Sulfate Dosage.	56
Figure 4.11	Variation of Sludge Volume with Polyethylamine Dosage.	57
Figure 4.12	Variation of Zeta Potential Values with pH of Wastewater Treated with Alum.	61

List of Figures

		Page
Figure 2.1	Schematic Diagram of Industrial Wastewater Treatment Plant	7
Figure 2.2	Structure of a Double Layer and the Corresponding Potentials	27
Figure 4.1	Variation of Zeta Potential Values with Alum Dosage.	45
Figure 4.2	Variation of Zeta Potential Values with Ferric Sulfate Dosage.	46
Figure 4.3	Variation of Zeta Potential Values with Polyvinylalcohol Dosage.	47
Figure 4.4	Variation of Zeta Potential Values with Sodium Alginate Dosage.	48
Figure 4.5	Variation of Zeta Potential Values with Polyethylenimine Dosage.	49
Figure 4.6	Variation of Percentage of Turbidity Removal with Alum Dosage.	51
Figure 4.7	Variation of Percentage of Turbidity Removal with Ferric Sulfate Dosage.	52
Figure 4.8	Variation of Percentage of Turbidity Removal with Polyethylenimine Dosage.	53
Figure 4.9	Variation of Sludge Volume with Alum Dosage	55
Figure 4.10	Variation of Sludge Volume with Ferric Sulfate Dosage.	56
Figure 4.11	Variation of Sludge Volume with Polyethylenimine Dosage.	57
Figure 4.12	Variation of Zeta Potential Values with pH of Wastewater Treated with Alum.	61

Figure 4.13	Variation of Zeta Potential Values with pH of Wastewater Treated with Ferric Sulfate.	62
Figure 4.14	Variation of Zeta Potential Values with pH of Wastewater Treated with Polyethylenimine	63
Figure 4.15	Variation of Percentage of Turbidity Removal with pH of Wastewater Treated with Alum.	65
Figure 4.16	Variation of Percentage of Turbidity Removal with pH of Wastewater Treated with Ferric Sulfate.	66
Figure 4.17	Variation of Percentage of Turbidity Removal with pH of Wastewater Treated with Polyethylenimine.	67
Figure 4.18	Variation of Zeta Potential Values with Mixing Time of Wastewater Treated with Alum.	71
Figure 4.19	Variation of Zeta Potential Values with Mixing Time of Wastewater Treated with Ferric Sulfate.	72
Figure 4.20	Variation of Percentage of Turbidity Removal with Mixing Time of Wastewater Treated with Alum.	74
Figure 4.21	Variation of Percentage of Turbidity Removal with Mixing Time of Wastewater Treated with Ferric Sulfate.	75
Figure 4.22	Variation of Zeta Potential Values with Mixing Intensity of Wastewater Treated with Alum.	78
Figure 4.23	Variation of Zeta Potential Values with Mixing Intensity of Wastewater Treated with Ferric Sulfate.	79
Figure 4.24	Variation of Percentage of Turbidity Removal with Mixing Intensity of Wastewater Treated with Alum.	81
Figure 4.25	Variation of Percentage of Turbidity Removal with Mixing Intensity of Wastewater Treated with Ferric Sulfate.	82
Figure 4.26	Variation of Zeta Potential Values with Settling Time of Wastewater Treated with Alum.	85
Figure 4.27	Variation of Zeta Potential Values with Settling Time of Wastewater Treated with Ferric Sulfate.	86

Figure 4.28	Variation of Percentage of Turbidity Removal with Settling Time of Wastewater Treated with Alum.	88
Figure 4.29.	Variation of Percentage of Turbidity Removal with Settling Time of Wastewater Treated with Ferric Sulfate.	89
Figure 4.30	Variation of Surface Tension of Wastewater with Dosage of Granulated Activated Carbon.	96
Figure 4.31	Variation of Absorbance at 384 nm and 392 nm of Wastewater with Dosage of Granulated Activated Carbon.	98

INTRODUCTION

Wastewater is a by-product of various industrial processes. Such wastewaters which are high in polluting matter are detrimental to the water quality. Analysis done by the Malaysian Department of Environment in 1993, on compliance status for manufacturing industries in meeting discharge standards of the Environmental Quality Act, 1974, (Sewage and Industrial Effluents) Regulations, 1979 revealed that only 10 percent comply with the regulation. 17 percent have sufficient treatment systems and 73 percent are without treatment systems.

In 1990, 11.7 percent and in 1994, 39 percent of the chemical factories in Malaysia were found not to be able to meet the standards stipulated by the Department of Environment, 1991, 1994. The soap and detergent industry has been classified under the chemical industry by the Department of Environment, and this sector has been expanding at a very high rate. Fast-food manufacturing companies, shampoos, hair cream, laundry detergent, general cleaning, solvents, and soaps are generally categorized in the soap and detergent industry. The industry frequently undergoes changes in the products, types and raw material composition due to the development of better products and changing consumer tastes. Consequently, there will always be a change in the wastewater characteristics. Many factories either do not have any or do not have adequate facilities to meet the stipulated discharge standards.