

TABLE OF CONTENTS

Chapter		Page
1	INTRODUCTION	
	1.1 The Need for Pollution Control	1-1
	1.2 Scope of Manual	1-3
	1.3 Sources of Information and References	1-4
2	TREATMENT REQUIREMENTS	
	2.1 Introduction	2-1
	2.2 EPA Industrial Guidelines	2-1
	2.3 State, Basin, and Regional Water Quality Standards	2-2
	2.4 Pretreatment	2-3
3	CATEGORIZATION OF THE TEXTILE INDUSTRY	
	3.1 Introduction	3-1
	3.2 Categorization by Mill Operation	3-1
	3.2.1 Wool Scouring Mill	3-3
	3.2.2 Wool Finishing Mill	3-5
	3.2.3 Dry Processing Mill	3-7
	3.2.4 Woven Fabric Finishing Mill	3-7
	3.2.5 Knit Fabric Finishing Mill	3-9
	3.2.6 Carpet Mill	3-11
	3.2.7 Stock and Yarn Dyeing and Finishing Mill	3-13
	3.3 References	3-16
4	SOURCES AND STRENGTHS OF TEXTILE WASTEWATER	
	4.1 Introduction	4-1
	4.1.1 Scouring	4-1
	4.1.2 Bleaching	4-2
	4.1.3 Dyeing and Printing	4-2
	4.1.4 Special Finishes	4-2
	4.1.5 Summary	4-3
	4.2 Cotton Processing	4-4
	4.2.1 Slashing	4-4
	4.2.2 Desizing	4-5
	4.2.3 Scouring	4-5

4 SOURCES AND STRENGTHS OF TEXTILE WASTEWATER (CONT'D)

4.2.4	Mercerizing	4-6
4.2.5	Bleaching	4-7
4.2.6	Dyeing and Printing	4-8
4.2.7	Finishing	4-11
4.3	Wool Processing	4-20
4.3.1	Scouring	4-20
4.3.2	Washing After Fulling	4-21
4.3.3	Neutralization After Carbonizing	4-21
4.3.4	Bleaching	4-22
4.3.5	Dyeing	4-22
4.4	Synthetics Processing	4-28
4.4.1	Rayon	4-28
4.4.2	Acetate	4-29
4.4.3	Nylon	4-30
4.4.4	Acrylic/Modacrylic	4-30
4.4.5	Polyester	4-31
4.5	Synthetic Blends	4-43
4.6	Individual Mill Operations	4-46
4.6.1	Introduction	4-46
4.6.2	ATMI Study	4-46
4.6.3	National Commission on Water Quality Study	4-49
4.6.4	Established Mill Waste Characteristics	4-51
4.7	References	4-56

5 THE WASTE SURVEY

5.1	Introduction	5-1
5.2	Preliminary Survey	5-1
5.3	Detailed Survey	5-18
5.4	Data Evaluation	5-21
5.5	Continuing Monitoring	5-23
5.6	References	5-25

6 IN-PLANT WASTEWATER CONTROLS

6.1	Waste Volume Reduction	6-1
6.1.1	Previous Studies	6-1
6.1.2	Flow Measurement	6-3

6. IN-PLANT WASTEWATER CONTROLS (CONT'D)

	6.1.3	Information to Collect	6-3
	6.1.4	What Are Others Doing	6-6
	6.1.5	Recommended Approach	6-14
	6.1.6	Waste Volume Reduction Checklist	6-23
6.2		Waste Strength Reduction	6-25
	6.2.1	New Pollution-Free Solvent Wool Scouring Method	6-34
	6.2.2	Wool Piece Scouring and pH	6-35
	6.2.3	Waste Strength Reduction Checklist	6-37
6.3		Waste and Water Recovery and Reuse	6-39
	6.3.1	Beck Cooling Water Savings	6-41
	6.3.2	Case Histories	6-42
	6.3.3	Waste and Water Recovery and Reuse checklist	6-51
6.4		Chemical Substitution	6-52
	6.4.1	Chemical BOD ₅ Lists	6-53
	6.4.2	Size Substitution	6-53
	6.4.3	Size Treatability	6-55
	6.4.4	Foam Control	6-56
	6.4.5	Wool Fulling	6-59
	6.4.6	Carriers	6-59
	6.4.7	Substitution for Acetic Acid in Dye Baths	6-60
	6.4.8	Dyeing Wool-Replace Acetic Acid	6-60
	6.4.9	Reactive Dyes	6-60
	6.4.10	Dye Selection	6-60
	6.4.11	Resin Selection	6-62
	6.4.12	Oil and Lubricant Substitute	6-62
	6.4.13	Solvents and Print Pastes	6-62
	6.4.14	Phosphates	6-62
	6.4.15	Nitrogen	6-63
	6.4.16	Phenolics	6-63
	6.4.17	Wool Scouring	6-63
	6.4.18	Ammonia Mercerization	6-63
	6.4.19	Chemical Inventory	6-66
	6.4.20	In-Plant Textile Changes in Burlington	6-66
	6.4.21	In-Plant Changes at United Piece	6-68
	6.4.22	Chemical Substitution Checklist	6-70
6.5		Process Changes	6-71
	6.5.1	Existing Process Modifications	6-72
	6.5.2	Dyeing Process Modification	6-75
	6.5.3	Preparation—Developments	6-94

6 IN-PLANT WASTEWATER CONTROLS (CONT'D)

6.5.4	Reduced Processing Sequences	6-99
6.5.5	New Technology	6-105
6.5.6	Process Changes Checklist	6-106
6.6	Good Housekeeping	6-106
6.6.1	Spills	6-107
6.6.2	Organization	6-107
6.6.3	Automatic Shut-Off	6-107
6.6.4	Records	6-107
6.6.5	Degreasing	6-108
6.6.6	Curbing	6-108
6.6.7	Disposal Containers	6-108
6.7	References	6-108

7 WASTEWATER TREATMENT PROCESS SELECTION

7.1	Introduction	7-1
7.2	Wool Scouring Wastewater Treatment	7-1
7.2.1	Screening	7-2
7.2.2	Equalization	7-2
7.2.3	Flotation	7-4
7.2.4	Chemical Treatment	7-4
7.2.5	Biological Treatment	7-4
7.2.6	Sludge Treatment and Disposal	7-4
7.3	Wool Finishing Wastewater Treatment	7-4
7.3.1	Screening	7-5
7.3.2	Equalization	7-5
7.3.3	Biological Treatment	7-5
7.3.4	Chemical Treatment	7-7
7.3.5	Sludge Treatment and Disposal	7-7
7.4	Dry Processing Wastewater Treatment	7-7
7.4.1	Screening	7-8
7.4.2	Equalization	7-8
7.4.3	Chemical Treatment	7-10
7.4.4	Biological Treatment	7-10
7.4.5	Disinfection	7-10
7.4.6	Sludge Treatment and Disposal	7-10
7.5	Woven Fabric Finishing Wastewater Treatment	7-10
7.5.1	Screening	7-11
7.5.2	Biological Treatment	7-11

7	WASTEWATER TREATMENT PROCESS SELECTION (CONT'D)	
	7.5.3	Chemical Treatment 7-13
	7.5.4	Sludge Treatment and Disposal 7-13
7.6	Knit Fabric Finishing Wastewater Treatment	7-13
	7.6.1	Chemical Treatment/Air Flotation 7-14
	7.6.2	Physical Treatment Using Ultrafiltration Technique 7-17
	7.6.3	Biological/Chemical Treatment 7-18
7.7	Carpet Mill Wastewater Treatment	7-19
	7.7.1	Latex Segregation 7-21
	7.7.2	Screening 7-21
	7.7.3	Biological Treatment 7-21
	7.7.4	Sludge Treatment and Disposal 7-21
7.8	Stock and Yarn Dyeing and Finishing Wastewater Treatment	7-22
	7.8.1	Screening 7-24
	7.8.2	Equalization/Neutralization 7-24
	7.8.3	Biological Treatment 7-24
	7.8.4	Treatment and Disposal 7-24
7.9	Color Removal	7-25
	7.9.1	Wool Scouring Wastewater 7-25
	7.9.2	Wool Finishing Wastewater 7-25
	7.9.3	Dry Processing Wastewater 7-25
	7.9.4	Woven and Knit Fabric Finishing Wastewater 7-25
	7.9.5	Carpet Mill Wastewater 7-27
	7.9.6	Stock and Yarn Dyeing and Finishing Wastewater 7-27
7.10	References	7-28
8	WASTEWATER TREATMENT FACILITIES DESIGN	
	8.1	Introduction 8-1
	8.2	Basic Design Considerations 8-1
	8.2.1	In-Plant Changes 8-1
	8.2.2	Degree of Treatment Required 8-2
	8.2.3	Anticipated Treatment Efficiencies 8-2
	8.2.4	Design Period 8-3
	8.2.5	Future Expansion 8-3
	8.2.6	Seasonal Considerations 8-3
	8.2.7	Costs 8-3
	8.2.8	Degree of Automation 8-3
	8.2.9	Sludge Disposal Methods 8-3
	8.2.10	Multiple Units and Emergency Power 8-3

8 WASTEWATER TREATMENT FACILITIES DESIGN (CONT'D)

	8.2.11	Design Standards	8-4
8.3		Site Requirements	8-4
	8.3.1	Topography	8-4
	8.3.2	Buffer Zone	8-5
	8.3.3	Flood Plains	8-5
	8.3.4	Subsurface Groundwater	8-5
	8.3.5	Soil Condition	8-5
	8.3.6	Existing Facilities	8-5
	8.3.7	Receiving Stream	8-5
	8.3.8	Future Expansion	8-5
	8.3.9	Miscellaneous	8-6
8.4		Sewers and Pumps	8-6
	8.4.1	Gravity Sewers	8-6
	8.4.2	Centrifugal Pumps	8-6
	8.4.3	Positive Displacement Pumps	8-7
	8.4.4	Rotary Screw Pumps	8-7
	8.4.5	Air Pumps	8-7
	8.4.6	Pumping Stations	8-7
8.5		Suspended Solids Removal	8-7
	8.5.1	Screening and Comminution	8-8
	8.5.2	Clarification	8-16
	8.5.3	Filtration	8-20
	8.5.4	Flotation	8-23
8.6		Equalization	8-24
8.7		Neutralization	8-28
8.8		BOD/COD Reduction	8-31
	8.8.1	Lagoons	8-32
	8.8.2	Activated Sludge	8-35
	8.8.3	Nutrient Addition	8-39
	8.8.4	Fixed Film Biological Reactors	8-39
	8.8.5	Activated Sludge Catalyst	8-44
	8.8.6	Chemical Coagulation	8-46
	8.8.7	Polishing Ponds	8-47
8.9		Oil and Grease Reduction	8-52
8.10		Chrome Removal	8-52
8.11		Color Removal	8-55
	8.11.1	Chemical Precipitation	8-57
	8.11.2	Activated Carbon Adsorption	8-58
	8.11.3	Synthetic Resin Adsorption	8-62

WASTEWATER TREATMENT FACILITIES DESIGN (CONT'D)

	8.11.4	Ozonation	8-64
	8.11.5	Hyperfiltration	8-66
8.12		Other Pollutants Removal	8-67
	8.12.1	Phenolics	8-67
	8.12.2	Metals	8-69
	8.12.3	Sulfide	8-69
	8.12.4	Detergents	8-69
	8.12.5	Phosphate	8-70
	8.12.6	Nitrogen	8-70
8.13		Sludge Treatment	8-70
	8.13.1	Aerobic Digestion	8-72
	8.13.2	Sludge Thickening	8-73
	8.13.3	Dewatering	8-75
		8.13.3.1 Drying Beds	8-75
		8.13.3.2 Drying Lagoons	8-79
		8.13.3.3 Vacuum Filtration	8-80
		8.13.3.4 Centrifugation	8-82
		8.13.3.5 Pressure Filtration	8-82
8.14		Sludge Disposal	8-85
	8.14.1	Spray Irrigation	8-85
	8.14.2	Landfill	8-87
	8.14.3	Incineration	8-89
8.15		Disinfection	8-89
	8.15.1	Chlorination	8-89
	8.15.2	Ozonation	8-92
8.16		Emerging Technology	8-92
	8.16.1	Pure Oxygen Activated Sludge	8-92
	8.16.2	Ultrafiltration	8-94
	8.16.3	Hyperfiltration	8-95
	8.16.4	Ion Exchange	8-95
	8.16.5	Electrodialysis	8-96
	8.16.6	Evaporation	8-97
	8.16.7	Freezing	8-97
	8.16.8	Spray Irrigation	8-98
	8.16.9	Algae Harvesting	8-99
8.17		Upgrading Existing Facilities	8-99
8.18		Laboratory Requirements	8-102
	8.18.1	Laboratory Facilities	8-104
	8.18.2	Reporting Laboratory Results	8-107
8.19		References	8-108

9 AIR POLLUTION

9.1	Introduction – Emission Sources	9-1
9.2	Available Abatement Equipment	9-3
9.2.1	Incineration and Chemical Destruction	9-3
9.2.2	Dry Collection Methods	9-10
9.2.2.1	Gravity and Centrifugal Collectors	9-11
9.2.2.2	Filters	9-14
9.2.2.3	Electrostatic Precipitators	9-23
9.2.2.4	Adsorption	9-24
9.2.3	Scrubbers	9-26
9.2.3.1	Gas-Liquidscrubbing	9-26
9.2.3.2	Scrubbing for Particulate Removal	9-29
9.3	Elimination of Oil and Acid Mists and Associated Pollutants	9-41
9.3.1	Design Considerations	9-41
9.3.2	Emissions Preconditioning	9-44
9.3.3	Process Modifications	9-46
9.3.4	Electrostatic Precipitators	9-46
9.3.5	High Efficiency Fiber Mist Eliminators	9-47
9.3.6	Incineration	9-47
9.3.7	Scrubbing	9-47
9.3.8	High Velocity Air Filters	9-48
9.3.9	Elimination of Acid Mists	9-49
9.4	Heat Recovery Systems	9-49
9.4.1	Economics and Feasibility of Heat Recovery	9-50
9.4.2	General Considerations	9-52
9.4.3	Air-Water Exchangers	9-53
9.4.4	Air-Air Exchangers	9-53
9.4.5	Heat Exchangers Employing Transfer Fluid	9-56
9.5	Solvent Recovery	9-56
9.5.1	Process Description	9-56
9.5.2	Installation and Operation	9-59
9.6	Odor Abatement	9-61
9.6.1	Introduction	9-61
9.6.2	Process Modifications or Chemical Substitution	9-62
9.6.3	Dilution	9-63
9.6.4	Masking and Modification	9-65
9.6.5	Scrubbing	9-66
9.6.6	Dry Adsorption	9-67

Chapter		Page
9	AIR POLLUTION (CONT'D)	
	9.6.7 Incineration and Chemical Destruction	9-68
	9.7 Lint and Dust Removal	9-68
	9.8 References	9-72
10	PERSONNEL REQUIREMENTS	
	10.1 Introduction	10-1
	10.2 Adjustment Factors	10-1
	10.3 Estimating Annual Manhours	10-2
	10.4 References	10-5
11	DESIGN PARAMETER CHECKLIST	
	11.1 General Process Data	11-1
	11.2 Treatment Unit Design	11-6
 APPENDIX		
A	Glossary	A-1
B	Metric Conversion Chart	B-1
C	Definitions of Manufacturing Operation	C-1
D	BOD of Textile Chemicals	D-1
E	ATMI-CRI Wastewater Survey	E-1
F	National Commission on Water Quality Survey	F-1
G	List of Trade Organizations and Journals	G-1