

Contents

Preface.....	xiii
Acknowledgments.....	xv
About the Author	xvii

Chapter 1	Air Pollution Control	101	1
1.1	It Is Separation Technology		1
1.2	Wet Collection of Particulate		4
1.3	Dry Collection		7
1.4	Gas Absorption.....		8
1.4.1	Concept of “Number of Transfer Units” in Absorption.....		10
1.4.2	The Transfer Unit Concept in Gas Absorption		11
	<i>Dan Dickeson</i>		
1.5	Hybrid Systems.....		14

Chapter 2	Adsorption Devices	19
2.1	Device Type.....	19
2.2	Typical Applications and Uses	19
2.3	Operating Principles.....	19
2.4	Primary Mechanisms Used	21
2.5	Design Basics.....	21
2.6	Operating Suggestions.....	25

Chapter 3	Bioreactors.....	27
	<i>Dr. Robert Richardson</i>	
3.1	Device Types	27
3.2	Typical Applications and Uses	28
3.3	Operating Principles.....	30
3.4	Primary Mechanisms Used	32
3.5	Design Basics.....	33
3.6	Operating Suggestions.....	34
3.6.1	Biotrickling Filter Technology	34
3.6.2	Aerobic Digester Technology	35
3.6.3	Bioscrubber Technology.....	36

Chapter 4	Dry Cyclone Collectors	37
4.1	Device Type.....	37
4.2	Typical Applications and Uses	37

4.3	Operating Principles.....	40
4.4	Primary Mechanisms Used	41
4.5	Design Basics.....	42
4.6	Operating/Application Suggestions	45
Chapter 5	Electrostatic Precipitators	49
	<i>Bob Taylor</i>	
5.1	Device Type.....	49
5.2	Typical Applications and Uses	49
5.3	Operating Principles.....	53
5.4	Primary Mechanisms Used	57
5.5	Creation of Charge	57
	5.5.1 Field Charging.....	57
	5.5.2 Diffusion Charging	57
5.6	Design Basics.....	58
5.7	Resistivity of Dust	58
5.8	Operating Suggestions.....	60
	5.8.1 Air Load/Gas Load Testing.....	60
	5.8.2 Alignment.....	60
	5.8.3 Thermal Expansion	61
	5.8.4 Air In-Leakage	61
	5.8.5 Rapping	61
	5.8.6 Insulator Cleaning	62
	5.8.7 Purge Heater and Ring Heater Systems	62
	5.8.8 Process Temperature	62
	5.8.9 Fuel Changes	62
Chapter 6	Evaporative Coolers	65
	<i>Wayne T. Hartshorn</i>	
6.1	Device Type.....	65
6.2	Typical Applications and Uses	65
6.3	Primary Mechanisms Used	65
6.4	Design Basics.....	66
	6.4.1 Types of Gas Cooling.....	66
	6.4.2 Gas Conditioning.....	67
	6.4.3 Basic Sizing	69
	6.4.4 All-Important Atomization	72
	6.4.5 Case History Example.....	76
	6.4.6 Cost Considerations.....	77
6.5	Operating Suggestions.....	78

Chapter 7	Fabric Filter Collectors.....	81
	<i>Deny Claffey, Michael Claffey, and Jerry Childress</i>	
7.1	Device Type.....	81
7.2	Typical Applications and Uses	81
7.3	Operating Principles.....	83
7.4	Primary Mechanisms Used	85
7.5	Design Basics.....	86
7.6	Operating Suggestions.....	94
 Chapter 8	 Fiberbed Filters	 97
	<i>Joe Mayo</i>	
8.1	Device Type.....	97
8.2	Typical Applications and Uses	97
8.2.1	Acid Mist.....	97
8.2.2	Asphalt Processing	98
8.2.3	Plasticizer/Vinyl/PVC Processing.....	98
8.2.4	Coating/Laminating	99
8.2.5	Electronics.....	99
8.2.6	Textile Processing.....	99
8.2.7	Metalworking	101
8.2.8	Lube Oil Vents and Machinery	101
8.2.9	Incinerator Emissions	101
8.2.10	Internal Combustion Engine Crankcase Vents	103
8.2.11	Precious Metal Recovery	103
8.2.12	Vacuum Pumps.....	103
8.3	Operating Principles.....	104
8.4	Primary Mechanisms Used	105
8.5	Design Basics.....	105
8.6	Operating/Application Suggestions	107
8.6.1	Filter Cleaning.....	107
8.6.2	Fiberbed Filter Life.....	107
8.6.3	Fire Protection if the Contaminant Is Combustible	108
 Chapter 9	 Filament (Mesh Pad) Scrubbers.....	 109
9.1	Device Type.....	109
9.2	Typical Applications.....	109
9.3	Operating Principles.....	111
9.4	Primary Mechanisms Used.....	111
9.5	Design Basics.....	111
9.6	Operating Suggestions.....	114

Chapter 10	Fluidized Bed Scrubbers	115
10.1	Device Type	115
10.2	Typical Applications and Uses	115
10.3	Operating Principles	116
10.4	Primary Mechanisms Used	121
10.5	Design Basics.....	121
10.6	Operating Suggestions.....	122
Chapter 11	Mechanically Aided Scrubbers	125
11.1	Device Type	125
11.2	Typical Applications and Uses	125
11.3	Operating Principles	126
11.4	Primary Mechanisms Used	128
11.5	Design Basics.....	129
11.6	Operating Suggestions.....	129
Chapter 12	Packed Towers	131
12.1	Device Type	131
12.2	Typical Applications and Uses	131
12.3	Operating Principles	132
12.4	Primary Mechanisms Used	136
12.5	Design Basics.....	136
12.5.1	Counterflow	136
12.5.2	Crossflow	139
12.6	Operating Suggestions.....	139
Chapter 13	Settling Chambers	141
13.1	Device Type	141
13.2	Typical Applications and Uses	141
13.3	Operating Principles	141
13.4	Primary Mechanisms Used	142
13.5	Design Basics.....	143
13.6	Operating/Application Suggestions	144
Chapter 14	Spray Towers/Scrubbers	145
14.1	Device Type	145
14.2	Typical Applications and Uses	145
14.3	Operating Principles	145
14.4	Primary Mechanisms Used	147
14.5	Design Basics.....	149
14.6	Operating Suggestions.....	150

Chapter 15	Thermal Nitrogen Oxide (NO _x) Control	153
	<i>Joseph Colannino</i>	
15.1	Device Type.....	153
15.2	Typical Applications and Uses: Combustion Sources	153
15.3	Operating Principles.....	153
15.4	Primary Mechanisms Used	154
15.5	Design Basics.....	154
15.5.1	Different Forms of NO _x	154
15.5.2	NO _x Measurement Units.....	154
15.5.3	Thermal NO _x	155
15.5.4	Fuel-Bound NO _x	157
15.6	Thermal-NO _x Control Strategies	159
15.7	Dilution Strategies	159
15.8	Staging Strategies	160
15.9	Postcombustion Strategies	160
15.10	Operating/Application Suggestions	162
Chapter 16	Thermal Oxidizers	163
	<i>Dan Banks</i>	
16.1	Device Type.....	163
16.2	Typical Applications.....	163
16.3	Operating Principles.....	163
16.4	Primary Mechanisms Used	164
16.5	Design Basics.....	166
16.6	Operating Suggestions.....	171
Chapter 17	Tray Scrubbers	173
17.1	Device Type.....	173
17.2	Typical Applications and Uses	173
17.3	Operating Principles.....	173
17.4	Primary Mechanism Used.....	177
17.5	Design Basics.....	177
17.6	Operating Suggestions.....	178
Chapter 18	Vane Type Scrubbers.....	181
18.1	Device Type.....	181
18.2	Typical Applications.....	181
18.3	Operating Principles.....	181
18.4	Primary Mechanisms Used	182
18.5	Design Basics.....	185
18.6	Operating Suggestions.....	186

Chapter 19	Venturi Scrubbers.....	189
19.1	Device Type.....	189
19.2	Typical Applications.....	189
19.3	Operating Principles.....	190
19.4	Primary Mechanisms Used	191
19.5	Design Basics.....	191
19.6	Operating/Application Suggestions	199
Chapter 20	Wet Electrostatic Precipitators	201
	<i>Wayne T. Hartshorn</i>	
20.1	Device Type.....	201
20.2	Typical Applications and Uses	201
20.3	Primary Mechanisms Used	202
20.4	Design Basics.....	203
20.5	Types of Wet Precipitators.....	207
20.5.1	Configuration.....	207
20.5.2	Arrangement.....	208
20.5.3	Irrigation Method	208
20.6	Selecting a Wet Electrostatic Precipitator	211
20.7	Operating Suggestions.....	214
Chapter 21	Special Applications: Venturi “Scrubbers” as Evaporators	217
21.1	Device Type.....	217
21.2	Typical Applications	217
21.3	Operating Principles.....	218
21.4	Primary Mechanism Used.....	218
21.5	Design Basics.....	218
21.6	Operating Suggestions.....	222
Chapter 22	Energy Recovery	223
22.1	Device Type.....	223
22.2	Typical Applications and Uses	223
22.3	Operating Principles.....	225
22.4	Primary Mechanism Used.....	227
22.5	Design Basics.....	227
22.6	Operating Suggestions.....	228
Chapter 23	Multitechnique Equipment for Gasification (Syngas)	231
23.1	Device Type(s)	231
23.2	Typical Applications and Uses	232
23.2.1	Starved-Air Gasification.....	232
23.2.2	Plasma Destruction.....	233

23.2.3	Reformer Gasification	234
23.3	Operating Principles.....	234
23.4	Primary Mechanisms Used	235
23.5	Design Basics.....	235
23.6	Operating Suggestions.....	237
Chapter 24	System Diagnostics and Testing.....	239
24.1	Tools	239
24.2	Isolate and Correct the Problem	241
24.2.1	Define the Problem.....	241
24.2.2	Inspect the Scrubber and/or System.....	242
24.2.3	Baseline the System.....	242
24.2.4	Search for a <i>Detailed</i> Solution to the Problem.....	243
24.2.4.1	Gas Cleaning Device	243
24.2.4.2	Liquid Circuit Problems	245
24.2.4.3	Instrumentation Issues	247
24.2.4.4	Gas Moving Device	248
24.2.4.5	Gas Discharge Device.....	250
24.2.5	Fix the Problem	252
Appendix A:	Additional Selected Reading	253
Appendix B:	List of Photo Contributors.....	259
Index.....		263