

Contents

Preface *xi*

Acknowledgments *xv*

1 Introduction *1*

Part A Water Contaminants *15*

2 Suspended Solids *17*

3 Floatables *29*

4 Dissolved Materials *39*

4.1 Dissolved Specific Ions: pH *39*

4.2 Dissolved Specific Ions: Hardness *40*

4.3 Dissolved Specific Ions: Alkalinity *42*

4.4 Dissolved Specific Ions: Iron and Manganese *44*

4.5 Dissolved Specific Ions: Nitrate and Nitrite *46*

4.6 Dissolved Specific Ions: Silica *47*

4.7 Dissolved Total Ions: TDS *49*

4.8 Dissolved Organic Materials *54*

4.9 Nutrients *60*

4.10 Organic Nitrogen and Other Nitrogen-Bearing Compounds *60*

4.11 Phosphorus *62*

4.12 Dissolved Gases *62*

4.13 Dissolved Oxygen *64*

4.14 Dissolved Carbon Dioxide *66*

4.15 Dissolved Ammonia *67*

4.16 Dissolved Hydrogen Sulfide *68*

4.17 Dissolved Volatile Organics *69*

5 Colloids *71*

6 Pathogens 73**7 Water Analysis 77**

- 7.1 Preparing of Water Analysis 78
- 7.2 Study and Investigating Water Analysis Report 79
- 7.3 Temperature 80
- 7.4 “Estimation” of Existence of Contaminants in Water 82
- 7.5 Units of Concentration 82

Part B Contaminants Removal Methods 85**8 Settleables Removal 87**

- 8.1 Sedimentation 89
- 8.2 Hydrocyclones 96
- 8.3 Centrifuges 97
- 8.4 Grit Chambers 99
- 8.5 Sieving 99
 - 8.5.1 Screening 99
 - 8.5.2 Filtration 104
 - 8.5.3 Cartridge Filters 113
 - 8.5.4 Membrane Filtration 114
- 8.6 Summary of Solid Separation Methods 117

9 Removing Floatable 123

- 9.1 Gravity Oil Separation Units 126
- 9.2 Gas-Assisted Flotation Units 136
- 9.3 Liquid-Liquid Hydrocyclones (LLHCs) 143
- 9.4 Centrifuges 145
- 9.5 Oil Filters 146
- 9.6 Oil Adsorption Units 148
- 9.7 Coalescers 151
- 9.8 Summary 152
- 9.9 Removal of Meso- and Microemulsions 153
- 9.10 Handling of Skimmed Oil 155

10 Dissolved Materials Removal Inorganics 159

- 10.1 Evaporators and Crystallizers 161
- 10.2 Ion Exchange 167
- 10.3 Reverse Osmosis 186
- 10.4 Specific Ion Removals 202
- 10.5 Adsorption of Ions 202
- 10.6 Selective Ion Exchange 203
- 10.7 Precipitation and Coprecipitation 203

11	Dissolved Organics	211
11.1	Nonbiological Organic Removal	211
11.2	GAC for Organic Removal	212
11.3	Removing Organics Through Ion Exchange Bed	214
11.4	Traditional Chemical Oxidation Processes	214
11.5	Advanced Oxidation Processes (AOPs)	215
11.6	Removal Methods from High Concentration Organic	215
11.7	Biological Organic Removal	215
11.8	Nitrogen Removal	231
11.9	Phosphorous Removal	237
12	Dissolved Gases and Volatiles	239
12.1	Stripping	240
12.2	Oxygen Removal	243
12.3	Carbon Dioxide Removal	244
12.4	Hydrogen Sulfide Removal	245
12.5	Ammonia Removal	246
13	Colloid Removal	247
13.1	Coprecipitation	251
14	Dealing with Pathogens	253
14.1	UV Disinfection	262

Part C Process Design 265

15	Preliminary Design	267
15.1	Wastewater Management Procedures	267
15.2	Conceptual Dealing with Contaminants	269
15.3	Flowrate Estimation	271
15.4	Dealing with Fluctuations in Consumption in Treated Water	275
15.5	Dealing with Surge at the Beginning of Wastewater Treatment Plants	276
15.6	Location of Water Consumer/Wastewater Generator in Relation to Treatment Facility	281
15.7	Materials of Construction	282
15.8	Plants' Construction Options	282
16	Basic Design	285
16.1	Finding the Most Suitable Removal Methods	285
16.2	Developing String of Units	289
16.3	Rule of Thumbs in Developing String of Removal Units	292
16.4	Dealing with Residual Streams	298

17	Nature-Based Treatment Systems	299
17.1	Pond Treatment Systems	301
18	Auxiliary Systems	309
18.1	Pumps	309
18.2	Blowers	309
18.3	Liquid Tanks	310
18.4	Handling Dry Solids	310
18.5	Sludge/Slurry Handling	312
18.6	Dealing with Oily Streams	313
18.7	Chemical Injection Packages	314
18.8	pH Adjustment and Neutralization	317
18.9	Lift Stations	318
18.10	Sumps	319
19	Miscellaneous Topics	323
19.1	Water–Media Interactions	323
19.2	Concept of ZLD	324
19.3	Ultimate Destinations of Treated Wastewater or Final Untreatable Liquids	327
19.4	Ultimate Destinations of Solid Wastes	328
19.5	Sludge Processing Units	329
19.6	Water Wells	330
19.7	Estimation of Required Footprint	330
19.8	Site Selection and Enclosing	331
19.9	Cost Matters	332
19.10	Decision Making and Option Selection	333
	Index	335