

**OPERATION OF WASTEWATER TREATMENT PLANTS
COURSE OUTLINE**

VOLUME I, SEVENTH EDITION

Chapter	Topic	Page
1	THE TREATMENT PLANT OPERATOR	1
2	WHY TREAT WASTES?	11
3	WASTEWATER TREATMENT FACILITIES.....	27
4	RACKS, SCREENS, COMMUNUTORS, AND GRIT REMOVAL	57
5	SEDIMENTATION AND FLOTATION	101
6	TRICKLING FILTERS	163
7	ROTATING BIOLOGICAL CONTACTORS	209
8	ACTIVATED SLUDGE (PACKAGE PLANTS AND OXIDATION DITCHES).....	239
9	WASTEWATER STABILIZATION PONDS	287
10	DISINFECTION PROCESSES	335
Appendix	COMPREHENSIVE REVIEW QUESTIONS AND SUGGESTED ANSWERS.....	435
	HOW TO SOLVE WASTEWATER TREATMENT PLANT ARITHMETIC PROBLEMS	455
	ABBREVIATIONS	498
	WASTEWATER WORDS	499
	SUBJECT INDEX	549

SUBJECT INDEX

VOLUME I

A

- AIDS (acquired immune deficiency syndrome), 20, 64, 347
- Abbreviations, 498
- Abnormal operation
- activated sludge, 265
 - aerated grit chambers, 88
 - chlorination, 363
 - chlorinators, 363, 366
 - grit channels, 87
 - oxidation ditches, 275
 - ponds, 307
 - primary treatment, 119
 - rotating biological contactors, 229
 - sedimentation, 119
 - sulfonator, 413
 - trickling filters, 182, 186
- Acquired immune deficiency syndrome (AIDS), 20, 64, 347
- Activated carbon, dechlorination, 401
- Activated sludge
- Also see Package aeration plants; Volume II, Chapter 11, "Activated Sludge"; and *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"
 - abnormal operation, 265
 - aeration methods, 261
 - aeration tank, 48, 254
 - aerobic digestion, 257
 - bulking, 265
 - centrifuge tests, 254
 - chlorination, 265, 399
 - clarifiers, 137, 142, 249, 254, 265, 266
 - cold weather, 265, 283
 - complete mix, 257, 260, 261
 - contact stabilization, 257, 260
 - contact time, 254, 257
 - control of process, 254, 255, 265
 - conventional activated sludge, 260
 - Also see Volume II, Chapter 11, "Activated Sludge"
 - description, 47, 249
 - diffusers, 261, 263, 264, 282
 - dissolved oxygen, 254
 - efficiency of process, 254, 256
 - effluent, 254, 255, 265, 266
 - energy use, 261
 - extended aeration, 257, 260
 - F/M ratio, 249, 257, 280, 281
 - floc mass, 254, 255
 - flow diagram, 38, 252, 253, 258, 259, 260
 - foam, 264, 265, 266
 - food/microorganism ratio, 249, 257, 280, 281
 - housekeeping, 266, 267
 - hydraulic loading, 254, 255, 265
 - industrial waste treatment, 256
 - Also see *INDUSTRIAL WASTE TREATMENT*, Volume II, Chapter 3, "Activated Sludge Process Control"
 - influent, 249, 256
 - inspecting new facilities, 261
 - laboratory testing, 266
 - layout, 38, 253, 258, 259, 260
 - maintenance, 266, 267
 - mechanical aeration, 257, 261, 262
 - microorganisms, 249, 250, 254, 265
 - mixed liquor suspended solids, 257, 261, 264, 267
 - mixing, 261
 - odors, 254, 264, 265
 - operation, 255, 264, 265
 - operational strategy, 255, 266
 - organisms, 249, 250, 254, 265
 - oxidation, 249
 - oxidation ditch, 269
 - oxygen requirements, 249, 254, 255, 264
 - package plants, 47, 257–267
 - plans and specifications, 282
 - preliminary treatment requirements, 249
 - pure oxygen, 47, 239
 - Also see *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"
 - purpose, 249, 257
 - recordkeeping, 264, 266, 267
 - removal efficiencies, 47
 - removal of sludge, 47
 - return sludge, 142, 264, 265
 - safety, 267
 - sampling, 266
 - secondary clarifiers, 47, 249, 254, 265, 267
 - settleability tests, 254, 266
 - shutdown, 266
 - sludge age, 257, 280, 281
 - sludge blanket, 254
 - sludge pumps, 138
 - sludge removal, 138
 - sludge volume index (SVI), 142
 - sludge wasting, 47, 142, 254, 261, 264, 266
 - solids, 136, 142, 254
 - stabilize, 249
 - start-up, 261, 264
 - storm flows, 265
 - temperature, 265
 - toxic wastes, 255, 265
 - trend chart, 266
 - troubleshooting, 265
 - types of processes, 249
 - visual inspection, 265, 266
 - wasting sludge, 47, 142, 254, 261, 264, 266
 - zoogeal mass, 249, 250
- Advanced waste treatment, 41, 54
- Aerated grit chamber, 88
- Aerated pond, 297
- Aeration systems, activated sludge, 47, 261
- Aeration tank appearance, activated sludge, 264, 265
- Aeration tanks, activated sludge, 48, 254
- Aerobic bacteria, 19

550 Treatment Plants

Aerobic digestion
Also see Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
description, 49, 257
package plant, 257
sludge disposal, 49, 55
sludge handling, 49
Aerobic ponds, 53, 297, 299, 300
activated sludge, 46, 287
Aerobic process
activated sludge, 46, 239
ponds, 287
rotating biological contactor, 47, 209
trickling filter, 46, 163
Agglomerate, 254
Air flotation, 145
Air gap, 361
Air lift pumps, 257
Air padding, 382
Algae, 21, 23, 294, 303, 309, 321, 328
Algae control methods
constructed wetlands, 329
duckweed, 329
land treatment, 329
straw, 329
Algal bloom, 303
Alkalinity buffer, 95
Alkalinity test
See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"
Amoebic dysentery, 347
Amperometric, 356
Anaerobic bacteria, 19
Anaerobic digester
See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
Anaerobic digestion
Also see Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
description, 49
mixing, 49
sludge disposal, 49, 50, 51, 55
sludge handling, 49
Anaerobic ponds, 53, 297, 300
Annual operating reports
See Volume II, Chapter 19, "Records and Report Writing"
Anthrax, 347
Ascariasis, 347
Axial flow pumps
See Volume II, Chapter 15, "Maintenance"

B

BOD (biochemical oxygen demand), 43, 182
BOD, soluble, 222
Bacillary dysentery, 347
Bar screens
automatic controls, 71
cleaning methods, 65
description, 41, 65
disposal of screenings, 67, 71
failure, 67
head loss, 67, 71
layout, 68
maintenance, 67, 71
manually cleaned, 67, 68, 69
mechanically cleaned, 69, 70
operation, 71
operational strategy, 95

parts, 69
purpose, 69
safety, 64, 67, 69
shutdown, 71
start-up, 71
troubleshooting, 69
Barminutor
description, 42, 80
head loss, 80
maintenance, 80
operational strategy, 95
parts, 80
picture, 81–83
purpose, 80
safety, 80
shutdown, 80
start-up, 80
troubleshooting, 80
Batch feed, ponds, 308
Beds, sludge
See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
Belt drives
pump maintenance
See Volume II, Chapter 15, "Maintenance"
rotating biological contactors, 233
Biochemical oxygen demand (BOD), 43, 182
Biodegradable, 214
Bioflocculation, 301
Biological contactors
abnormal operation, 229
advantages, 222
alkalinity, 228
biomass, 225, 228
bulkhead, 214, 220, 228
clarifiers, 214
clearances, 225
cold weather, 214, 222, 225, 226, 234
contact time, 225
covered, 214, 220, 222, 234
description, 214
dissolved oxygen, 226
drive units, 220, 222, 223, 232, 233
efficiency of process, 222, 226
effluent, 222, 226, 228
energy use, 222
equalization tanks, 222, 229
flow diagram, 219
flow equalization tanks, 222, 229
growth, 214, 225
holding tanks, 214
housekeeping, 232
hydraulic balance, 225
hydraulic loading, 222, 226, 234, 235
industrial waste discharges, 228
influent, 226, 228
inspecting new contactors, 226
layout, 219, 221
limitations, 222
loadings, 222, 228, 234–236
lubrication, 225, 231
maintenance, 231
media, 214, 217, 218, 220, 228
metric calculations, 235, 236
nitrogen removal, 222, 226, 228, 234
odors, 228, 229
operation, 222, 226
operational strategy, 222
organic loading, 222, 226, 227, 228, 235, 236

- Biological contactors (continued)
 parts, 220
 performance, 222, 226
 pH, 228, 229
 plans and specifications, 234
 power outage, 229
 pretreatment requirements, 222
 purpose, 220
 recirculation, 222, 225, 229, 234
 recordkeeping, 225
 rotation of media, 225
 safety, 225, 234
 sampling, 226
 shutdown, 229
 slime growth, 214, 225, 228, 229
 sloughing, 214, 225, 228, 229
 sludge deposits, 228
 snail control, 229
 speed of rotation, 225
 stages, 214
 start-up, 222, 225
 sulfur compounds, 228
 supernatant treatment, 228
 temperature, 214, 222, 225, 226, 234
 time of contact, 225
 toxic wastes, 228
 trend chart, 226, 227
 troubleshooting, 229, 230, 232
 underdrain, 220
 visual inspection, 225, 226, 228
- Biological filter
 rotating biological contactor, 47
 trickling filter, 46
- Biological growth
 rotating biological contactor, 214, 225
 trickling filter, 169
- Biological process, effects of industrial wastes
 See Toxic wastes
- Biological treatment, 34, 46
- Biomass, rotating biological contactor, 225, 228
- Biosolids, 49
- Blowers, activated sludge, 261
 Also see Volume II, Chapter 11, "Activated Sludge"
- Bourdon tube, pressure measurement
 See *ADVANCED WASTE TREATMENT*, Chapter 9,
 "Instrumentation and Control Systems"
- Breakout of chlorine, 373
- Breakpoint chlorination, 351
- Bubbler tube, level measurement
 See *ADVANCED WASTE TREATMENT*, Chapter 9,
 "Instrumentation and Control Systems"
- Bulking
 Also see Volume II, Chapter 11, "Activated Sludge"
 oxidation ditch, 277
 sludge, 121, 122, 265
 toxic waste, 122
- C**
- Carbon adsorption, physical–chemical treatment
 See *INDUSTRIAL WASTE TREATMENT*, Volume I,
 Chapter 10, "Physical Treatment Processes"
- Carbon regeneration, physical–chemical treatment
 See *INDUSTRIAL WASTE TREATMENT*, Volume I,
 Chapter 10, "Physical Treatment Processes"
- Carbon usage, management
 See *INDUSTRIAL WASTE TREATMENT*, Volume I,
 Chapter 10, "Physical Treatment Processes"
- Cathodic protection, 261, 413
- Centrifugal pumps
 See Volume II, Chapter 15, "Maintenance"
- Centrifuges
 operation
 See *ADVANCED WASTE TREATMENT*, Chapter 3,
 "Residual Solids Management"
 sludge dewatering, 49
- Chemical characteristics, wastewater, 18
- Chemical conditioning
 See *ADVANCED WASTE TREATMENT*, Chapter 3,
 "Residual Solids Management"
- Chemical feed, physical–chemical treatment
 See *INDUSTRIAL WASTE TREATMENT*, Volume I,
 Chapter 8, "Physical–Chemical Treatment Processes"
- Chlorination
 abnormal operation, 363
 activated sludge, 399
 application points, 354, 355
 BOD reduction, 399
 baffles, 352
 breakout of chlorine, 373
 breakpoint, 351
 chlorinator control, 356
 collection system, 353, 354
 contact time, 351, 352
 container storage area, 363
 containers, 378
 control of process, 356
 corrosion control, 398
 description, 347
 diffusers, 359
 disinfection, 54, 368
 dosage, 353, 357
 emergency repair kits, 386–388
 evaporators, 363
 flow diagram, 348
 gas, 361
 grease, 399
 hypochlorination, 351, 357
 injectors, 361, 365
 leaks, 361, 377, 384, 386–388
 liquid, 361
 measurement of residual, 359
 mixing, 352, 357, 359, 373
 odor control, 368, 398
 operation, 363
 operational strategy, 367
 pH, 349–352
 plans and specifications, 394, 398
 plant chlorination, 354
 points of application, 354, 355
 ponds, 304, 307
 postchlorination, 354
 prechlorination, 354
 process control, 356, 368
 protection of structures, 398
 purpose, 347
 reactions of chlorine, 349
 recordkeeping, 396
 repair kits, 386–388
 requirements, 352
 residual, 356
 safety, 375
 Also see Chlorine safety
- sedimentation, 399
 short-circuiting, 352, 357, 372
 shutdown, 367
 snail control, RBCs, 229
 solution lines, 358

552 Treatment Plants

- Chlorination (continued)
 - start-up, 360, 361
 - storage for containers, 363
 - temperature, 352
 - trickling filters, 180, 186, 187, 188, 189, 399
 - troubleshooting, 368–373
 - water supply, 361
- Chlorinators
 - abnormal operation, 363, 366
 - chlorine residual control, 356
 - compound-loop control, 356
 - connections, 382
 - container storage area, 363
 - controls, 356, 390
 - corrosion, 364
 - description, 390
 - dew point test, 362
 - differences (from sulfonators), 413
 - electrolysis, 364
 - evaporators, 362, 363, 390, 393, 394, 405
 - filters, 394
 - flow-proportional control, 356
 - gas, 361
 - injectors, 361, 365, 366, 397
 - installation, 394, 396
 - leaks, 361, 386–388
 - liquid, 361
 - maintenance, 394
 - manual control, 356
 - moisture, 361
 - operation, 363
 - operational strategy, 367
 - orifice, 390
 - parts, 392
 - piping, 396
 - plans and specifications, 394, 398
 - purpose, 390
 - recordkeeping, 396
 - residual control, 356, 365
 - safety, 375
 - Also see Chlorine safety
 - shutdown, 367
 - start-stop control, 356
 - start-up, 360, 361
 - step-rate control, 356
 - storage of containers, 363
 - temperature, 396
 - timed-program control, 356
 - troubleshooting, 363, 368–373
 - vacuum system, 390, 391
 - valves, 382, 396
 - vent lines, 366
 - ventilation, 396
 - water supply, 361, 396, 397
- Chlorine
 - absorption solution, 388
 - activated sludge, 399
 - air padding, 382
 - alarm systems, 388
 - ammonia, 350
 - application, 353
 - BOD reduction, 399
 - breakout, 373
 - breakpoint, 351
 - chloramines, 350
 - chlorine dioxide, 350
 - cleaning lines, 386
 - connections, 382
 - contact basin, 352
 - contact time, 351, 352
 - container storage area, 363
 - containers, 378
 - corrosion control, 398
 - cylinders, 378
 - demand, 349
 - diffusers, 359
 - disinfection, 54, 347
 - disposal, leaking container, 388
 - dosage, 353, 357
 - emergency procedures, 377
 - emergency repair kits, 386–388
 - evaporators, 362, 363, 390, 393, 394, 405
 - first aid, 377
 - free chlorine, 349
 - fusible plug, 378, 379
 - gas, 361
 - grease, 399
 - handling, 378
 - hypochlorite, 349
 - IDLH level, 376, 396
 - injectors, 365
 - leak detection, 361, 377, 386–388
 - leaks, 361, 377, 384, 386–388
 - liquid, 361
 - manifolds, 396
 - mixing, 352, 359
 - odor control, 398
 - pH, 349–352
 - physiological response, 376
 - piping, 396
 - properties, 375
 - protection of structures, 398
 - protective clothing, 376
 - railroad tank cars, 380, 381, 382–386
 - reactions, 349, 350
 - recordkeeping, 396
 - repair kits, 386–388
 - residual, 351, 356, 359
 - safety, 375
 - Also see Chlorine safety
 - sedimentation, 399
 - solution lines, 358
 - tank cars, 380, 381, 382–386
 - temperature, 352, 396
 - ton tanks, 382
 - trickling filters, 399
 - troubleshooting, 363, 368–373
 - use, 349
 - valves, 382, 396
 - ventilation, 396
 - weight measurement, 396
- Chlorine demand
 - trickling filter, 182
 - wastewater, 349
- Chlorine dioxide
 - disinfection, 349, 350
 - facility, 394
 - handling sodium chlorite, 394
 - hazards, 394
 - installation, 394
 - layout, 395
 - maintenance, 394
 - pH, 350
 - reactions, 350
 - sodium chlorite, 394
 - system parts, 392, 394, 395
 - wastewater treatment, 350
- Chlorine measurement, 359

- Chlorine requirement, test, 352, 357
 - Chlorine residual, test, 352
 - Chlorine safety
 - absorption solution, 388
 - alarm systems, 388
 - breathing apparatus, 376
 - calibration of equipment, 375
 - chlorine properties, 375
 - cleaning lines, 386
 - disposal, leaking container, 388
 - emergency procedures, 377
 - emergency repair kits, 386–388
 - equipment calibration, 375
 - first aid, 377
 - fusible plug, 378, 379
 - handling chlorine, 378
 - handling sodium chlorite, 394
 - hazards, 375
 - leak detection, 361, 377, 386–388
 - leaks, 361, 377, 384, 386–388
 - physiological response, 376
 - planning, 377
 - program, 375
 - protective clothing, 376
 - railroad tank cars, 380
 - repair kits, 386–388
 - rules, 375
 - sodium chlorite, 394
 - tank cars, 380
 - training, 375
 - Chlororganic, 351
 - Cholera, 20, 347
 - Clarifier
 - drawing, 44, 45
 - effluent, 109, 128
 - influent, 128
 - primary, 43, 109
 - removal efficiencies, 43
 - scum removal, 46
 - secondary, 47, 109
 - sludge, 109
 - sludge removal, 46
 - Clarity, 183, 274
 - Classifier, grit, 89, 90, 91
 - Closed impeller
 - See Volume II, Chapter 15, “Maintenance”
 - Coagulants, 145
 - Coarse screens, 65
 - Coliforms, 183
 - Collection system, 33
 - Collector mechanism, sludge
 - start-up, 117
 - troubleshooting, 125
 - Colloids, 144
 - Combined sewers, 33
 - Comminutor
 - description, 42, 72
 - drawing, 73, 74, 75, 76, 78, 79
 - head loss, 80
 - mercury seal, 77
 - operation, 80
 - operational strategy, 95
 - parts, 77
 - purpose, 72, 77
 - safety, 77, 80
 - section view, 75, 76, 78, 79
 - shutdown, 80
 - start-up, 80
 - troubleshooting, 80
 - Community relations, management responsibilities, 7
 - Complete-mix system, activated sludge, 257, 260, 261
 - Composite sample, 128, 226, 317
 - Conditioning sludge
 - See Volume II, Chapter 12, “Sludge Digestion and Solids Handling”; and *ADVANCED WASTE TREATMENT*, Chapter 3, “Residual Solids Management”
 - Constructed wetlands, algae control, 329
 - Contact, chlorine disinfection, 351, 352
 - Contact stabilization, activated sludge, 257, 260
 - Control methods, activated sludge, 254, 255, 265
 - Controlled-discharge ponds, 299, 301, 308
 - Conventional activated sludge
 - See Volume II, Chapter 11, “Activated Sludge”
 - Conventional treatment, 54
 - Conversion units,
 - See Arithmetic Appendix, A.10, “Basic Conversion Factors (English System),” 481
 - Cryptosporidiosis, 347
 - Cycle
 - natural purification, 4, 22
 - nutrient, 22
 - Cyclone grit separator
 - description, 88
 - disposal, 91
 - layout, 89
 - maintenance, 91
 - operation, 91
 - parts, 91
 - purpose, 65, 88, 91
 - safety, 91
 - section drawing, 90, 92
 - shutdown, 91
 - start-up, 91
- D**
- DO (dissolved oxygen), 182
 - DPD tests, 359
 - Data collection and laboratory control
 - See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”
 - Dechlorination, 41, 54, 401
 - Density, 134
 - Detention time
 - activated sludge clarifiers, 138
 - aerated grit chamber, 88
 - aeration tanks, 257
 - calculation, 135
 - definition, 43
 - measurement, 134
 - oxidation ditch, 270
 - ponds, 299, 301, 317, 325
 - primary sedimentation, 43, 118, 135
 - trickling filter clarifiers, 138
 - Detritus, 93
 - Dew point test, 362, 409
 - Dewatering, sludge, 49
 - Diaphragm bulb, level measurement
 - See Volume II, Chapter 15, “Maintenance”
 - Diffusers, activated sludge, 261, 263, 264, 282
 - Digester cleaning, maintenance
 - See Volume II, Chapter 12, “Sludge Digestion and Solids Handling”
 - Digester gas
 - See Volume II, Chapter 12, “Sludge Digestion and Solids Handling”
 - Digestion
 - aerobic, 49
 - anaerobic, 49
 - Discharge permit, 23, 24, 308, 352

554 Treatment Plants

Diseases, 347

Disinfection

chlorine, 54

chlorine dioxide, 349, 350

chlorine residual, 351

effluent, 41, 54, 368

flow diagram, 348

importance, 347

ozone systems, 424

purpose, 347, 351

ultraviolet (UV) systems, 416

Disposal

Also see Volume II, Chapter 13, "Effluent Discharge, Reclamation, and Reuse"; and *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management," and Chapter 8, "Wastewater Reclamation and Reuse"

effluent, 54

grit, 42, 65, 86, 95

screening, 41, 67, 71

scum, 109

sludge, 53, 109

solids, 53

Dissolved air flotation, 144

Also see *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

Dissolved oxygen

activated sludge, 254

oxidation ditch, 270, 273, 274, 275

ponds, 297, 299, 315, 321

rotating biological contactor, 226

test

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

trickling filter, 182

Dissolved solids, in wastewater, 21

Distribution, trickling filter, 169, 195, 202

Domestic wastes, 18

Domestic wastewater, characteristics, 18

Dosing tanks, trickling filter, 175, 176

Drying, sludge, 49

Also see Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

Duckweed, 305, 329

Dysentery, 20, 347

E

Eductor, 358

Efficiency of processes

activated sludge, 254, 256

clarifiers, 128

oxidation ditch, 270, 273, 274

package aeration, 256

ponds, 301, 317

primary treatment, 129

rotating biological contactors, 222, 226

sedimentation, 43, 128

trickling filters, 188

Effluent disposal, 54

Electric transmitters

See Volume II, Chapter 15, "Maintenance"; and *ADVANCED WASTE TREATMENT*, Chapter 9, "Instrumentation and Control Systems"

Electrical safety

See Volume II, Chapter 14, "Plant Safety"

Electrolysis, 364

Elutriation, sludge

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"; and *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

Emergency planning

See Volume II, Chapter 19, "Records and Report Writing"

Employment for operators, 4, 8

Emulsions, 144

Enclosure, rotating biological contactor, 214, 220, 222, 234

Energy

activated sludge, 261

oxidation ditches, 274

package aeration, 261

ponds, 297

rotating biological contactors, 222

trickling filters, 175, 180, 184

Enzymes, 351

Equalization tanks, 222, 229

Erosion, ponds, 306, 321

Evaporators

chlorine, 362, 363, 390, 393, 394, 405

diagram, 393

maintenance, 390, 414

operation, 363, 390

sulfur dioxide, 405

troubleshooting, 370

Explosimeters, 96

Extended aeration, activated sludge, 257, 260

F

F/M (food/microorganism) ratio

activated sludge, 249, 257, 280, 281

oxygen activated sludge

See *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"

Facultative bacteria, 254

Facultative ponds, 54, 297, 299, 301

Fecal coliform test

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

Filamentous growth, bulking

See Volume II, Chapter 11, "Activated Sludge"

trickling filters, 121, 122

Filamentous organisms, 254, 399

Filter press

operation

See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

sludge dewatering, 49

Filter staging, trickling filter, 177, 178

Filters

See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management," and Chapter 4, "Solids Removal from Secondary Effluents"

Fire control, safety

See Volume II, Chapter 14, "Plant Safety"

First aid program

See Volume II, Chapter 14, "Plant Safety"

chlorine, 377

sulfur dioxide, 404

Flame trap, anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

Flies, trickling filter, 187

Flights, 117, 121

Float mechanism, level measurement

See Volume II, Chapter 15, "Maintenance"

Floating covers, anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

Floating sludge

See Volume II, Chapter 11, "Activated Sludge"

Floc, 254, 272, 274

Flocculation, 145
 Flotation
 chemical, 145
 description, 144
 dissolved air, 144
 pressure, 145
 purpose, 109
 vacuum, 145
 Flow diagram
 activated sludge, 38, 252, 253, 258, 259, 260
 chlorination, 348
 chlorine dioxide, 395
 combined sedimentation-digestion unit, 147
 disinfection, 348
 oxidation ditch, 269
 package aeration, 258, 259, 260
 ponds, 40, 295, 296
 preliminary treatment, 66
 primary treatment, 110, 111
 rotating biological contactors, 219
 sedimentation, 110, 111
 trickling filters, 36, 170, 171
 Flow equalization, 222, 229
 Flow measurement, 42
 Flow proportioning, sampling, 128, 226, 317
 Flowmeter, 43
 Foaming, 264, 265, 266, 275
 Also see Volume II, Chapter 11, "Activated Sludge," and
 Chapter 12, "Sludge Digestion and Solids Handling"
 Food/microorganism (F/M) ratio
 activated sludge, 249, 257, 280, 281
 oxygen activated sludge
 See *ADVANCED WASTE TREATMENT*, Chapter 2,
 "Activated Sludge"
 Force main, 182

G

Gasification, 119, 130
 Gastroenteritis, 347
 Giardiasis, 347
 Grab sample, 226, 315
 Grit
 aerated removal, 42
 chambers, 42
 channels, 42
 cleaning channels, 86
 cyclone removal, 88
 definition, 42, 84
 disposal, 42, 65, 86, 95
 quantities, 95
 removal, 42, 84
 transport, 42
 washing, 42, 93
 Grit chambers, aerated
 abnormal operation, 88
 description, 88
 detention time, 88
 drawing, 89
 grit removal, 88
 operation, 88
 parts, 88
 purpose, 88
 shutdown, 88
 start-up, 88
 Grit channels
 abnormal operation, 87
 aerated grit chamber, 88
 cleaning, 86
 dead spots, 86

deflector, 86, 87
 description, 84
 disposal of grit, 86
 drawing, 85, 87, 89
 example problems, 84
 grit removal, 84
 maintenance, 88
 measuring velocity, 84, 86, 87
 operation, 87
 operational strategy, 95
 parts, 84
 plans and specifications, 96
 purpose, 84
 safety, 87
 shutdown, 87
 start-up, 87
 troubleshooting, 86
 velocity, 84
 Grit classifier, 90, 91
 Grit washer
 description, 93
 maintenance, 93
 operation, 93
 parts, 93
 purpose, 93
 safety, 93
 section drawing, 94
 shutdown, 93
 Groundwater recharge, wastewater, 55

H

HIV (human immunodeficiency virus), 347
 Headworks, 42, 306, 319
 Heart anomalies, 347
 Heat exchanger, anaerobic digester
 See Volume II, Chapter 12, "Sludge Digestion and Solids
 Handling"
 Hepatitis, 20, 347
 Herbicides, 305
 High rate
 activated sludge
 See Volume II, Chapter 11, "Activated Sludge"
 anaerobic digesters
 See Volume II, Chapter 12, "Sludge Digestion and Solids
 Handling"
 trickling filter, 177, 199
 High resolution redox (HRR), 359
 Housekeeping, 232, 266, 267, 303
 Human immunodeficiency virus (HIV), 347
 Hydraulic loading
 activated sludge, 254, 255, 265
 clarifiers, 129, 130
 ponds, 325, 327
 rotating biological contactors, 222, 226, 234, 235
 sedimentation, 129
 trickling filters, 184, 199, 200, 201
 Hydraulic overloads
 See specific process of interest
 Hydrogen sulfide
 collection systems, 33
 hazards, 20, 131
 problems, 20
 Hydrogen sulfide removal, digester gas
 See Volume II, Chapter 12, "Sludge Digestion and Solids
 Handling"
 Hydrostatic system, 138
 Hypochlorinators
 control, 357
 description, 357, 394

556 Treatment Plants

Hypochlorinators (continued)

- eductors, 358
- feed rate, 357
- flowmeters, 358
- hypochlorite, 351, 357
- maintenance, 358
- pH, 351, 352
- pipng, 358
- purpose, 351
- safety, 358, 375
- storage, 358
- valves, 358

Hypochlorite, 349

I

IDLH (Immediately Dangerous to Life or Health), chlorine, 376, 396

Icing

- oxidation ditch, 270, 277, 283
- trickling filter, 188

Imhoff cone, 21

Imhoff tank

- operation, 154
- process equipment, 154
- section, 154

Immediately Dangerous to Life or Health (IDLH), chlorine, 376, 396

Impacts of waste discharges

- algae, 23
- human health, 20
- nutrients, 21
- odors, 19
- oxygen depletion, 19
- pathogenic bacteria, 20
- sludge and scum, 19
- toxic substances, 20

Impellers, open and closed

See Volume II, Chapter 15, "Maintenance"

Incineration

Also see *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

- description, 53
- sludge, 53

Industrial waste treatment

Also see *INDUSTRIAL WASTE TREATMENT*, Volume I, Chapter 5, "Industrial Waste Monitoring"

- activated sludge, 242, 256

Also see *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"

- oxidation ditches, 273
- ponds, 319
- rotating biological contactors, 228
- trickling filters, 175, 190

Industrial wastes, 18

Industrial wastewater flows, 33

Infectious hepatitis, 20, 347

Infiltration, 33, 188

Influent, 33

Inhibitory substances, 228

Inorganic compounds, in wastewater, 21

Inorganic wastes, 18, 65

Insect control

- ponds, 304
- trickling filters, 181, 187

Inspecting new facilities

- activated sludge, 261
- clarifiers, 117
- cyclone grit separator, 91

- grit channels, 88
- oxidation ditches, 272
- rotating biological contactors, 226
- sedimentation basins, 117
- trickling filters, 179

J

Jobs for operators, 4, 8

K

Kjeldahl nitrogen

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

Kraus process, activated sludge

See Volume II, Chapter 11, "Activated Sludge"

L

Laboratory

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

Lagoons, 297

See Ponds

Land disposal, effluent, 54, 297

Land treatment, 297

Also see *ADVANCED WASTE TREATMENT*, Chapter 8, "Wastewater Reclamation and Reuse"

Land treatment, algae control, 329

Landfill, 55

Launders, 136

Le Système International d'Unités (SI), 466

Also see Metric conversion factors and Metric problem solutions

Lemna duckweed system, 305, 329

Leptospirosis, 347

Levees, 306, 321

Lift station, 34

Lifting, safe practices

See Volume II, Chapter 14, "Plant Safety"

M

MPN (Most Probable Number), 352

Magnetic meters

See Volume II, Chapter 15, "Maintenance"

Maintenance

Also see Volume II, Chapter 15, "Maintenance"; and *INDUSTRIAL WASTE TREATMENT*, Volume II, Chapter 8, "Maintenance"

- activated sludge, 266, 267

aerobic digestion

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

- bar screens, 67

- barminutors, 80

- chlorinators, 394

- chlorine dioxide, 394

- comminutors, 72

- cyclone grit separators, 91

- disinfection, 390, 394

- grit channels, 88

- grit washer, 93

- hypochlorinators, 358

- mechanically cleaned screens, 69

Maintenance (continued)
 oxidation ditch, 278
 oxygen activated sludge
 See *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"
 package aeration, 266, 267
 ponds, 303, 314
 primary treatment, 117, 131, 144
 pumps
 See Volume II, Chapter 15, "Maintenance"
 racks, 67
 recordkeeping, 131
 rotating biological contactors, 231
 sedimentation, 117, 131, 144
 sulfonator, 414
 surface aerators, 314
 trickling filters, 195
 ultraviolet (UV) systems, 422, 423
 Masking agent, 152, 187
 Mean cell residence time
 See Volume II, Chapter 11, "Activated Sludge"
 Media
 rotating biological contactor, 47, 214, 217, 218, 220, 228
 trickling filters, 46, 169, 172, 173, 174, 199
 Median, 302
 Meningitis, 347
 Mesophilic process, anaerobic digester
 See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
 Methane gas, 49, 299, 301
 Metric conversion factors
 chlorination, 425
 dechlorination, 425
 preliminary treatment, 97
 primary treatment, 155
 rotating biological contactors, 235, 236
 sedimentation, 155
 Metric problem solutions
 chlorination, 425
 dechlorination, 425
 oxidation ditches, 281, 283
 ponds, 327, 330
 preliminary treatment, 97
 primary treatment, 156
 rotating biological contactors, 235, 236
 sedimentation, 156
 trickling filters, 200, 203
 Microorganisms
 in wastewater, 347
 removal by treatment, 347
 Mixed flow pumps
 See Volume II, Chapter 15, "Maintenance"
 Mixed liquor, 47
 Mixing, anaerobic digestion, 49
 Molecule, 134
 Most probable number (MPN), 352
 Multiple-hearth incinerator
 See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

N

NPDES (National Pollutant Discharge Elimination System)
 permits, 23, 24, 308, 352
 Nameplate, 225
 National Pollutant Discharge Elimination System (NPDES)
 permits, 23, 24, 308, 352
 National Safety Council, 64
 Natural purification cycle, 4, 22

Nephelometry
 See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"
 Neutralization, 228
 Nitrification, 200, 214, 228
 Nitrogen
 cycle, 23
 removal, 222, 226, 228, 234, 278
 test in wastewater
 See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"
 Nuclear power plants, 19
 Nutrient cycle, 22
 Nutrient removal
 See *ADVANCED WASTE TREATMENT*, Chapter 5, "Phosphorus Removal," Chapter 6, "Nitrogen Removal," and Chapter 7, "Enhanced Biological (Nutrient) Control"
 Nutrients, 21
 ponds, 294, 301, 319
 trickling filters, 183

O

ORP (oxidation-reduction potential), 359
 ORP probe, 359
 OSHA (Occupational Safety and Health Act), 132, 375
 Also see Volume II, Chapter 14, "Plant Safety"
 Objectives of operators, 25
 Occupational Safety and Health Act (OSHA), 132, 375
 Also see Volume II, Chapter 14, "Plant Safety"
 Odor
 activated sludge, 254, 264, 265
 chlorination, 368, 398
 disinfection, 368, 398
 masking, 152, 187
 oxidation ditch, 274
 ponds, 297, 301, 304
 rotating biological contactor, 228, 229
 trickling filter, 187, 202
 Odor control, 398
 Also see *ADVANCED WASTE TREATMENT*, Chapter 1, "Odor Control"
 Open impeller
 See Volume II, Chapter 15, "Maintenance"
 Operation
 activated sludge, 255, 264, 265
 bar screens, 71
 barminutors, 80
 chlorinators, 363
 comminutors, 72, 80
 cyclone grit separators, 91
 grit channels, 87
 grit washer, 93
 oxidation ditch, 273, 275, 279
 package aeration, 264, 265
 ponds, 303–309
 primary treatment, 117, 134, 142
 racks, 71
 rotating biological contactors, 222, 226
 sedimentation, 117, 134, 142, 249
 sulfonators, 408–413
 trickling filters, 175, 180, 184
 Operation problems
 See Troubleshooting
 Operational strategy
 activated sludge, 255, 266
 bar screens, 95
 barminutors, 95
 chlorination, 367

558 Treatment Plants

Operational strategy (continued)

- comminutors, 95
- grit channels, 95
- hydraulic overloads
 - See specific process of interest
- organic overloads
 - See specific process of interest
- oxidation ditch, 278
- package aeration, 266
- ponds, 308
- primary treatment, 118
- racks, 95
- rotating biological contactors, 222
- screens, 95
- sedimentation, 118
- sulfonator, 413
- trickling filters, 184

Operators

- jobs, 4, 8
- objectives, 25
- salary, 4

Organic compounds in wastewater, 21

Organic loading or overloads

- See specific process of interest

Overflow rate, weir, 136, 137

Overturb, 307

Oxidation, 249

Oxidation ditches

- abnormal operation, 275
- activated sludge, 269
- aeration basin, 269
- BOD loading, 270, 280, 281
- bulking, 277
- bump start, 272
- chlorination, 273
- clarifiers, 269, 272, 283
- cold weather, 270, 283
- contact time, 273, 274, 280, 283
- cover, 277
- description, 270
- dimensions, 279
- dissolved oxygen, 270, 273, 274, 275
- ditch, 269
- efficiency of process, 270, 273, 274
- effluent, 269, 273, 274, 277, 282, 283
- energy use, 274
- F/M ratio, 270, 280, 281
- floc, 272, 274
- flow diagram, 269
- flow path, 269
- foam, 275
- food, 273
- food/microorganism ratio, 270, 280, 281
- gear reducer, 271, 272, 275, 277, 278, 282
- housekeeping, 274, 278
- hydraulic loading, 270, 277
- ice buildup, 270, 277, 283
- industrial waste treatment, 273
- influent, 269, 273, 282
- inspecting new facilities, 272
- layout, 269
- lining, 282
- loadings, 270, 277, 280, 281
- lubrication, 278, 279
- maintenance, 278
- metric system, 281, 283
- microorganisms, 277
- mixed liquor, 269, 270, 277
- nitrogen removal, 278

- odors, 274
- operation, 273, 275, 279
- operational strategy, 278
- organic loading, 270, 280, 281
- oxygen, 273, 274
- parts, 270
- performance, 270, 273, 275, 276
- pinpoint floc, 274
- plans and specifications, 282
- power outage, 283
- pumps, 269, 272
- purpose, 269
- recordkeeping, 272, 275
- return sludge, 269, 272, 274
- rotor, 269, 271, 283
- safety, 270
- sampling, 273
- scum, 269, 274
- secondary clarifiers, 274, 283
- seed activated sludge, 273
- settleability tests, 273
- settling tank, 269, 274
- shock loads, 270
- shutdown, 278
- slingers, 279
- sludge age, 270, 280
- solids, 269, 270
- start-up, 272, 273
- temperature, 270, 277, 283
- toxic wastes, 273
- trend chart, 276
- troubleshooting, 278
- velocity, 269, 270, 274, 275
- visual inspection, 273–275
- waste sludge, 269, 273–275
- weir, 270, 272

Oxidation ponds, 54, 297, 298

Oxidation-reduction potential (ORP), 359

Oxidizing agent, 349

Oxygen activated sludge

- See *ADVANCED WASTE TREATMENT*, Chapter 2, “Activated Sludge”

Oxygen depletion, 19

Ozonation, 95

Ozone

- odor control
 - See *ADVANCED WASTE TREATMENT*, Chapter 1, “Odor Control”
- systems
 - costs, 424
 - description, 424
 - disinfection, 424
 - effectiveness, 424

P

POTW (Publicly Owned Treatment Works), 190

Package aeration plants

- Also see Activated sludge
- abnormal operation, 265
- aeration methods, 261
- aerobic digestion, 257
- bulking, 265
- chlorination, 265
- clarifiers, 265
- cold weather, 265
- complete mix, 257, 260, 261
- contact stabilization, 257, 260
- contact time, 254, 257, 266

- Package aeration plants (continued)
 - description, 257
 - diffusers, 261, 263, 264, 282
 - efficiency of process, 256
 - effluent, 254, 255, 265, 266
 - energy use, 261
 - extended aeration, 257, 260
 - flow diagram, 258–260
 - foam, 264, 265, 266
 - housekeeping, 266, 267
 - hydraulic loading, 254, 255, 265
 - industrial waste treatment, 256
 - influent, 256
 - inspecting new facilities, 261
 - layout, 258–260
 - maintenance, 266, 267
 - mechanical aeration, 257, 261, 262
 - microorganisms, 249, 250, 254, 265
 - mixed liquor suspended solids, 257, 261, 264, 267
 - odors, 264, 265
 - operation, 264, 265
 - operational strategy, 266
 - parts, 257
 - plans and specifications, 282
 - pretreatment requirements, 254
 - purpose, 257
 - recordkeeping, 264, 266
 - return sludge, 264, 265
 - safety, 267
 - sampling, 266
 - secondary clarifiers, 265, 267
 - settleability tests, 254, 266
 - shutdown, 266
 - sludge age, 257, 280, 281
 - start-up, 261, 264
 - storm flows, 265
 - temperature, 265
 - toxic wastes, 255, 265
 - trend chart, 266
 - troubleshooting, 265
 - types of plants, 257
 - visual inspection, 265, 266
 - wasting sludge, 261, 264, 266
- Package treatment plant
 - activated sludge, 257
 - combined sedimentation-digestion unit, 147
 - oxidation ditch, 269
- Parallel operation
 - ponds, 307
 - trickling filters, 189
- Parasites, 347
- Paratyphoid, 347
- Parshall flume, 43
- Particle settling, 134
- Particle size, primary sedimentation, 134
- Pathogenic bacteria, 54, 347
- Pay for operators, 4
- Percolation, wastewater, 155, 301
- Permits, effluent discharge, 23, 24
- Personal hygiene, 64
- pH
 - definition, 20, 299
 - ponds, 299, 303, 315
 - rotating biological contactors, 228, 229
 - test
 - See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”
 - trickling filter effluent, 183
- pH effects
 - ponds, 299
 - rotating biological contactor, 228, 229
 - snail control, RBCs, 229
 - trickling filter, 183
- pH measurement
 - See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”
- Phosphorus removal
 - See *ADVANCED WASTE TREATMENT*, Chapter 5, “Phosphorus Removal”
- Photosynthesis, 53, 299
- Physical treatment, 169
- Physical–chemical treatment
 - See *INDUSTRIAL WASTE TREATMENT*, Volume I, Chapter 8, “Physical–Chemical Treatment Processes”
- Physiological response
 - chlorine, 376
 - sulfur dioxide, 402, 403, 404
- Plans and specifications
 - activated sludge, 282
 - bar screens, 96
 - chlorination, 394, 398
 - chlorinators, 394, 398
 - grit channels, 96
 - oxidation ditch, 282
 - package aeration, 282
 - ponds, 319
 - primary treatment, 142
 - racks, 96
 - rotating biological contactors, 234
 - screens, 96
 - sedimentation, 142
 - trickling filters, 202
 - wet wells, 96
- Poliomyelitis (polio), 20, 347
- Polishing ponds, 297, 298
- Pollution, 18
- Polymer feed, operation
 - See *ADVANCED WASTE TREATMENT*, Chapter 3, “Residual Solids Management”
- Ponding, trickling filter, 186, 191
- Ponds
 - abnormal operation, 307
 - acid production, 299
 - advantages, 297
 - aerobic ponds, 297, 299, 300
 - algae, 294, 303, 309, 321, 328
 - alkalinity, 317
 - anaerobic ponds, 297, 300
 - arithmetic, 325–328, 330
 - BOD loading, 307, 309
 - batch operation, 308
 - bioflocculation, 301
 - chlorination, 304, 307
 - classification, 297, 298
 - cleaning, 307, 318
 - cold weather, 301, 303, 304, 308, 309
 - color, 303, 309
 - controlled-discharge, 299, 301, 308
 - cover, 307
 - depth, 303, 308, 321
 - description, 53, 294, 299
 - detention time, 299, 301, 317, 325
 - dissolved oxygen, 297, 299, 315, 321
 - efficiency of process, 301, 317
 - effluent, 299, 307, 309, 310, 315, 317, 328
 - energy use, 297

560 Treatment Plants

- Ponds (continued)
 - facultative ponds, 297, 299, 301
 - fencing, 325
 - filamentous algae, 321
 - flow diagram, 40, 295, 296
 - headworks, 306, 319
 - herbicides, 305
 - history, 294
 - housekeeping, 303
 - hydraulic loading, 325, 327
 - industrial waste treatment, 319
 - influent, 315, 317
 - inlet structure, 319
 - insect control, 304
 - land, 297
 - layout, 40, 295, 296, 298
 - levee maintenance, 306, 321
 - limitations, 297
 - loadings, 310, 325, 327
 - maintenance, 303, 314
 - mechanical aeration, 297
 - methane fermentation, 299, 301
 - metric calculations, 327, 330
 - mosquito control, 304, 305
 - nutrients, 294, 301, 319
 - odors, 297, 301, 304
 - operation, 303–309
 - operational strategy, 308
 - organic loading, 310, 327
 - outlet structure, 319, 320–323
 - overturn, 307
 - oxidation ponds, 297, 298
 - parallel operation, 307
 - parts, 294
 - performance, 301, 317
 - pH, 299, 303, 315
 - plans and specifications, 319
 - polishing ponds, 297, 298
 - pond isolation, 307
 - population loading, 325, 326
 - purpose, 294
 - recirculation, 304, 307, 310, 321, 326
 - recordkeeping, 315, 319, 334
 - removal efficiencies, 301, 317
 - safety, 305, 318
 - sampling, 308, 309, 315
 - scum control, 303
 - series operation, 307
 - short-circuiting, 321
 - shutdown, 308
 - signs, 325
 - stabilization, 53, 297, 298
 - start-up, 303
 - surface aerators, 304, 309, 312, 313, 325
 - temperature, 301, 303, 304, 308, 315, 317, 329
 - toxic wastes, 301, 319
 - trend chart, 316
 - troubleshooting, 309, 310–311
 - tules, 304, 321
 - use of ponds, 294
 - visual inspection, 309, 310
 - weed control, 304, 305
- Population equivalent, 326
- Positive displacement pumps
 - See Volume II, Chapter 15, “Maintenance”
- Power outage, 119, 229, 283
- Pre-aeration
 - definition, 65
 - description, 95
 - purpose, 95
- Preliminary treatment, 34, 64
- Preserving samples
 - See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”
- Pretreatment facility inspection, 33, 120, 183, 190, 273
- Pretreatment/Preliminary treatment
 - activated sludge, 249
 - bar screens, 65
 - barminutors, 80
 - comminutors, 72
 - cyclone grit separators, 88
 - domestic wastes, 33, 41, 64
 - grit removal, 84
 - industrial wastes
 - See *INDUSTRIAL WASTE TREATMENT*, Volume I, Chapter 5, “Industrial Waste Monitoring”
 - pre-aeration, 95
 - purpose, 64
 - racks, 65
 - rotating biological contactor, 222
- Preventive maintenance
 - See Volume II, Chapter 15, “Maintenance”
- Primary sedimentation
 - definition, 43
 - detention time, 43
- Primary treatment
 - abnormal operation, 119
 - description, 34, 43, 109
 - detention time, 135
 - efficiency of process, 129
 - effluent, 128
 - flow diagram, 110, 111
 - hydraulic load, 130
 - influent, 128
 - maintenance, 117, 131, 144
 - operation, 117, 134, 142
 - operational strategy, 118
 - overflow rate, 136
 - parts, 112, 113, 114
 - plans and specifications, 142
 - pumping, 130
 - purpose, 109, 115
 - recordkeeping, 131, 161
 - safety, 117, 131, 144
 - sampling, 128
 - section, 112
 - shutdown, 118
 - sludge and scum pumping, 130
 - solids loading, 136
 - start-up, 117
 - surface loading, 136
 - toxic wastes, 119, 122
 - troubleshooting, 119, 120, 129
 - weir overflow rate, 136, 137
- Probe, ORP, 359
- Process control
 - See Operation and Operational strategy
- Public relations, 7
- Publicly Owned Treatment Works (POTW), 190
- Pump station, 34
- Pumping, sludge and scum, 130
- Pumps
 - See Volume II, Chapter 15, “Maintenance”
- Purification cycle, 4
- Purpose of treatment process
 - activated sludge, 249, 257
 - bar screens, 69
 - barminutors, 80
 - chlorination, 347
 - comminutors, 72, 77

- Purpose of treatment process (continued)
 cyclone grit separators, 65, 88, 91
 dechlorination, 41, 54
 disinfection, 347
 flotation, 109
 grit channels, 84
 grit washers, 93
 hypochlorination, 351
 oxidation ditch, 269
 package aeration, 257
 ponds, 294
 preliminary treatment, 64
 primary treatment, 109
 racks, 67, 69
 rotating biological contactors, 220
 sedimentation, 109
 trickling filters, 169
 Pyrometer, 225
- Q**
- Qualifications for operators, 6
- R**
- Racks
 See Bar screens
 Radioactive wastes, 19
 Receiving waters
 algae, 23
 human health, 20
 nutrients, 21
 odors, 19
 oxygen depletion, 19
 pathogenic bacteria, 20
 sludge and scum, 19
 toxic substances, 20
 Recharge, groundwater, 55
 Recirculation
 ponds, 304, 307, 310, 321, 326
 rotating biological contactor, 222, 225, 229, 234
 trickling filter, 175, 178, 180, 182, 184, 189, 197
 Reclamation
 See *ADVANCED WASTE TREATMENT*, Chapter 8,
 "Wastewater Reclamation and Reuse"
 Recordkeeping
 activated sludge, 264, 267
 chlorination, 396
 chlorinators, 396
 oxidation ditch, 272, 275
 package aeration, 264, 266
 ponds, 315, 319, 334
 primary treatment, 131, 161
 rotating biological contactors, 225
 sedimentation, 131, 161
 sulfonator, 414
 trickling filters, 208
 Records and reports
 See Volume II, Chapter 19, "Records and Report Writing"
 Redox potential, 359
 Reducing agent, 350
 Reliquefaction, 392, 394
 Retention time, 138
 Reuse
 See *ADVANCED WASTE TREATMENT*, Chapter 8,
 "Wastewater Reclamation and Reuse"
 Review of plans and specifications
 activated sludge, 282
 bar screens, 96
 chlorination, 394, 398
 chlorinators, 394, 398
 grit channels, 96
 oxidation ditch, 282
 package aeration, 282
 ponds, 319
 primary treatment, 142
 racks, 96
 rotating biological contactors, 234
 screens, 96
 sedimentation, 142
 trickling filters, 202
 wet wells, 96
 Riprap, 305, 306
 Rotameter, 358
 Rotating biological contactor
 abnormal operation, 229
 advantages, 222
 alkalinity, 228
 biomass, 225, 228
 bulkhead, 214, 220, 228
 clarifiers, 214
 clearances, 225
 cold weather, 214, 222, 225, 226, 234
 contact time, 226
 covered, 214, 220, 222, 234
 description, 214
 dissolved oxygen, 226
 drive units, 220, 222, 223, 232, 233
 efficiency of process, 222, 226
 effluent, 222, 226, 228
 energy use, 222
 equalization tanks, 222, 229
 flow diagram, 219
 flow equalization tanks, 222, 229
 growth, 214, 225
 holding tanks, 214
 housekeeping, 232
 hydraulic balance, 225
 hydraulic loading, 222, 226, 234, 235
 industrial waste discharges, 228
 influent, 226, 228
 inspecting new contactors, 226
 layout, 219, 221
 limitations, 222
 loadings, 222, 228, 234–236
 lubrication, 225, 231
 maintenance, 231
 media, 214, 217, 218, 220, 228
 metric calculations, 235, 236
 nitrogen removal, 222, 226, 228, 234
 odors, 228, 229
 operation, 222, 226
 operational strategy, 222
 organic loading, 222, 226, 227, 228, 235, 236
 parts, 220
 performance, 222, 226
 pH, 228, 229
 plans and specifications, 234
 power outage, 229
 pretreatment requirements, 222
 purpose, 220
 recirculation, 222, 225, 229, 234
 recordkeeping, 225
 rotation of media, 225
 safety, 225, 234
 sampling, 226
 shutdown, 229
 slime growth, 214, 225, 228, 229
 sloughing, 214, 225, 228, 229
 sludge deposits, 228

562 Treatment Plants

Rotating biological contactor (continued)
snail control, 229
speed of rotation, 225
stages, 214
start-up, 222, 225
sulfur compounds, 228
supernatant treatment, 228
temperature, 214, 222, 225, 226, 234
time of contact, 226
toxic wastes, 228
trend chart, 226, 227
troubleshooting, 229, 230, 232
underdrain, 220
visual inspection, 225, 226, 228
Roughing filter, trickling filter, 177

S

SI (Le Système International d'Unités), 466

Also see Metric conversion factors and Metric problem solutions

SVI (sludge volume index), 138

Sacrificial anode, 364

Safety hazards

Also see Chlorine safety; and Volume II, Chapter 14, "Plant Safety"

activated sludge, 267

bar screens, 64, 67, 69

barminutors, 80

causes, 64

chlorination, 375

chlorinators, 375

chlorine, 375

clarifiers, 131

comminutors, 80

cyclone grit separators, 91

grit channels, 87

grit washer, 93

hypochlorinators, 358, 375

National Safety Council, 64

oxidation ditch, 270

package aeration, 267

ponds, 305, 318

primary treatment, 131, 144

racks, 67

rotating biological contactors, 225, 234

sedimentation, 117, 131, 144

sulfur dioxide, 402

trickling filters, 197, 203

ultraviolet (UV) systems, 417

Safety program

See Volume II, Chapter 14, "Plant Safety," and Chapter 20, "Treatment Plant Administration"

Salmonellosis, 347

Sample size

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

Sampling

Also see Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

activated sludge, 266

combined sedimentation-digestion unit, 150

composite, 128, 226, 317

grab, 226, 315

oxidation ditch, 273

package aeration, 266

ponds, 308, 309, 315

primary treatment, 128

rotating biological contactors, 226

sedimentation, 128

trickling filters, 181, 184

Sand drying beds, 49

Sanitary landfill, 55

Sanitary sewers, 33

Saprophytes, 347

Screening

disposal, 41, 67, 71

quantity, 71

wastewater, 41

Screens

See Bar screens

Screw lift pumps

See Volume II, Chapter 15, "Maintenance"

Scum

pumping, 130

receiving water, 19

removal, 130

Scum and foam control, anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

Secondary clarifiers

activated sludge, 137

description, 47

operation, 138, 142

oxidation ditches, 274, 283

package aeration, 265, 267

sludge collection, 137–142

trickling filter, 138

Secondary treatment, 34, 46, 169, 214, 249

Sedimentation

abnormal operation, 119

description, 109

detention time, 135

drawing, 44, 45, 110, 111

efficiency of process, 43, 128, 137

effluent, 128

flow diagram, 110, 111

hydraulic load, 129

influent, 128

maintenance, 117, 131, 144

operation, 117, 134, 142, 249

operational strategy, 118

overflow rate, 136

parts, 112, 113, 114

performance, 137

plans and specifications, 142

primary clarifiers, 130, 134

pumping, 130

purpose, 109, 115

recordkeeping, 131, 161

safety, 117, 131, 144

sampling, 128

scum removal, 130

secondary clarifiers, 47, 137–142

section, 112

short-circuiting, 135

shutdown, 118

sludge and scum pumping, 46, 130

solids loading, 136

start-up, 117

surface loading, 136

temperature, 134

toxic wastes, 119, 122

trend chart, 151

- Sedimentation (continued)
 - troubleshooting, 119, 120, 129
 - types of units, 134
 - weir overflow rate, 136
- Sedimentation-digestion unit
 - abnormal operation, 153
 - description, 147
 - efficiency of process, 147, 149, 150
 - flow diagram, 147
 - maintenance, 153
 - operation, 149, 152
 - operational strategy, 153
 - parts, 149
 - purpose, 149
 - safety, 153
 - sampling, 149
 - section, 148
 - shutdown, 153
 - start-up, 149
 - troubleshooting, 153
- Septic, 23, 265, 267
- Septic tanks, 155
- Septicity, 119, 399
- Series operation
 - ponds, 307
 - trickling filters, 189, 190
- Settleability test, 254, 266, 273
 - Also see Volume II, Chapter 16, "Laboratory Procedures and Chemistry"
- Settleable solids, 182
- Settling
 - See Sedimentation
- Settling tanks
 - activated sludge, 249, 254, 265, 267
 - oxidation ditches, 269, 274
 - oxygen activated sludge
 - See *ADVANCED WASTE TREATMENT*, Chapter 2, "Activated Sludge"
 - package aeration plants, 265, 267
 - rotating biological contactors, 214
 - trickling filter, 138
- Settling velocity
 - grit, 86
 - particles, 134
- Sewer systems, 33
- Sewer-use ordinance, 190
 - Also see *INDUSTRIAL WASTE TREATMENT*, Volume I, Chapter 3, "Regulatory Requirements," and Chapter 5, "Industrial Waste Monitoring"
- Shigellosis, 347
- Shock load, 49, 120, 184, 222, 270
- Short-circuiting
 - clarifiers, 135
 - density, 135
 - ponds, 321
 - sedimentation, 135
 - temperature, 135
- Shredding, 41, 42
- Shutdown
 - activated sludge, 266
 - aerated grit chambers, 88
 - bar screen, 71
 - barminutors, 80
 - chlorination, 367
 - chlorinators, 367
 - comminutors, 80
 - cyclone grit separators, 91
 - grit channels, 87
 - grit washer, 93
 - oxidation ditch, 278
 - package aeration, 266
 - ponds, 308
 - primary treatment, 118
 - rotating biological contactors, 229
 - sedimentation, 118
 - sulfonator, 414
 - trickling filters, 180
 - ultraviolet (UV) systems, 421
- Sixty-minute settling test, activated sludge, 254, 266
- Slingers, 279
- Sloughing, 138, 175, 182, 188, 214, 225, 228, 229
- Sludge
 - definition, 46, 130
 - dewatering, 49
 - digestion, 49
 - disposal, 49
 - heat drying and incineration, 53
 - incineration, 53
 - lagoons, 49
 - multiple hearth incinerators
 - See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
 - pumping, 130
 - receiving waters, 19
 - wet oxidation, 53
- Sludge age, activated sludge, 257, 280, 281
- Sludge blanket, 254
- Sludge bulking
 - activated sludge, 265
 - toxic waste, 122
- Sludge collection
 - collector failure, 121, 130
 - primary sedimentation, 130
 - secondary sedimentation, 137–142
 - start-up, 117
- Sludge deposits, ponds, 301
- Sludge dewatering, 49
 - Also see Volume II, Chapter 12, "Sludge Digestion and Solids Handling"; and *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
- Sludge disposal, 49
- Sludge handling
 - Also see Volume II, Chapter 12, "Sludge Digestion and Solids Handling"; and *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
 - aerobic digester, 49, 257
 - anaerobic digester, 49
 - primary sedimentation, 130
- Sludge pumping
 - anaerobic digester
 - See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
 - failure, 121
 - operation problems, 121
 - primary sedimentation, 130
- Sludge thickening and conditioning
 - See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
- Sludge treatment
 - See Volume II, Chapter 12, "Sludge Digestion and Solids Handling," and *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"

564 Treatment Plants

- Sludge volume index (SVI)
 - activated sludge, 138
 - test, 142
- Snails
 - rotating biological contactors, 229
 - trickling filters, 186
- Sodium chlorite, 394
- Sodium hypochlorite disinfection, maintenance, 394
- Sodium sulfite, 405, 406
- Soil conditioner, 55
- Solar heat, 226
- Solids
 - Also see *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
 - dewatering, 49
 - digestion, 49
 - disposal, 34, 55
 - dissolved, 21, 22
 - floatable, 21, 22
 - handling, 49, 50, 51
 - inorganic, 21
 - land application
 - See *ADVANCED WASTE TREATMENT*, Chapter 3, "Residual Solids Management"
 - loading on clarifiers, 136
 - nonsettleable, 21
 - organic, 21
 - settleable, 21
 - suspended solids, 21
 - test in wastewater, 21
 - total, 21
 - wastewater characteristics, 21
- Solids accumulation, rotating biological contactor, 228
- Solids loading
 - activated sludge clarifiers, 138
 - dissolved-air flotation, 137
 - secondary clarifiers, 137
 - sludge thickening, 137
- Soluble BOD, 222
- Specific gravity, 134
- Splash pad, 321
- Stabilization ponds, 53, 297, 298
- Stabilized waste, 249, 294
- Staffing needs, 8
- Standard rate
 - anaerobic digester
 - See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"
 - trickling filter, 177, 199
- Start-up
 - activated sludge, 261, 264
 - aerated grit chambers, 88
 - bar screens, 71
 - barminutors, 80
 - chlorination, 360
 - chlorinators, 360, 361
 - comminutors, 80
 - cyclone grit separators, 91
 - grit channels, 87
 - oxidation ditch, 272, 273
 - package aeration, 261, 264
 - ponds, 303
 - primary treatment, 117
 - rotating biological contactors, 222, 225
 - sedimentation, 117
 - sulfonator, 408, 409, 411
 - trickling filters, 179
 - ultraviolet (UV) systems, 421
- Sterilization, 54, 347
- Storm sewers, 33
- Stormwater, 33, 188, 265
- Straw, algae control, 329
- Sulfonator
 - abnormal operation, 413
 - controls, 407
 - dechlorination, 401
 - diaphragm, 401
 - differences, 413
 - emergency safety equipment, 404
 - evaporator, 405, 411, 413
 - feed-rate control, 407, 413
 - maintenance, 414
 - operation, 408–413
 - operational strategy, 413
 - plugging, 407
 - recordkeeping, 414
 - shutdown, 414
 - start-up, 408, 409, 411
 - troubleshooting, 410, 412, 413
 - water supply, 409, 411
- Sulfur dioxide
 - application point, 402
 - chemical reactions, 401
 - containers, 403, 405
 - controls, 407
 - dechlorination, 401
 - detection of leaks, 403
 - emergency safety equipment, 404
 - evaporator, 405
 - feed rate, 407, 413, 425
 - first aid, 404
 - hazards, 402
 - injector, 406, 411
 - leaks, 403
 - liquified gas, 403
 - maintenance, 414
 - odor, 401, 402
 - physiological response, 402, 403, 404
 - pipng, 405, 414
 - properties, 401
 - purpose, 401
 - reactions, 401
 - repair kit, 403, 404, 405
 - residual, 408
 - safety, 402, 403, 404
 - shutdown, 414
 - sodium sulfite tablets, 405, 406
 - start-up, 408, 409, 411
 - sulfonator, 405
 - supply system, 405, 409, 411
 - troubleshooting, 410, 412, 413
 - use, 41, 54, 401
 - valves, 405
- Supernatant, 49
- Surface aerators, ponds
 - applications, 309
 - description, 309
 - maintenance, 314
 - ON/OFF cycles, 309
 - operating time, 314
 - parts, 314
 - photograph, 312
 - purpose, 314
 - section, 313
- Surface loading
 - activated sludge clarifiers, 138
 - clarifiers, 118, 136
 - trickling filter clarifiers, 138

Suspended solids, 21, 181, 182
Système International d'Unités (SI), 466
 Also see Metric conversion factors and Metric problem solutions

T

Tablets, sodium sulfite, 405, 406

Temperature effect

activated sludge, 265

anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

chlorination, 352, 396

clarifiers, 134

oxidation ditches, 270, 277, 283

ponds, 301, 303, 304, 308, 315, 317, 329

rotating biological contactor, 214, 222, 225, 226, 234

sedimentation, 135

short-circuiting, 135

trickling filter, 177, 181, 184, 188

Terminology, wastewater treatment, 499

Tertiary treatment, 54, 297

Tests

activated sludge, 266

combined sedimentation-digestion unit, 150

effluent disposal

See Volume II, Chapter 13, "Effluent Discharge, Reclamation, and Reuse"

oxidation ditches, 273, 274

package aeration, 266

ponds, 315

primary sedimentation, 128

rotating biological contactors, 226

trickling filters, 181, 184

Thermal wastes, 19

Thermophilic process, anaerobic digester

See Volume II, Chapter 12, "Sludge Digestion and Solids Handling"

Titrate, 356

Total coliform, test

See Volume II, Chapter 16, "Laboratory Procedures and Chemistry"

Toxic wastes

activated sludge, 255, 265

combined sedimentation-digestion unit, 153

general, 19

oxidation ditch, 273

package aeration, 255, 265

ponds, 301, 319

primary treatment, 119, 120, 122

rotating biological contactors, 228

sedimentation, 119, 122

trickling filters, 175, 190

Training opportunities, 8

Treatment plant operator

duties, 4, 6, 7

employers, 4

pay, 4

Treatment plants, 34

Treatment processes, 34

Trend chart

activated sludge, 266

oxidation ditches, 276

ponds, 316

rotating biological contactors, 226, 227

sedimentation, 151

trickling filters, 184, 185

Trickling filters

abnormal operation, 182, 186

chlorination, 180, 186, 187, 188, 189, 399

clarifiers, 138

classification of filters, 177

cold weather, 188

covered, 188, 202

description, 169

distribution system, 169, 195, 202

dosing tanks, 175, 176

downstream process problems, 190

efficiency of process, 181, 188

effluent, 180, 181, 188

energy use, 175, 180, 184

filter flies, 187

flow diagram, 36, 170, 171

growth removal, 181

high-rate filters, 177, 199

hydraulic loading, 184, 199, 200, 201

industrial waste treatment, 175, 190

influent, 181, 184, 188

inspecting new filters, 179

layout, 36, 171

loadings, 184, 199, 200, 201

maintenance, 195

media, 169, 172, 173, 174, 199

nutrients, 183

odors, 187, 202

operation, 175, 180, 184

operational strategy, 184

organic loading, 184, 199, 201

parallel operation, 189

parts, 173

performance, 182

plans and specifications, 202

ponding, 186, 191

recirculation, 175, 178, 180, 182, 184, 189, 197

recordkeeping, 208

roughing filters, 177

safety, 197, 203

sampling, 181, 184

section, 172

series operation, 189, 190

shutdown, 180

site, 202

sloughing, 175, 182, 188

snails, 186

solids contact, 201

stages, 177, 178

standard-rate filters, 177, 199

start-up, 179

suspended solids, 181, 182

temperature, 177, 181, 184, 188

toxic wastes, 175, 190

trend chart, 184, 185

troubleshooting, 182, 186–195

underdrains, 169, 197

upstream process problems, 190

ventilation, 175, 187

visual inspection, 184

zoogical film, 169

Trickling filter/solids contact process, 201

Troubleshooting

activated sludge, 265

bar screens, 69

barminutors, 80

chlorination, 368–373

chlorinators, 363, 368–373

566 Treatment Plants

Troubleshooting (continued)
chlorine, 363, 368–373
combined sedimentation-digestion unit, 153
comminutors, 80, 95
grit channels, 95
oxidation ditch, 278
package aeration, 265
ponds, 309, 310–311
primary treatment, 119, 120, 129
rotating biological contactors, 229, 230, 232
sedimentation, 119, 120, 129
sludge collector, 121
sludge pump, 121
sulfonator, 410, 412, 413
sulfur dioxide, 410, 412, 413
trickling filters, 182, 186–195
ultraviolet (UV) systems, 423

Turbidity test
See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”

Typhoid fever, 20, 347

U

Ultrafiltration, 328
Ultraviolet (UV) systems
description, 416
disinfection, 416
equipment, 416, 417, 418
fouling, quartz sleeve, 422
lamp disposal, 423
lamp maintenance, 423
maintenance, 422, 423
operation, 419
safety, 417
shutdown, 421
sleeve cleaning, 422
start-up, 421
troubleshooting, 423
types of systems, 416
uses, 416

V

Vacuum filtration, operation
See Volume II, Chapter 12, “Sludge Digestion and Solids Handling,” and *ADVANCED WASTE TREATMENT*, Chapter 3, “Residual Solids Management”
Valves, maintenance
See Volume II, Chapter 15, “Maintenance”; and *INDUSTRIAL WASTE TREATMENT*, Volume II, Chapter 8, “Maintenance”
Velocity of settling
grit, 86
particles, 134

Ventilation, safety, 96, 175, 187, 396

Venturi meters, 43

Viruses in wastewater, 347

Visual inspection

activated sludge, 265, 266

oxidation ditch, 273–275

package aeration, 265, 266

ponds, 309, 310

rotating biological contactors, 225, 226, 228

trickling filters, 184

Volatile acids, test

See Volume II, Chapter 16, “Laboratory Procedures and Chemistry”

W

Washing, grit, 42, 93

Waste discharges, 18

Waste treatment ponds, 34, 40, 53

Wastewater characteristics, 18

Wastewater treatment objectives, 18, 25

Wastewater treatment processes, introduction, 34

Wastewater words, defined, 499

Wasting activated sludge, 47, 142, 254, 261, 264, 266

Water, 18

Water Environment Federation, safety surveys, 64

Water quality protector, 5

Weed control, ponds, 304, 305

Weir overflow rates

activated sludge clarifiers, 138

primary clarifiers, 136

trickling filter clarifiers, 138

Weirs

diameter, 136

flow measuring, 43

Wet oxidation, 53

Wet wells, review of plans and specifications, 96

White biomass, rotating biological contactors, 228

White foam, activated sludge, 265

X

(NO LISTINGS)

Y

(NO LISTINGS)

Z

Zoogleal film, 169

Zoogleal mass, 249, 250