

Contents

Introduction	1
2. Process Mechanics	3
Basic Mechanisms of the Activated Sludge Process	3
Formation of Activated Sludge	9
Growth of Micro-organisms	11
Classification of Micro-organisms	14
Solids Separation and Return	16
3. Factors Affecting Operation	17
Raw Wastewater Strength	17
Nutrients	18
Dissolved Oxygen	19
Detention Time	19
pH	20
Toxicity	21
Temperature	22
Mixing	23
Hydraulics	24
4. Process Modifications	27
Plug Flow	27
Complete Mix	28
Contact Stabilization	29
Extended Aeration	31
Other Modifications	31
Oxidation Ditch	31
Step Feed	32
Tapered Aeration	33
Kraus Process	34
Hatfield Process	35
5. Process Monitoring	37
Visual Indicators	37
Color	38
Odor	38
Foam	38
Algal Growth	39
Spray Patterns	39

Effluent Clarity	39
Bubbles	40
Floating Material	40
Solids Accumulations	40
Flow Patterns	41
Turbulences	41
Touch	41
Analytical Indicators	42
Dissolved Oxygen	42
BOD	43
COD	44
D.O. Uptake Rate Test	44
SS and VSS	45
30-Minute Settling Test	46
Nutrients	47
pH	48
Oil and Grease	48
Temperature	48
Microscopic Examinations	49
Sludge Blanket Depth	51
Acidity and Alkalinity	53
Jar Tests	53
Flow Rates	54
Detention Time	54
Chemical Feed Rates	54
Tank Levels and Weights	55

6. Operational Control **57**

Plant Loadings	57
Food/Micro-organisms (F/M) Ratio	58
Sludge Age	61
Sludge Wastage Rate Control	64
Sludge Recycle Rate Control	64
Chemical Feed Rates	64
Ammonia	68
Phosphoric Acid	68
Neutralization Chemicals	71
Additional Chemicals	77
Volumetric Dosages	77
Dry Weight Dosages	79

7. Troubleshooting **81**

Introduction	81
General Troubleshooting Techniques	81
Typical Operating Problems	85
General	85
Low Soluble BOD Removal	86
Organic Loads	87
Toxic or Inhibitory Substances	89
Low Temperatures	90
System pH Out of Range	90

Insufficient Aeration Time	91
Insufficient MLVSS	92
Poor Solids Settling	94
Rising Sludge vs Bulking Sludge	94
Deflocculation	96
Straggler Floc	97
Pin Floc	97
Solids Carryover	97
Case Histories	100
Troubleshooting Matrices	100
8. Start-up	107
Introduction	107
Pre-Start-up Preparation	108
Wastewater Analysis	108
Seed Screening	110
Process Checklist	113
Mechanical Equipment Checklist	115
Tanks	116
Aeration Equipment	116
Pumps	117
Clarifier Mechanisms	117
Familiarization and Training ..	117
Start-up	118
Seeding	119
Process Monitoring	123
Dissolved Oxygen	124
pH	124
Nutrients	124
BOD and COD	125
Organic Removal Efficiency ..	125
Effluent Quality	126
MLSS and MLVSS	127
Growth Rate	127
D.O. Uptake Rate	128
Microscopic Examinations	129
Settling Tests	129
Transition	130
Typical Start-up Problems	130
Foaming	130
Settling Problems	132
Low BOD Removal	133
Index	135