
CONTENTS

Preface xvii

Part I Perspectives

1	Evolution of Solid Waste Management	3
1-1	Solid Waste—A Consequence of Life	3
1-2	Waste Generation in a Technological Society	5
1-3	The Development of Solid Waste Management	7
1-4	Integrated Solid Waste Management	15
1-5	Operation of Solid Waste Management Systems	18
1-6	Discussion Topics and Problems	21
1-7	References	22
2	Legislative Trends and Impacts	23
2-1	Major Legislation	23
2-2	Impact of Federal Legislation	27
2-3	Governmental Agencies	32
2-4	Enforcing the Hierarchy of Integrated Solid Waste Management	34
2-5	Future Trends	35
2-6	Discussion Topics and Problems	36
2-7	References	36

Part II Sources, Composition, and Properties of Solid Waste

3	Sources, Types, and Composition of Municipal Solid Wastes	39
3-1	Sources of Solid Wastes	40
3-2	Types of Solid Wastes	40
3-3	Composition of Solid Wastes	45
3-4	Determination of the Composition of MSW in the Field	58

3-5	Types of Materials Recovered from MSW	59
3-6	Future Changes in Waste Composition	64
3-7	Discussion Topics and Problems	67
3-8	References	67
4	Physical, Chemical, and Biological Properties of Municipal Solid Waste	69
4-1	Physical Properties of MSW	69
4-2	Chemical Properties of MSW	76
4-3	Biological Properties of MSW	87
4-4	Physical, Chemical, and Biological Transformations of Solid Waste	90
4-5	Discussion Topics and Problems	97
4-6	References	98
5	Sources, Types, and Properties of Hazardous Wastes Found in Municipal Solid Waste	99
5-1	Properties and Classification of Hazardous Wastes	99
5-2	Sources, Types, and Quantity of Hazardous Wastes Found in MSW	103
5-3	Significance of Hazardous Wastes in MSW	110
5-4	Physical, Chemical, and Biological Transformations of Hazardous Waste Constituents Found in MSW	113
5-5	Management of Hazardous Wastes in MSW	119
5-6	Discussion Topics and Problems	121
5-7	References	122

Part III Engineering Principles

6	Solid Waste Generation and Collection Rates	125
6-1	Importance of Waste Quantities	125
6-2	Measures and Methods Used to Assess Solid Waste Quantities	126
6-3	Solid Waste Generation and Collection Rates	137
6-4	Factors That Affect Waste Generation Rates	142
6-5	Quantities of Materials Recovered from MSW	146
6-6	Quantities of Household Hazardous Wastes	147
6-7	Waste Characterization and Diversion Studies	149
6-8	Discussion Topics and Problems	152
6-9	References	157
7	Waste Handling and Separation, Storage, and Processing at the Source	159
7-1	Handling and Separation of Solid Waste at the Source	159
7-2	Waste Handling and Separation at Residential Dwellings	160
7-3	Waste Handling and Separation at Commercial and Industrial Facilities	170
7-4	Storage of Solid Wastes at the Source	170

7-5	Processing of Solid Wastes at Residential Dwellings	181
7-6	Processing of Solid Wastes at Commercial and Industrial Facilities	190
7-7	Discussion Topics and Problems	190
7-8	References	191
8	Collection of Solid Waste	193
8-1	Waste Collection	193
8-2	Types of Collection Systems, Equipment, and Personnel Requirements	204
8-3	Analysis of Collection Systems	210
8-4	Collection Routes	228
8-5	Alternative Techniques for Analysis of Collection Systems	237
8-6	Discussion Topics and Problems	238
8-7	References	245
9	Separation and Processing and Transformation of Solid Waste	247
9-1	Reuse and Recycling Opportunities for Waste Materials	248
9-2	Materials Recovered at Drop-off and Buy-back Centers	251
9-3	Options for the Separation of Waste Materials	253
9-4	Introduction to the Unit Operations Used for the Separation and Processing of Waste Materials	255
9-5	Facilities for Handling, Moving, and Storing Waste Materials	265
9-6	Development and Implementation of MRFs	270
9-7	Waste Transformation through Combustion	291
9-8	Waste Transformation through Aerobic Composting	302
9-9	Impact of Source Reduction and Waste Recycling on Waste Transformation Processes	317
9-10	Selection of Proper Mix of Technologies	320
9-11	Discussion Topics and Problems	320
9-12	References	323
10	Transfer and Transport	325
10-1	The Need for Transfer Operations	325
10-2	Types of Transfer Stations	328
10-3	Transport Means and Methods	343
10-4	Transfer Station Design Requirements	352
10-5	Location of Transfer Stations	354
10-6	Discussion Topics and Problems	357
10-7	References	360
11	Disposal of Solid Wastes and Residual Matter	361
11-1	The Landfill Method of Solid Waste Disposal	362
11-2	Landfill Classification, Types, and Methods	371
11-3	Landfill Siting Considerations	377
11-4	Composition and Characteristics, Generation, Movement, and Control of Landfill Gases	381

11-5	Composition, Formation, Movement, and Control of Leachate in Landfills	417
11-6	Surface Water Management	447
11-7	Structural and Settlement Characteristics of Landfills	457
11-8	Environmental Quality Monitoring at Landfills	460
11-9	Layout and Preliminary Design of Landfills	468
11-10	Landfill Operation	485
11-11	Landfill Closure and Postclosure Care	490
11-12	Landfill Process Computations	491
11-13	Discussion Topics and Problems	531
11-14	References	538

Part IV Separation, Transformation, and Recycling of Waste Materials

12	Materials Separation and Processing Technologies	543
12-1	Unit Operations for the Separation and Processing of Waste Materials	543
12-2	Size Reduction	544
12-3	Size Separation	552
12-4	Density Separation	559
12-5	Magnetic and Electric Field Separation	565
12-6	Densification (Compaction)	570
12-7	Selection of Facilities for Handling, Moving, and Storage of Waste Materials	578
12-8	Movable Equipment Used for Materials Handling	582
12-9	Design of Materials Recovery Facilities (MRFs)	583
12-10	Discussion Topics and Problems	606
12-11	References	608
13	Thermal Conversion Technologies	611
13-1	Fundamentals of Thermal Processing	611
13-2	Combustion Systems	618
13-3	Pyrolysis Systems	627
13-4	Gasification Systems	630
13-5	Environmental Control Systems	636
13-6	Energy Recovery Systems	657
13-7	Discussion Topics and Problems	666
13-8	References	668
14	Biological and Chemical Conversion Technologies	671
14-1	Biological Principles	671
14-2	Aerobic Composting	684
14-3	Low-Solids Anaerobic Digestion	697
14-4	High-Solids Anaerobic Digestion	701
14-5	Development of Anaerobic Digestion Processes and Technologies for Treatment of the Organic Fraction of MSW	705

14-6	Other Biological Transformation Processes	710
14-7	Chemical Transformation Processes	710
14-8	Energy Production from Biological Conversion Products	713
14-9	Discussion Topics and Problems	713
14-10	References	715
15	Recycling of Materials Found in Municipal Solid Waste	717
15-1	Key Issues in Materials Recycling	718
15-2	Aluminum Cans	720
15-3	Paper and Cardboard	723
15-4	Plastics	728
15-5	Glass	735
15-6	Ferrous Metal (Iron and Steel)	738
15-7	Nonferrous Metals	742
15-8	Yard Wastes Collected Separately	743
15-9	Organic Fraction of MSW	747
15-10	Construction and Demolition Wastes	749
15-11	Wood	752
15-12	Waste Oil	754
15-13	Used Tires	758
15-14	Lead-Acid Batteries	760
15-15	Household Batteries	762
15-16	Future Recycling Opportunities	763
15-17	Discussion Topics and Problems	764
15-18	References	765

Part V Closure, Restoration, and Rehabilitation of Landfills

16	Closure of Landfills	769
16-1	Development of a Closure Plan	769
16-2	Revegetation of Closed Landfill Sites	778
16-3	Long-term Postclosure Care	790
16-4	Legal Framework	796
16-5	Discussion Topics and Problems	797
16-6	References	798
17	Remedial Actions at Inactive Waste Disposal Sites	799
17-1	Impact of Inactive Landfills	800
17-2	Quantifying the Problem and Completing the Site Designation	803
17-3	Hazardous Waste Landfill Remediation	810
17-4	Other Designated Waste Landfill Remediation	811
17-5	Discussion Topics and Problems	816
17-6	References	817

Part VI Solid Waste Management and Planning Issues

18	Meeting Federal- and State-Mandated Diversion Goals	821
18-1	Strategies for Meeting Diversion Goals	822
18-2	Source Reduction	824
18-3	Recycling—Source Separation of Wastes	828
18-4	Recycling—Materials Recovery	834
18-5	Waste Transformation through Composting	844
18-6	Discussion Topics and Problems	845
18-7	References	846
19	Implementation of Solid Waste Management Options	847
19-1	Changing Priorities in Integrated Solid Waste Management	847
19-2	Collection System Mechanization	848
19-3	Energy Recovery	855
19-4	Landfill Disposal	864
19-5	Discussion Topics and Problems	871
19-6	References	872
20	Planning, Siting, and Permitting of Waste Management Facilities	873
20-1	Planning in Solid Waste Management	873
20-2	Developing a Facilities Plan	880
20-3	Securing a Site and Obtaining Permits	885
20-4	Discussion Topics and Problems	904
20-5	References	904
	Appendixes	
A	Glossary	905
B	Metric Conversion Factors	913
C	Physical Properties of Water	915
D	Presentation and Analysis of Solid Waste Management Data	917
E	Typical Cost Data and Cost-Estimating Procedures for Equipment Used in Solid Waste Management Systems	931
F	Solubility of Landfill Gases Dissolved in Water	937
G	Carbonate Equilibrium	941
H	Physical Properties of Selected Volatile and Semivolatile Organic Compounds	943
I	Landfill Gas Flow Head Loss Computations	945
	Indexes	
	Name Index	951
	Subject Index	957