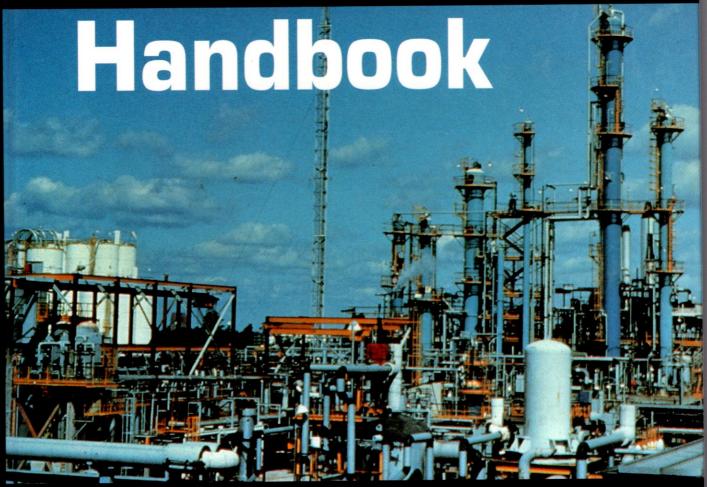
Industrial Pollution Prevention



HARRY M. FREEMAN

Contents

Contributors xix Preface xxiii

| 1.1 Introduction 1 1.2 Benefits of Pollution Prevention 4 1.3 Pollution Prevention in Other Countries 5 1.4 Industrial Programs 6 1.5 Where Do We Go from Here? 7 References 7 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws 3.1 Introduction 27 | 1. | Pollu | tion Prevention | 1 |
|---|----|-------|--|----|
| 1.3 Pollution Prevention in Other Countries 5 1.4 Industrial Programs 6 1.5 Where Do We Go from Here? 7 References 7 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 1.1 | Introduction 1 | |
| 1.4 Industrial Programs 6 1.5 Where Do We Go from Here? 7 References 7 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 1.2 | Benefits of Pollution Prevention 4 | |
| 1.5 Where Do We Go from Here? 7 References 7 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 1.3 | Pollution Prevention in Other Countries 5 | |
| References 7 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 1.4 | Industrial Programs 6 | |
| 2. Overview of Waste Reduction Techniques Leading to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 1.5 | Where Do We Go from Here? 7 | |
| to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | | References 7 | |
| to Pollution Prevention 2.1 Introduction 9 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | | | |
| 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | 2. | | | 9 |
| 2.2 Managing Inventory 10 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 2.1 | Introduction 9 | |
| 2.3 Modifying Production Processes 12 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 2.2 | Managing Inventory 10 | |
| 2.4 Reducing Waste Volume 16 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | | | |
| 2.5 Recovering Waste 17 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | | 100 March 100 Ma | |
| 2.6 Summary 19 References 25 Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 2.5 | 100 CO | |
| Further Reading 26 3. Pollution Prevention Requirements in United States Environmental Laws | | 2.6 | | |
| 3. Pollution Prevention Requirements in United States Environmental Laws | | | References 25 | |
| Environmental Laws | | | Further Reading 26 | |
| Environmental Laws | | | | |
| 3.1 Introduction 27 | 3. | | | 27 |
| | | 3.1 | Introduction 27 | |

86

| | History and Process Description 847 Major Steps in the Kraft Process 849 |
|-----|--|
| 847 | ition Prevention in the Pulp and Paper Industry |
| | Further Reading 845 |
| | re |
| | ms |
| | Process Description 831 |
| 829 | in the Textile Industries |
| | Other Resources 827 |
| | |
| | Bibliography 826 |
| | Examples of POTW Pollution Prevention Initiatives 823 |
| | Encouraging Pollution Prevention through Permitting Activities 821 |
| | Encouraging Pollution Prevention through On-Site Inspections 813 |
| | Setting Priorities to Focus Pollution Prevention Efforts 810 |
| | Prevention among Businesses? 810 |
| | Why Should POTWs Encourage Pollution Prevention? 809 |
| | Background 809 |
| 809 | ouraging Pollution Prevention through Publicly od Treatment Works Activities |
| | Further Reading 806 |
| | References 805 |
| | rev |
| | Pollution Prevention Options 799 |
| | |
| | ם |
| | Industry Overview 791 |
| 791 | d Furniture Finishing |
| | Packaging Reduction and Recycling 784 |
| | |
| | Industry Overview 777 GM's Pollution Prevention Program 779 |
| 777 | ution Prevention at General Motors |

Index 911

| | Further Reading 910 | | |
|----------|--|--------------|------------|
| | Consulting Companies 907 Nonprofit Research Organizations 908 | 53.7 53.8 | |
| | تَ | 53.6 | |
| 894 | University Programs and Research Institutions | 53.5 | |
| | State Programs 894 | 53.4 | |
| | Federal Programs 890 | 53.3 | |
| | Forms of Information 887 | 53.2 | |
| | Introduction 885 | 53.1 | |
| | 53. Sources of Pollution Prevention Information | Sour | 53. |
| | References 881 | | |
| | Conclusion 879 | 52.6 | |
| stry 873 | Pollution Prevention in the Pharmaceutical Industry | 52.5 | -3}-=· |
| 871 | Solvent Usage in the Pharmaceutical Industry | 52.4 | |
| | Waste Disposal Practices in the Pharmaceutical Industry 869 | 52.3 | |
| | Overview of Pharmaceutical Industry and Waste Generation 866 | 52.2 | |
| | Introduction 865 | 52.1 | 7 |
| dustr | 52. Pollution Prevention in the Pharmaceutical Industry | Pollu | Q 1 |
| | Further Reading 863 | | |
| | References 863 | | |
| | Pollution Prevention Successes 862 | 5 1.5 | |
| | Pollution Prevention Options 854 | 51.4 | |
| | Major Wastestreams 853 | 51.3 | |

88

| rovisions 28 | | |
|---|----|------------|
| iscussion 32 kecutive Orders Promoting Federal Pollution Prevention | 42 | |
| eferences 49 | | |
| ling the Pollution Prevention Framework | | 51 |
| troduction 51 | | |
| cal Government Perspective 52 | | |
| 臣 | | |
| anclusions 60 | | |
| ferences 61 | | |
| ury Pollution Prevention Programs | | 63 |
| rnewis of Voluntary Programs 63 | | |
| nutury Programs of the EPA 64 | | |
| Service 69 | | |
| acility Planning Requirements | | 71 |
| mining Requirements 72 | | |
| | | |
| objection of Confidential Business Information 78 | | |
| whnical Assistance Activities and Funding Mechanisms | 79 | |
| runts 79 | | |
| illution Prevention Barriers and Reasons for huvers 79 | | |
| ate-Specific Components 80 | | |
| mining Follow-up 81 | | |
| miniary 82 | | |
| irther Reading 82 | | |
| on Prevention Incentives, Barriers, | | |
| tions, and State Programs | | 6 1 |
| Hullon Prevention Incentives 86 | | |
| œ | | |
| guilatory Framework Encouraging Pollution Prevention | 95 | |
| ferences 97 | | |
| irther Reading 97 | | |

| | • |
|------------|------------|
| Prevention | Developing |
| Pro | ane |
| gran | N N |
| | Maiı |
| | ntain |
| | inin |
| | 100 |
| | |
| | ŏ |
| | Muti |
| | m |
| | |
| | |

- Benefits of and Obstacles to a Pollution Prevention Program 101
- Definition of Pollution Prevention Program, Plan, and Project 102
- Overview of Steps to Implementing a Pollution Prevention Program
- Top-Management Support 103
- 8.5 Getting Started 107
- 8.6 Out in the Plant—A Learning Process 111
- 8.7 Sustain the Pollution Prevention Program 116
- Summary 118
- Bibliography 119
- Further Reading 119

9. Pollution Prevention and Total Quality Management

1:

- The Paradigms: Their Basis and Substance
- Convergence of the Paradigms
- The Future Factory 133
- References

10. Examples of Successful Pollution Prevention Programs

- Introduction 135
- Overview of Reduction Techniques 137
- 10.3 Grumman Corporation 138
- Panel Processing, Incorporated
- 10.5 Avondale Industries, Incorporated 142
- Conclusions 145 Other Pollution Prevention Achievements

144

11. Agile Manufacturing

- 11.1 Introduction 147
- 11.2 Manufacturing Background 147
- 11.3Agile Manufacturing History 148
- 11.4 How Does an Agile Company Operate?
- What Capabilities Exist in an Agile Manufacturing Company? 149
- 11.6 What Are the Characteristics of an Agile Company? 150
- 11.7 What's New in Agility?
- Why Agility?

References

| ** | | | and the specific to | | | | |
|---|--|---------------------------------------|---------------------|--|---|-----------------------------------|--|
| 20. Product 20.1 Int 20.2 Soc Sy 20.3 Gre 20.4 Sct 20.5 Lat 20.6 Con Fur | 19.1 Cor 19.2 Apr 19.3 Fac 19.4 Sur Ref Fur | Ref | | 18.1 Intr 18.2 Def 18.3 Goz 18.4 Dev 18.5 Nee | Bib Bib | | 17.1 Intr 17.2 Wh: 17.3 Wh: 17.4 Wh: |
| Product Labeling 20.1 Introduction to Environmental Labeling 313 20.2 Society of the Plastics Industry Resin Coding System 315 20.3 Green Seal 316 20.4 Scientific Certification Systems 321 20.5 Labeling Programs around the World 322 20.6 Conclusion 327 Further Reading 327 Organizations to Contact for Additional Information | Concepts and Methods 295 Applications of LCA for Pollution Prevention 307 Facilitating Applications 309 Summary 311 References 311 Further Reading 312 | References 291 Life-Cycle Assessment | e es | Introduction 253 Definition of the Product System 254 Goals of Life-Cycle Design 257 Development Activities 258 Needs Analysis 281 | Prevenuon Progress 249 Bibliography 251 Pollution Prevention through Life-Cycle Design | sues earned TRI? ing a M | Introduction/Overview 235 What Is Pollution Prevention Progress? 236 Why Measure Progress? 236 What to Measure? 237 How to Measure 239 |
| 328 | | | | | | ntion | |
| 31 | | 29 | | | N CA | | |

17. Measuring Pollution Prevention Progress

Contents is

23!

| - |
|---|
| 1 |
| C |
| Ξ |
| 5 |
| 2 |
| - |
| 5 |
| ŭ |

4

| 409 | ne Effect of Measurement Accuracy on Pollution Fourfol 395 pullizing Control System Performance to Reduce Follutants 397 rocess Control Strategies to Prevent Pollutant Finissions 401 onclusion 407 arther Reading 407 on Prevention through Process Simulation frocess Design 410 omputer-Aided Process Design for Pollution Prevention 412 xamples 420 ther Environmental Simulation Tools 429 onclusion 430 eferences 431 |
|------------|---|
| 361 | inic Terminology 344 usuffication of Reactors 345 ferences 357 Irther Reading 358 Lions Technologies In of Separations in Pollution Prevention 361 puration Technologies for Liquid Waste 363 puration Technologies for Gaseous Waste 383 Eferences 392 |
| 343 | 7 A D |
| 329 | ign troduction 329 te Process Development Cycle 331 y Tools and Techniques for Incorporating Pollution revention 335 |

| 9 |
|------------|
| Pollution |
| Prevention |
| through |
| Chemistry |

- Alternative Synthetic Pathways for Pollution Prevention
- Process Analytical Chemistry 436
- 26.3Pollution Prevention in PMN Review
- 26.4 Chemicals and Safety 446 References 450

27. Mixing as a Tool for Pollution Prevention in Reactive Systems

- 27.1 Introduction 455
- 27.2 Mixing Equipment 457
- 27.3 Industrial Examples 459
- 27.4 Reactive Mixing Models
- Summary 464
- References

28. Process Equipment for Cleaning and Degreasing

- Introduction 467
- 28.2Traditional Processes and Add-On Improvements
- 28.3Aqueous Processing
- 28.4 Ultrasonic Cleaning
- 28.5Low-Emission Vapor Degreasing
- 28.6Alternative Soldering Techniques
- Emerging Technologies 478 References

29. Pollution Prevention in Coating Application and Removal

- 29.1 Industry Overview 483
- 29.2Description of Main Processes
- 29.3 Typical Wastestreams 484
- 29.4 Pollution Prevention Options
- **Pollution Prevention Successes**
- Further Reading 493 References 493

30. Pollution Prevention in Office Operations

- 30.1 Introduction 495
- Benefits of Practicing Pollution Prevention in the Office 496
- 30.3 Pollution Prevention Options for Office Operations 497

Contents

| 30.4 | lis | |
|-------|--|-----|
| 30.5 | Conclusions 504 | |
| | lin | |
| | Other Resources 505 | |
| Pollu | Pollution Prevention in Laboratory Operations | 507 |
| 31.1 | Introduction 507 | |
| 31.2 | Nature of Waste Generated by Laboratories 508 | |
| 31.3 | Pollution Prevention Assessment 508 | |
| 31.4 | Purchasing and Inventory Management 509 | |
| 31.5 | Downsizing 510 | |
| 31.6 | Product Substitution 510 | |
| 31.7 | Computer Simulation 510 | |
| 31.8 | Regulatory Structure 512 | |
| 31.9 | Waste Minimization Requirements in the Laboratory 514 | |
| 31.10 | Designing a Laboratory Pollution Prevention Program 515 | |
| | Reference 516 | |
| | Further Reading 516 | |
| Bolve | Solvent Substitutes | 517 |
| 32.1 | Introduction 517 | |
| 32 2 | Metal Fabrication and Finishing 522 | |
| 32.3 | Precision Instruments and Devices 526 | |
| 32.4 | Printed Circuit Board Manufacture and Assembly 533 | |
| 32.5 | Maintenance Activities 536 | |
| 32.6 | Nonmetallic Materials 537 | |
| 32.7 | Adhesives, Coatings, Inks, and Aerosols 537 | |
| 32.8 | Material and Process Change Considerations 538 | |
| | References 539 | |
| Main | Maintenance Operations and Pollution Prevention | 541 |
| 33,1 | Definition of Maintenance 541 | |
| 33.2 | Maintenance Tasks 544 | |
| 33.3 | The Bathtub Curve 546 | |
| 33,4 | Maintenance Wastes 550 | |
| 33.5 | Environmental Impact 555 | |
| 33.6 | Selecting Priorities 555 | |
| 33.7 | Maintenance Trends 556 | |
| 33.8 | Addressing Pollution Prevention in Plant Maintenance 558 | |
| 33.9 | 3 | |
| | References 560 | |

84. Measuring the Performance of Environmentally Friendly Cleaning Solvents

Col

34.1 Analytical Tools 564

34.2 Materials Compatibility and Environmental Testing Bibliography

35. Materials Management

35.1 Business Benefits and Environmental Potentials

Information Sources for Facility Materials Management 574

- Managing Purchasing, Distribution, and Demand Inventories Do Count in Pollution Prevention 575 57
- 35.6 35.5 Managing Materials Handling to Minimize Waste Benefits and Effects of Materials Substitution 581
- Material and Waste Exchanges

Checklist for Materials Management Success Further Reading 583 References

36. Generic Pollution Prevention

36.1 Introduction 585

General Approach to Initiating a P2 Water Management Program

36.4 36.3 Techniques for Recycling Untreated Wastewater In-Plant Wastewater Reduction Techniques 597

36.5By-Product Recovery 600

Techniques for Reusing Treated Wastewater References 614

Further Reading 614

37. An Overview of Potential Environmental Impact fro Industrial Activity

Generalized Environmental Impact

37.2 Generalized Case Study

37.3 Natural Resource Collection

37.4 Materials Processing

37.5 Manufacturing 620

37.7 37.6 Use and Maintenance Packaging 624

37.8 Disposal 626

Conclusions References 627

=

Contents

| | intry Overview 685 «eription of Major Processes 686 deal Wastestreams 688 |
|-----|--|
| 883 | n Prevention in the Power Generation |
| | Frent Reclamation Requirements 673 Frences 683 Friber Reading 684 |
| 667 | Interest Consideration 668 Include Technical Consideration 668 |
| | |
| 659 | ior |
| | |
| 653 | ial Waste Recycling at an Automotive ent Manufacturing Facility |
| | |
| | Pical Wastestreams 645 Ilution Prevention Options 645 Ilution Prevention Successes 650 |
| | 4 |
| 641 | n Prevention in the Electronics Industry |
| | _ |
| | ocess Changes 638 Nelsonmental Control 638 |
| | ò o |
| | oduct Substitution 631 oduct Recycling 636 |
| | Itential and Advantages of Biotechnology 630 Illution Prevention Techniques 631 |
| 4 | troduction 629 |
| 629 | nology for Pollution Prevention |

| 43.1 Industry Overview 701 43.2 Stripping 704 43.3 Cleaning 706 43.4 Painting 709 43.5 Inorganic Surface Treatment 713 43.6 Inorganic Surface Finishing 715 Bibliography 718 Pollution Prevention in the Chemical Industry 44.1 Introduction 721 44.2 Pollution Prevention—a Review of Chemical Industry Performance 723 A4.3 Implementing Pollution Prevention 705 |
|--|
|--|