

# **AIR POLLUTION CONTROL EQUIPMENT SELECTION GUIDE**

**Kenneth C. Schifftner**



**LEWIS PUBLISHERS**

---

# Contents

## Chapter 1 Air pollution control 101

|   |    |
|---|----|
| It is separation technology .....                           | 1  |
| Wet collection of particulate.....                          | 4  |
| Dry collection.....   | 6  |
| Gas absorption.....   | 9  |
| The concept of number of transfer units in absorption ..... | 11 |
| The transfer unit concept in gas absorption .....           | 11 |
| Hybrid systems .....  | 15 |

## Chapter 2 Adsorption devices

|                                     |    |
|-------------------------------------|----|
| Device type .....                   | 17 |
| Typical applications and uses ..... | 17 |
| Operating principles.....           | 18 |
| Primary mechanisms used .....       | 19 |
| Design basics .....                 | 20 |
| Operating suggestions .....         | 23 |

## Chapter 3 Biofilters

|                                    |    |
|------------------------------------|----|
| Device type .....                  | 25 |
| Typical applications and uses..... | 25 |
| Operating principles.....          | 27 |
| Primary mechanisms used .....      | 29 |
| Design basics .....                | 29 |
| Operating suggestions .....        | 30 |

## Chapter 4 Dry cyclone collectors

|   |    |
|---|----|
| Device type .....                       | 33 |
| Typical applications and uses.....      | 33 |
| Operating principles.....               | 34 |
| Primary mechanisms used .....           | 36 |
| Design basics .....                     | 36 |
| Operating/application suggestions ..... | 38 |

## Chapter 5 Electrostatic precipitators

|  |    |
|--|----|
| Device type .....                          | 45 |
| Typical applications and uses .....        | 45 |
| Operating principles .....                 | 51 |
| Primary mechanisms used .....              | 53 |
| Creation of charge .....                   | 53 |
| Field charging .....                       | 54 |
| Diffusion charging .....                   | 54 |
| Design basics .....                        | 54 |
| Resistivity of dust .....                  | 55 |
| Operating suggestions .....                | 57 |
| Air load/gas load testing .....            | 57 |
| Alignment .....                            | 57 |
| Thermal expansion .....                    | 57 |
| Air in-leakage .....                       | 58 |
| Rapping .....                              | 58 |
| Insulator cleaning .....                   | 58 |
| Purge heater and ring heater systems ..... | 59 |
| Process temperature .....                  | 59 |
| Fuel changes .....                         | 59 |

## Chapter 6 Evaporative coolers

|                                     |    |
|-------------------------------------|----|
| Device type .....                   | 61 |
| Typical applications and uses ..... | 61 |
| Primary mechanisms used .....       | 62 |
| Design basics .....                 | 62 |
| Types of gas cooling .....          | 63 |
| Gas conditioning .....              | 64 |
| Basic sizing .....                  | 66 |
| The all important atomization ..... | 68 |
| A case history example .....        | 72 |
| Cost considerations .....           | 73 |
| Operating suggestions .....         | 75 |

## Chapter 7 Fabric filter collectors

|                                     |    |
|-------------------------------------|----|
| Device type .....                   | 77 |
| Typical applications and uses ..... | 77 |
| Operating principles .....          | 78 |
| Primary mechanisms used .....       | 80 |
| Design basics .....                 | 80 |
| Operating suggestions .....         | 89 |

## Chapter 8 Fiberbed filters

|                                     |    |
|-------------------------------------|----|
| Device type .....                   | 91 |
| Typical applications and uses ..... | 91 |
| Acid mist .....                     | 92 |

|   |     |
|---|-----|
| Asphalt processing .....                                | 92  |
| Plasticizer/vinyl/PVC processing .....                  | 92  |
| Coating/laminating .....                                | 94  |
| Electronics .....                                       | 94  |
| Textile processing .....                                | 94  |
| Metalworking .....                                      | 94  |
| Lube oil vents and reservoirs .....                     | 95  |
| Incinerator emissions .....                             | 95  |
| Internal combustion engine crankcase vents .....        | 95  |
| Precious metal recovery .....                           | 97  |
| Vacuum pumps .....                                      | 97  |
| Operating principles .....                              | 98  |
| Primary mechanisms used .....                           | 98  |
| Design basics .....                                     | 100 |
| Operating/application suggestions .....                 | 100 |
| Filter cleaning .....                                   | 100 |
| Fiberbed filter life .....                              | 101 |
| Fire protection if the contaminant is combustible ..... | 101 |

#### **Chapter 9 Filament (mesh pad) scrubbers**

|                               |     |
|-------------------------------|-----|
| Device type .....             | 103 |
| Typical applications .....    | 103 |
| Operating principles .....    | 105 |
| Primary mechanisms used ..... | 105 |
| Design basics .....           | 105 |
| Operating suggestions .....   | 108 |

#### **Chapter 10 Fluidized bed scrubbers**

|                                     |     |
|-------------------------------------|-----|
| Device type .....                   | 111 |
| Typical applications and uses ..... | 111 |
| Operating principles .....          | 112 |
| Primary mechanisms used .....       | 117 |
| Design basics .....                 | 117 |
| Operating suggestions .....         | 118 |

#### **Chapter 11 Mechanically aided scrubbers**

|                                     |     |
|-------------------------------------|-----|
| Device type .....                   | 121 |
| Typical applications and uses ..... | 121 |
| Operating principles .....          | 122 |
| Primary mechanisms used .....       | 125 |
| Design basics .....                 | 125 |
| Operating suggestions .....         | 125 |

#### **Chapter 12 Packed towers**

|                                     |     |
|-------------------------------------|-----|
| Device type .....                   | 127 |
| Typical applications and uses ..... | 127 |

|   |     |
|---|-----|
| Operating principles.....                                 | 128 |
| Primary mechanisms used .....                             | 132 |
| Design basics .....                                       | 133 |
| Counter flow.....   | 133 |
| Cross flow .....  | 135 |
| Operating suggestions .....                               | 136 |
| <b>Chapter 13 Settling chambers</b>                       |     |
| Device type .....   | 139 |
| Typical applications and uses .....                       | 139 |
| Operating principles.....                                 | 139 |
| Primary mechanisms used .....                             | 141 |
| Design basics .....                                       | 141 |
| Operating/application suggestions .....                   | 142 |
| <b>Chapter 14 Spray towers/scrubbers</b>                  |     |
| Device type .....   | 143 |
| Typical applications and uses .....                       | 143 |
| Operating principles.....                                 | 143 |
| Primary mechanisms used .....                             | 145 |
| Design basics .....                                       | 147 |
| Operating suggestions .....                               | 148 |
| <b>Chapter 15 Nitrogen oxide (NO<sub>x</sub>) control</b> |     |
| Device type .....   | 151 |
| Typical applications and uses .....                       | 151 |
| Combustion sources.....                                   | 151 |
| Operating principles.....                                 | 152 |
| Primary mechanisms used .....                             | 152 |
| Design basics .....                                       | 152 |
| Different forms of NO <sub>x</sub> .....                  | 152 |
| NO <sub>x</sub> measurement units.....                    | 152 |
| Thermal NO <sub>x</sub> .....                             | 153 |
| Fuel-bound NO <sub>x</sub> .....                          | 156 |
| Thermal-NO <sub>x</sub> control strategies.....           | 157 |
| Dilution strategies.....                                  | 158 |
| Staging strategies .....                                  | 158 |
| Postcombustion strategies .....                           | 159 |
| Operating/application suggestions .....                   | 160 |
| <b>Chapter 16 Thermal oxidizers</b>                       |     |
| Device type .....   | 161 |
| Typical applications .....                                | 161 |
| Operating principles.....                                 | 161 |
| Primary mechanisms used .....                             | 163 |
| Design basics .....                                       | 164 |
| Operating suggestions .....                               | 167 |

|   |            |
|---|------------|
| <b>Chapter 17 Tray scrubbers</b>                    |            |
| Device type .....                                   | 171        |
| Typical applications and uses .....                 | 171        |
| Operating principles.....                           | 171        |
| Primary mechanism used .....                        | 175        |
| Design basics .....                                 | 175        |
| Operating suggestions .....                         | 177        |
| <b>Chapter 18 Vane type scrubbers</b>               |            |
| Device type .....                                   | 179        |
| Typical applications .....                          | 179        |
| Operating principles.....                           | 179        |
| Primary mechanisms used .....                       | 180        |
| Design basics .....                                 | 183        |
| Operating suggestions .....                         | 184        |
| <b>Chapter 19 Venturi scrubbers</b>                 |            |
| Device type .....                                   | 185        |
| Typical applications .....                          | 185        |
| Operating principles.....                           | 187        |
| Primary mechanisms used .....                       | 187        |
| Design basics .....                                 | 188        |
| Operating/application suggestions .....             | 195        |
| <b>Chapter 20 Wet electrostatic precipitators</b>   |            |
| Device type .....                                   | 197        |
| Typical applications and uses .....                 | 197        |
| Primary mechanisms used .....                       | 198        |
| Design basics .....                                 | 199        |
| Types of wet precipitators .....                    | 204        |
| Configuration .....                                 | 204        |
| Arrangement .....                                   | 204        |
| Irrigation method .....                             | 204        |
| Selecting a wet electrostatic precipitator .....    | 206        |
| Operating suggestions .....                         | 209        |
| <b>Appendix A: Additional selected reading.....</b> | <b>211</b> |
| General topics .....                                | 211        |
| Industrial ventilation.....                         | 211        |
| Air pollution engineering manual.....               | 211        |
| Fan engineering .....                               | 211        |
| McIllvaine scrubber manual.....                     | 212        |
| Psychrometric tables and charts .....               | 212        |
| Cameron hydraulic book.....                         | 212        |
| Mass transfer operations .....                      | 212        |
| Various corrosion guides.....                       | 212        |
| Publication details.....                            | 212        |

|  |            |
|--|------------|
| <b>Appendix B: List of photo contributors.....</b> | <b>217</b> |
| <b>Index.....</b>                                  | <b>221</b> |