Handbook for the Operation and Maintenance of Air Pollution Control Equipment

Edited by
Frank L. Cross, Jr., P.E.
Howard E. Hesketh, PhD, P.E.

Handbook for the Operation and Maintenance of Air Pollution Control Equipment

Edited by,
Frank L. Cross, Jr., P.E.
Howard E. Hesketh, PhD, P.E.

a TECHNOMIC® publication
TECHNOMIC Publishing Co., Inc.
265 W. State St., Westport, Conn. 06880

ACKNOWLEDGMENTS

Many individuals and companies helped us in this project by supplying information for evaluation and by providing encouragement for this undertaking. The interest they have shown is sincerely appreciated.

We wish to specifically acknowledge and thank the Air Moving and Conditioning Association, Inc. (AMCA), 30 West University Drive, Arlington Heights IL 60004; and Technical Publishing Company (TPC), 1301 South Grove Avenue, Barrington IL 60010. AMCA permitted us to publish in its entirety Publication 202, "AMCA Fan Application Manual, Part 2—Troubleshooting" in Appendix B. TPC gave permission to reprint portions of Lesson 10 of the Plant Engineering Training Systems Manual in Appendix C.

The services of Diane Keller and Margaret Cross in preparing the manuscript are greatly appreciated and we thank James Christoff and Joyce Hesketh for their help in proofreading.

PREFACE

Our rapidly expanding industrial developments have made it possible for us to "modernize" our way of living. In only a few years, we have advanced from the "horse and buggy" and most of these changes have been easy to accept. However, along with the pleasant benefits have come side effects which we recognize as being wasteful and harmful. Pollution is recognized as being potentially dangerous and we have made the decision to control it. This decision by the people of our country has not been easy for all to accept.

We, the editors, as engineers trained and experienced in air pollution control, recognize that pollution control can be a significant expense. Even more significantly, we also recognize that this expense is seriously expanded in too many situations because of the lack of installation, operation and maintenance information. The Council on Environmental Quality in their fourth annual report predicted that over the next 10 years, operating and maintenance costs alone will account for 69.3% of air pollution abatement costs. This is nearly 200 billion dollars.

The authors of this publication hope that the information presented here will be valuable to owners of air pollution control equipment and, in particular, to their supervisors, operators and maintenance personnel. This handbook is not intended to be highly technical. Indeed, we hope that this will be a very practical, easily read and understood manual.

Optimum operating and maintenance techniques will help minimize wastes and costs. We do not attempt to discuss selection of equipment (which also relates to control efficiency and costs), but want to help you do the best with what you are using. With proper equipment, the pollution control operation itself could even provide a return on investment and should be thought of with this potential. Considering product savings and other health and related benefits, the same Council on Environmental Quality Report shows cost figures that indicate overall, in the United States, a 14.7% return on investment is being obtained as a result of controlling air pollution.

In addition to the introductory chapter, this handbook is divided into eight chapters plus 5 appendices. Each chapter is related to specific control equipment. The appendix contains general information that could apply to any of the systems and should be reviewed so that applicable material can be used. We have attempted to correlate each chapter so that you will have a minimum of confusion progressing from one subject to another.

Each chapter is broken into many subsections to help make it possible to locate specific topics easily. The Table of Contents includes all these subsections and

serves as an index. The portion of the Table of Contents specific to each chapter is repeated at the beginning of the respective chapter for your convenience. The appendices also provide a Glossary of Terms and information relative to testing and training courses.

We realize that air pollution control may be a change from past practices and hope that our work will make this change less unpleasant and perhaps may even make it a welcomed process improvement.

Howard E. Hesketh, P.E.
Frank L. Cross, Jr., P.E.
April 1975

LIST OF AUTHORS

1. Introduction	Frank L. Cross, Jr., P.E. State of Florida Department of Pollution Control 3444 McCrory Place Orlando, FL 32803
2. Baghouse Filters	Richard P. Bundy Product Manager Air Pollution Control Division Stanley A. Reigel Vice President—Engineering Standard Havens, Inc. 7219 E. 17th St. Kansas City, MO 64126
3. Mechanical Collectors	Alfred G. Schneider Vice President Rhoades Equipment Co. 1401 S. Brentwood Blvd. St. Louis, MO 63144
4. Electrostatic Precipitators	Howard E. Hesketh, P.E. Engineering Professor & Consultant School of Engineering & Technology SOUTHERN ILLINOIS U AT CARBONDALE Carbondale, IL 62901 Frank L. Cross, Jr., P.E. State of Florida Department of Pollution Control 3444 McCrory Place Orlando, FL 32803
5. Incinerators	Richard D. Ross Environmental Consultant 204 Weldy Ave. Oreland, PA 19075

6. Wet Scrubbers (Particulates)	Peter M. Wechselblatt Manager—Process Engineering CHEMICO Air Pollution Control Co. One Penn Plaza New York, NY 10001
7. Absorption Equipment (Gases)	James H. Clark, P.E. Manager of Scrubber Sales Heil Process Equipment Corp. 34250 Mills Road Avon, OH 44011
8. Adsorption Equipment	Howard E. Hesketh, P.E. Engineering Professor & Consultant School of Engineering & Technology SOUTHERN ILLINOIS U AT CARBONDALE Carbondale, IL 62901

TABLE OF CONTENTS

1

INTRODUCTION

By F. L. Cross, PE
State of Florida Dept. of
Air Pollution Control

Air pollution control in the United States has progressed rather slowly from the early 1900's up until 1970 when the Clean Air Act was passed. Early control programs were based around visible emissions associated with coal burning; and few pollution control systems existed other than some mechanical collectors and an occasional electrostatic precipitator, which were installed for particulate reduction. During this period, little was done for preventative maintenance.

The Clean Air Act precipitated an increase in control activity and in the sales of equipment of all types; both for gaseous and particulate control. During the next 10 years, it is predicted that air pollution control costs will amount to $105.6 billion. There is interest in protecting health (primary air quality standards) and in esthetic values (secondary air quality standards). The implementation plans were originally designed to achieve the primary air quality standards by 1975. Although this may be extended, considerable legal pressures will still be exerted to enforce pollution control. The plans require substantial reduction of emissions with efficient control equipment having removal efficiencies of over 99% in some cases.

The other Federal activity which has stimulated equipment installations is the new National Performance Standards for Stationary Sources. These emission standards are being developed for various classes of industries and apply to new sources or substantially modified sources. These new standards require high efficiency collectors and in many instances, continuous monitoring of emissions. Until this time, very little concern has been shown for:

- Operator Training
- Operation Practices
- Maintenance Procedures

It is recognized that the installation of control equipment is one way to meet stringent emission regulations. However, Air Quality Management will not be realized unless the control systems are properly operated and maintained.

Design and installation of control systems is a primary concern, but it by no means is the only factor to consider. Control agencies are now becoming concerned

not only with reliability but with equipment performance. In wastewater treatment, operations reporting has been required for some time. For many years, it has been necessary to submit monthly operating reports to regulatory agencies as a check on the performance of the waste treatment systems.

It is anticipated that similar records and reports may be required for agency inspection of air pollution control equipment performance. Only through proper operation and good maintenance practices will industrial management be able to obtain satisfactory records over extended periods of time.

There are a number of useful reasons for setting up an operation and maintenance program. Some of the features of this type of program are:

- Early detection of malfunctions
- Predict failures and thereby prevent them
- Identify and correct problems as they occur
- Prevent damage to equipment
- Reduce air pollution emissions (improve product recovery)

Management should also be interested in the benefits of such a program, which may include:

- Reduced operating costs by requiring less operator time, power, fuel, services, equipment replacement and parts inventory.
- Compliance with emission regulations/standards
- Extending the life of control equipment
- Recovery of valuable products

Items often overlooked in the design stage are features necessary to carry out proper operation and maintenance and may include:

- Adequate access openings
- Test ports
- Static pressure taps
- Platforms and stairs
- Adequate instrumentation to monitor equipment operation
- Alert systems to warn operations personnel of impending malfunctions.

Since many key inspection points may be impossible or impractical to instrument, it is important to have a schedule for frequent and complete external and internal inspections of the equipment.

The general principles involved are:

1. DESIGN:
   a. Selection of appropriate equipment
   b. Understand the functions of the various parts
   c. System controls and auxiliary components
   d. Access to equipment to perform inspections
2. OPERATIONAL:
   a. Knowledge of equipment operating principles
   b. Start up and shut down procedures
   c. Equipment adjustment and operation

d. Routine surveillance
e. Maintaining operating records

3. MAINTENANCE
   a. Lubrication
   b. Equipment inspections (internal and external)
   c. Prompt adjustments, repairs and replacement of parts
   d. General sight and sound during operation
4. OPTIMIZATION
5. SAFETY

All air pollution control systems generally consist of:

- Process
- Duct System
- Prime Mover
- Control Device(s)
- Stack

The control device itself may require no inputs if it is a purely mechanical collector or it may require input of energy, usually in the form of electricity or fuel and/or steam, and it may require dry and/or liquid chemicals. In many systems, there will be a product, by-product or waste to remove.

Some of the parameters that should be considered in routine operation of the system are:

1. Production rate
2. Fuel and raw material
3. System gas flow rate
   a. Calibrated flow measurement equipment
   b. Induced draft (I.D.) fan power input
4. System resistance(s) (pressure drop)
   a. I.D. fan static pressure
   b. Collector resistance(s)
   c. Duct and stack resistances
5. Stack gas characteristics
   a. Temperature(s)
   b. Gas composition
   c. Moisture content
   d. Others, depending upon process (e.g. particle size and size distribution, corrosive potential, etc.)
6. Control equipment function indicators
7. Ancilliary equipment function indicators

Routine operation and maintenance also includes the emission monitoring system(s). Some of the items that should be included are:

1. Monitoring particulate emissions
   a. Mass emission sensors (Beta gage, etc.)
   b. Dust catch rate (material collected in hoppers, clarifiers, etc.)