

prepared coconut shell charcoals, are sometimes called *activated charcoals* or *activated carbon*.¹²⁻¹⁴ These materials can absorb approximately 50 percent of their own weight of many organic gases at 70 F. The charcoal may be used for a long time if reactivated at high temperatures, to give up the adsorbed gases. Temperatures of approximately 1800 F are desirable for reactivation. Charcoals for use in air-handling systems should be able to stand physical handling, without excessive loss by breakage or dusting.

As applied in air-handling systems, the charcoal is placed in perforated metal containers which are grouped in frames and set in the air stream. The percentage removal of an organic gas, such as carbon tetrachloride, is 95 percent or above, when placed in intimate contact with the carbon at 70 F. In commercial apparatus there may be a bypass effect which depends on the physical arrangement of the charcoal containers. This bypassing reduces the percentage removed in the total gas passing through the adsorber. Resistance to air flow is usually selected within the general range of resistance of impingement filters.

The required quantity of recirculated air to be treated is determined by dividing the requirements for contaminant-free air, minus the outdoor air, by the fraction denoting the percentage removal of the gas in question in the adsorber bank which is to be used.

Adsorbers may be applied to reduce objectionable gases entering through the outdoor air inlet. They may also be used to reduce the odors caused by exhausts from processing. Adsorber beds, in all cases, should be protected from dust, free oil, and grease.

REFERENCES

- ¹ G. W. Penney: A new electrostatic precipitator (*Electrical Engineering*, January 1937, p. 159).
- ² Code for Testing Air Cleaning Devices Used in General Ventilation, Section 1: Unit or Panel Type Air Filtering Devices (Air Filter Institute, 1953).
- ³ R. S. Dill: A test method for air filters (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 379).
- ⁴ API Dust Spot Test Code (1960) (Air Filter Institute).
- ⁵ K. T. Whitby, A. B. Algren, R. C. Jordan, and J. C. Annis: The ASHRAE air-borne dust survey (ASHRAE TRANSACTIONS, Vol. 64, 1958, p. 129).
- ⁶ K. T. Whitby, A. B. Algren, and R. C. Jordan: Size distribution and concentration of air-borne dust (ASHRAE TRANSACTIONS, Vol. 61, 1955, p. 463).
- ⁷ C. E. Zinner, E. C. Tabor, and A. C. Stern: Particulate pollutants in the air of the United States (*Journal of Air Pollution Control Association*, Vol. 9, No. 3, November 1959).
- ⁸ M. W. First and P. Drinker: Concentrations of particulates found in air (*Heating and Ventilating*, November 1952).
- ⁹ Chart: Concentrations of materials in the air (Mine Safety Appliance Co. No. 1500-1).
- ¹⁰ K. T. Whitby et al.: Evaluation of air cleaners for occupied spaces (*Technical Report No. 14*, University of Minnesota and U. S. Public Health Service, February 1961).
- ¹¹ C. Y. Chen: Filtration of aerosols by fibrous media (*Chem. Review*, Vol. 55, No. 3, June 1955).
- ¹² T. E. Wright, R. J. Stoney, and C. E. Lapple: High velocity filters (WADC Technical Report 55-457, ASTIA Document No. AD 124075, October 1957).
- ¹³ Ranz: Principles of inertial impaction (*Engineering Research Bulletin B-66*, Penn State University, December 1956).
- ¹⁴ G. W. Penney and G. W. Hewitt: Electrically charged dust in rooms (AIEE TRANSACTIONS 1949).
- ¹⁵ Standards and Guidelines for the Design and Operation of

Clean Rooms and Clean Work Stations (U.S. Air Force TO 00-22-203, 1958).

¹⁶ Clean Room and Work Station Requirements, Controlled Environments (Federal Standard 209).

¹⁷ H. L. Barnebey: Activated charcoal for air purification (ASHAE Journal Section, *Heating, Piping and Air Conditioning*, March 1958, p. 153).

¹⁸ H. Sleik and A. Turk: Air Conservation Engineering (Connor Engineering Corp., 1953).

BIBLIOGRAPHY

- M. W. First, J. B. Graham, G. M. Butler, C. B. Walworth, and R. P. Warren: High temperature gas filtration (*Industrial and Engineering Chemistry*, Vol. 48, No. 4, April 1956).
- S. S. Leopold and C. S. Leopold: Bronchial asthma and allied allergic disorders (*Journal of the American Medical Association*, March 7, 1925, p. 731).
- L. H. Crip, M.D., and M. A. Green, M.D.: Air cleaning as an aid in the treatment of hay fever and bronchial asthma (*Journal of Allergy*, January 1936, p. 120).
- G. M. Edwell: The bacterial filtration efficiency of an electrostatic air cleaner (*Journal of the Institution of Heating and Ventilating Engineers*, London, June 1951, p. 139).
- P. Drinker and T. Hatch: *Industrial Dust* (McGraw-Hill Co., New York).
- J. W. May: Selecting the right air filter carefully (*REFRIGERATING ENGINEERING*, March 1956, p. 43).
- R. A. Nielsen: Dirt pattern on walls (ASHVE TRANSACTIONS, Vol. 46, 1941, p. 247).
- Laboratory Design for Handling Radioactive Materials (Building Research Advisory Board, National Research Council, Washington, D. C., Research Conference Report, 1952).
- J. W. May: Solving the ink mist problem (*Heating, Piping, and Air Conditioning*, July 1953, p. 120).
- H. C. Murphy: Design and application of oil-coated air filters (ASHVE TRANSACTIONS, Vol. 33, 1927, p. 73).
- W. G. Frank: Operation and maintenance of air filters (*Heating, Piping and Air Conditioning*, May 1931, p. 378).
- W. G. Frank: Size and characteristics of air-borne impurities (*Heating, Piping and Air Conditioning*, January 1932, p. 35).
- O. Wechsberg: Fundamental principles in the design of dry air filters (ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*, April 1933, p. 217).
- H. E. Ziel and Henry Sleik: The economic factors in converting recirculated air for ventilation (ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*, July 1943, p. 347).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1024—Air filter performance as affected by kind of dust, rate of dust feed, and air velocity through filter (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 415).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1122—Air filter performance as affected by low rate of dust feed, various types of carbon, and dust particle size and density (ASHVE TRANSACTIONS, Vol. 45, 1939, p. 339).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1145—The effect of lint on air filter performance (ASHVE TRANSACTIONS, Vol. 49, 1940, p. 25).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1169—Comparison of the weight, particle count and discoloration methods of testing air filters (ASHVE TRANSACTIONS, Vol. 47, 1941, p. 29).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1187—Economical air velocities for mechanical air filtration (ASHVE TRANSACTIONS, Vol. 47, 1941, p. 391).
- F. B. Rowley and R. C. Jordan: ASHVE RESEARCH REPORT No. 1218—Overloading of viscous air filters during accelerated tests (ASHVE TRANSACTIONS, Vol. 48, 1942, p. 437).
- H. E. Corbitt and N. J. Clark: Electrostatic precipitation for aircraft (*Aero Digest*, December 1940, p. 132).
- A. Nutting and R. F. Logsdon: New air filter code (*Heating, Piping and Air Conditioning*, June 1953, p. 77).

CHAPTER 37

INDUSTRIAL AIR AND GAS CLEANERS

Degree of Air Cleaning Required, Factors Affecting Selection, Types of Application, Mechanical Collectors, Wet Collectors, Fabric Collectors, Electrostatic Precipitators, Absorbers, Adsorbers, and Combustion Devices

INDUSTRIAL development and growth of industrial areas have had a cumulative effect upon the problem of controlling contaminants. Not only has the atmosphere in many cities become more polluted, but the intensity of pollution at the points of control has increased. Accompanying this increase in pollution there has been a growing consciousness of the need for more effective air cleaning among housewives, store managers, industrialists, and legal inspectors, and this has resulted in increasing severity of regulations pertaining to collection of dust and contaminants.

This chapter deals with the cleaning of exhaust system air streams and flue gases, usually to avoid a neighborhood air pollution nuisance. Typical dust concentrations in such streams range from 100 to 20,000 grains per 1000 cu ft of air.

Air cleaning for the supply system is usually accomplished by means of some type of air filter. To prevent escape of industrial dust into the atmosphere, some type of collector is required. An industrial air-cleaning installation is designed to perform one or more of the following 6 functions:

1. Prevent a nuisance or physical damage to an individual, a plant, or adjacent property.
2. Prevent re-entry of contaminants to working spaces.
3. Recycle usable material.
4. Reduce fire, explosion, or other hazards.
5. Permit recirculation of cleaned air to working spaces.
6. Allow utilization of cleaned gases for processes.

DEGREE OF AIR CLEANING REQUIRED

The amount of material which can be discharged to the atmosphere is established by local or state regulations prepared by pollution control, labor, or health departments. Standards are established to prevent injury to persons or property. The need for control within the plant is often of prime interest to the industrialist for protecting his equipment, improving his product, and providing a clean working environment. The re-entry of contaminants to working spaces is prevented by effective air-cleaning devices since only a clean effluent is discharged to the ambient atmosphere. Public nuisance complaints often occur even when the effluent concentration discharged to the atmosphere is below the permissible limits of concentration and visibility. Plant location, contaminants involved, and meteorological condition of the areas must be evaluated in addition to existing regulations or codes of good practice.

Fire and explosion hazards are created by combustible dusts, vapors, or gases. Safety may be affected by loss of

The general responsibility for this chapter is assigned to TC 4.1, Industrial Environment.

visibility, settlement, or accumulation of various materials. The cleaning device can prevent these hazards by providing an effluent below the inflammation limit, visibility index, and point where settlement or accumulation will occur.

The degree of air cleaning for the recovery of usable material is a matter of economic evaluation which will vary with such factors as quantity and value of material collected, capital cost, and operating cost.

Air cleanliness must be of the highest order where toxic materials are involved and the cleaned air is recirculated to the workroom. Such recirculation is considered poor practice and is prohibited by many regulations where toxic materials are involved, except for those cases where discharge to atmosphere is impossible or decidedly impracticable. Where air is recirculated, its contamination must not exceed the established maximum allowable concentrations listed in Chapter 11. Usual requirements are a fraction, often $\frac{1}{10}$ of this standard, depending on: regulation involved, air quantities recirculated in relation to the cubical content of working space, and the presence of other exhaust systems discharging to the atmosphere.

Cleaning requirements for the utilization of cleaned gases are dependent on the process and are generally of the highest order (usually comparable to atmospheric air cleanliness).

Regardless of standards it is good practice to install the most effective collection equipment available in the light of practical operation features, installation, and equipment costs. This is warranted because the required degree of cleaning is increasing continually.

The Industrial Gas Cleaning Institute was formed by a group of Dust Control manufacturers to assist in the establishment of performance standards and ratings to help in the proper choice of equipment to meet specific needs.

FACTORS AFFECTING SELECTION

Selection of an industrial air cleaner for a given application requires an evaluation of the following 5 considerations:

1. Concentration, particle size, and size distribution of the contaminant.
2. Degree of cleaning required.
3. Conditions of air or gas stream with reference to temperature, moisture content, and chemical composition.
4. Characteristics of the contaminant, corrosiveness, solubility, adhesion, or packing, and its specific gravity, surface, and shape.
5. Methods of disposal or salvage that meet the conditions imposed by material, process, or plant location.