

TABLE 1. RINGELMANN SMOKE CHART SPACINGS

NUMBER OF CARD	THICKNESS OF LINES, MM	DISTANCE IN CLEAR BETWEEN LINES, MM
1	1.0	9.0
2	2.3	7.7
3	3.7	6.3
4	5.5	4.5

(Subject 296), March 1934 and subsequent revisions, shall not reduce the output of a standard photoelectric cell from 9 microamperes, with a clear smoke pipe, to less than 8 microamperes." The Commercial Standard also requires that during a test after installation, the burner shall operate without visible smoke at the chimney top.

A method of evaluating smoke produced by pot type oil burners was developed for the *Institute of Cooking and Heating Appliance Manufacturers* by R. N. St. John. A glass rod is interposed between a light source and a photo-sensitive cell, both before and after being exposed to the flue gases from a heating device. The diminution of the light transmitted by the rod, due to the deposit of soot on its surface, causes a reduction in the cell emf which is taken as an index of the concentration of smoke in the flue gases. A description of the method is contained in National Bureau of Standards Commercial Standard CS104-46.⁵¹

DETERMINATION OF AIR CONTAMINANTS

Two measures of air dustiness are in use: particles per unit volume of air, and weight per unit volume of air. A comparative method consists in drawing known samples of air through a known area of filter cloth or paper, and comparing the density of the resulting spots with blackness charts or with spots from other sources.

For counting, particles are captured in a device such as the Smith-Greenburg impinger, the Owens jet dust counter, or in an electrostatic or a thermal precipitation device designed for the purpose.⁵⁶ Counting is done with a microscope, and the method yields important results when the nature or constituents of the dust are of interest.

For a weight determination, a known volume of air is drawn through a porous crucible or thimble, and the weight gained by the thimble during the operation is the weight of the dust captured from the air sample.⁵⁷ For precise work, the thimble must be dried in a desiccating chamber before weighing each time. The test method specified in the A.S.H.V.E. Code for Testing and Rating Air Cleaning Devices Used in General Ventilating Work is based on a weight method for evaluating the cleanliness of air after passing through an air cleaner.⁵⁸

The Code has not filled all needs for an air cleaner testing method and the subject is now under investigation by the A.S.H.V.E. Research Laboratory. At the *National Bureau of Standards* a test method was developed for interested Government agencies, under which measured samples of the uncleaned air and of the air cleaned by a device under test are passed through filter papers.⁵⁹ The ratio of the flow rates through the two filter papers is adjusted during successive tests, until the resulting dust spots approach equality in density as shown by a photometer. The ratio of the flow rates is then indicative of the effectiveness of the cleaner in arresting dust. A statement of an air cleaner's efficiency by any test method, is meaningless unless the test dust is specified. Other instruments for determining gaseous

and particulate air contaminants are described in industrial hygiene literature.^{55, 60, 61, 62}

Sound and Vibration Measurements

Approximate measurements of sound intensity can be made by aural methods. The ear is used to compare the measured noise with sounds of known strength.

Electrical devices, in which the ear plays no part, furnish the most satisfactory means of measuring noise intensities. The sound meter consists essentially of a microphone coupled to an amplifier designed with an ear-like response. The output of the microphone is read on a sensitive direct current milliammeter graduated to read directly in decibels. Instruments of this type, if connected with suitable band pass filters, can be used to study the intensity of the sound over its entire range of frequencies.

Electrical instruments are available for measuring the frequency, amplitude and acceleration of a vibrating mass. They are usually more convenient and accurate than the vibrating reed tachometer, the seismic type displacement meters or the accelerometers which can also be used for this purpose. Sound level meters are discussed in several text books^{63, 64} and standards.⁶⁵

REFERENCES

- ¹ Standard Code for Testing and Rating Steam Unit Heaters (adopted jointly by THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the Industrial Unit Heater Association, January 1950, second edition).
- ² A.S.H.V.E. Standard Code for Testing and Rating Steam Unit Ventilators (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 25), adopted June, 1932.
- ³ A.S.R.E. Standard Methods of Rating and Testing Air Conditioning Equipment, A.S.R.E. Circular No. 13.
- ⁴ A Survey of Testing Methods and Rating Limits for Domestic Heating Devices, by R. S. Dill (A.S.H.V.E. TRANSACTIONS, Vol. 51, 1945, p. 185).
- ⁵ For a comprehensive treatment of temperature measurement the reader is referred to *Temperature, Its Measurement and Control in Science and Industry*, a symposium sponsored by the American Institute of Physics and published by Reinhold Publishing Corp.
- ⁶ Errors in the Measurement of the Temperature of Flue Gases, by P. Nicholls and W. E. Rice (A.S.H.V.E. TRANSACTIONS, Vol. 35, 1929, p. 473).
- ⁷ Temperature Measurement (A.S.M.E. Power Test Code, Part 3).
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- ⁹ Measuring Heat Transmission in Building Structures and a Heat Transmission Meter, by P. Nicholls (A.S.H.V.E. TRANSACTIONS, Vol. 30, 1924, p. 94).
- ¹⁰ Parallel-Connected Thermocouples for the Testing of Gas Appliances, by Walter B. Kirk and George J. Pacanovsky (Gas, September, 1939, p. 51).
- ¹¹ American Standard for Indicating Pressure and Vacuum Gages, Round Dial Type, with Elastic Pressure Chamber, B. 40.1 1939—American Standards Association).
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- ¹⁴ Illinois Micromanometer (University of Illinois, Engineering Experiment Station Bulletin No. 120, p. 91).
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- ¹⁶ Pressure Measurement (A.S.M.E. Power Test Code 1936, Part 2, Chapter 2).
- ¹⁷ The Measurement of Static Pressure, by C. J. Fechheimer (Mechanical Engineering, August, 1927).
- ¹⁸ Psychrometric Tables for Vapor Pressure, Relative Humidity and Temperatures of the Dew-Point (U. S. Department of Agriculture, Weather Bureau, Washington, D. C.).
- ¹⁹ For technical data refer to Fluid Meter Reports, Parts 1—1937, 2—1931, and 3—1933 (American Society of Mechanical Engineers).
- ²⁰ Technical Notes No. 546 (National Advisory Committee for Aeronautics, November, 1935).
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- ²² Discharge Coefficients of Square Edged Orifices for Measuring the Flow of Air, by H. S. Bean, E. Buckingham and P. S. Murphy (Bureau of Standards Journal of Research, Vol. 2, 1929, p. 561).
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- ²⁴ Air Flow Measurement in the Laboratory, by D. D. Wile (Refrigerating Engineering, June, 1947, p. 515).
- ²⁵ A.S.H.V.E. RESEARCH REPORT No. 1204—Entrainment and Jet-Pump Action of Air Streams, by G. L. Tuve, G. B. Priestler and D. K. Wright, Jr. (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 241).