

are in the order of 3 to 10 parts in 10,000, extreme care must be used to obtain accurate determinations. Since occupants also give off moisture, the increase in humidity may also be used as an index of ventilation within a space. Humidity determinations are much simpler to make, but the accuracy may be affected slightly by absorption of moisture by hygroscopic materials such as fabrics and wood within the space. Measured amounts of either carbon dioxide or water vapor may be added for test purposes. Neither method is used at the present time, and more direct methods of measuring air supply and air distribution are in favor.

MEASUREMENT OF RELATIVE HUMIDITY

Wet- and dry-bulb mercurial thermometers are usually used to determine relative humidity. The sling psychrometer is a common mounting of the thermometers to permit swinging. The wet-bulb wick and water for wetting it must be clean, and the temperature of the water should preferably be slightly above the wet-bulb temperature. An air stream velocity of 900 fpm is recommended, although velocities from 300 fpm to 1000 fpm have been found satisfactory for passage over the wet-bulb wick. The velocity may be obtained by whirling the thermometer or by aspirating air over the wet-bulb. In ducts, the air flow itself gives the proper evaporating conditions. Several observations should be made until the minimum temperature is reached. Relative humidity may be obtained from tables or psychrometric charts²¹. Although it is common practice to use the charts which are based on a barometric pressure of 29.92 in. mercury, a correction for barometric pressure is necessary for extreme accuracy. This correction is made by multiplying the relative humidity as determined from the chart by the ratio of the observed barometric pressure and the standard barometric pressure.

For temperatures below 32 F, the water on the wick is allowed to freeze, during which time the temperature will drop below the true wet-bulb. A thin film of ice is more desirable than a thick one, and it is satisfactory to remove the wick and freeze a thin film directly on the bulb. Care must be taken to read the temperatures accurately due to the slight wet-bulb depressions. Tables for ice conditions must be used²⁴.

The dew-point apparatus for humidity measurements consists of a polished plated container cooled by the evaporation of a volatile liquid within. The temperature at which the first slight water vapor forms is the dew-point. If the temperature is below 32 F, the deposit will appear as frost. Another method of determining humidity is by chemical means in which the water vapor is removed by a drying agent and weighed on a chemical balance. A thermal conductivity method is available for temperatures above 212 F or for extremely low humidities²⁵.

DUST DETERMINATION

The measurement of dust is complicated by the many kinds involved. Some of the collecting methods are impingement on viscous surfaces,

²¹Psychrometric Tables for Vapor Pressure, Relative Humidity and Temperatures of the Dew-Point, (U. S. Department of Agriculture, Weather Bureau, Washington, D. C.).

²⁴A Review of Existing Psychrometric Data in Relation to Practical Engineering Problems, by W. H. Carrier and C. O. Mackey (A.S.M.E. Transactions, January, 1937, p. 33; Discussion, A.S.M.E. Transactions, August, 1937, p. 528).

²⁵Gas Analysis by Measurement of Thermal Conductivity, by H. A. Daynes (Cambridge Press, 1933).

impingement at high velocity under water, collection on porous crucibles through which air passes, and electric precipitation. Determination may be by direct weighing of samples or by microscopic counting. The most commonly used methods are the modified Hill dust counter using microscopic count, the Smith-Greenburg impinger which collects samples in water and which are counted under a microscope in a Sedgwick cell²⁶, and the Lewis sampling tube with the analytical determination of the increase in weight of a porous crucible. All reports should state the method of sampling and counting. The A.S.H.V.E. Code for Testing and Rating Air Cleaning Devices Used in General Ventilation Work specifies the porous crucible method²⁷.

HEAT TRANSFER THROUGH BUILDING MATERIALS

The A.S.H.V.E. Standard Test Code for Heat Transmission Through Walls²⁸ describes the construction and use of the guarded hot box for determining overall heat transmission coefficients of built-up sections. The standard temperature range through the test section is specified as 80 F and the mean temperature of the wall as 40 F.

In June, 1942, the A.S.H.V.E. adopted a standard test procedure for determining the conductivity of materials by the use of a guarded hot plate²⁹. The Nicholls heat meter is very useful for determining the heat flow through walls of buildings³⁰.

MEASUREMENT OF HEAT EXCHANGE FOR COMFORT CONDITIONS

Several instruments have been devised to measure the effect of various factors as they relate to the comfort of the body³¹. The principal ones are the Kata-thermometer, Dufton's eupatheoscope, Vernon's globe thermometer, Winslow and Greenburg's thermo-integrator, and Yaglou's heated globe^{32,33}. These instruments are attempts to stimulate and measure the heat exchanges between the human body and its environment. In order to stimulate conditions of hard physical labor, the entire surface of the device is covered with a wet cloth. At present special attention is being given the thermo-integrator as a means of measuring radiant effects of environmental conditions.

COMBUSTION ANALYSIS

The analysis of flue gases to determine completeness and efficiency of combustion is usually made chemically with the Orsat apparatus. This

²⁶Public Health Bulletin, No. 144, 1925, (U. S. Public Health Service).

²⁷Testing and Rating of Air Cleaning Devices Used for General Ventilation Work, by S. R. Lewis (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 277).

²⁸A.S.H.V.E. Standard Test Code for Heat Transmission Through Walls (A.S.H.V.E. TRANSACTIONS, Vol. 34, 1928, p. 253).

²⁹Standard Method of Test for Thermal Conductivity of Materials by Means of the Guarded Hot Plate (Tentative). Reprints of this code are available at \$.10 a copy.

³⁰A.S.H.V.E. RESEARCH REPORT No. 685—Measuring Heat Transmission in Building Structures and a Heat Transmission Meter, by F. Nicholls (A.S.H.V.E. TRANSACTIONS, Vol. 30, 1924, p. 65).

³¹Measurement of the Physical Properties of the Thermal Environment, by D. W. Nelson, F. R. Bichowsky, L. M. K. Boelter, R. S. Dill, A. P. Gagge, John A. Goff, A. E. Hershey, F. C. McIntosh, F. W. Reichelderfer, G. L. Tuve and C. P. Yaglou (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, June, 1942, p. 382).

³²Instruments and Methods for Recording Thermal Factors Affecting Human Comfort, by C. P. Yaglou, A. P. Kratz and C. E. A. Winslow (Year Book, American Journal Public Health, 36-37).

³³The Thermo-Integrator—A New Instrument for the Observation of Thermal Interchanges, by C. E. A. Winslow and Leonard Greenburg (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 149).