

accuracy is desired. In duct measurements the same procedure is followed as for the Pitot tube. The anemometer usually reads directly in linear feet. To obtain the velocity in feet per minute, the reading must be divided by the elapsed time in minutes.

The following procedure for obtaining anemometer readings is based on research conducted at *Armour Institute of Technology* in coöperation with the A.S.H.V.E. Research Laboratory².

Supply Grilles. The surface of the grille should be marked off into a number of equal areas approximately 6 in. square. A 4-in. anemometer should be used and should be held at the center of each section in contact with the grille (or as close as possible) for a period of time sufficient to insure an average reading. In the case of supply grilles, the instrument should always be held with the dial facing the operator. The average of the corrected readings should then be used in the following formula to obtain the flow in cubic feet per minute:

$$cfm = CV \frac{A + a}{2} \text{ or } \frac{CVA(1 + p)}{2} \quad (1)$$

where

- V = average of corrected anemometer readings in feet per minute.
- A = gross area of grille, square feet.
- a = net free area of grille, square feet.
- p = percentage of free area of grille expressed as a decimal.
- C = a coefficient that varies with the velocity from grille and may vary slightly with type of grille. For average use, with supply grilles, C can be taken as 0.97 at velocities from 150 to 600 fpm, and as 1.00 at higher velocities.

Particular care should be exercised in the case of long, narrow grilles. The nature of the approach sometimes results in a narrow strip along the top or bottom of the grille through which no air will be flowing. This may be detected by holding the anemometer completely out of the air stream and then moving it slowly inward over the grille until the vanes just start to move. The distance which the vanes extend over the grille opening at this moment will indicate the width of the dead strip. Only the remaining portion of the grille should be considered in making the calculations for gross and free area.

Exhaust Grilles. The surface of the grille should be marked off and readings taken in the same manner as with supply grilles, except that the instrument should be held with the dial facing the grille, and in contact with it. The traverse should be taken at a uniform rate, allowing sufficient time in each space to minimize the percentage of error. In the case of exhaust grilles it is found that the formula

$$cfm = KVA \quad (2)$$

in which

- V = average indicated velocity obtained by the anemometer traverse in contact with grille.

²Measurement of Flow of Air through Registers and Grilles, by L. E. Davies (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, Vol. 37, 1931, and A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, September, 1933).

A = gross area of grille, square feet.

K = coefficient determined by experiment. For average use, with exhaust grilles, K may be taken as 0.8 for all usual velocities.

This formula is of advantage, especially with ornamental grilles, in that the free area need not be measured.

The flow of air through registers and grilles is of considerable importance, being frequently the only convenient method of measuring the volume of supply air to a room. While duct measurements, if available, are more dependable, grille measurements provide a fairly accurate method, if care is taken in the technique of using the anemometer.

Kata-Thermometer

The Kata-thermometer can be used as an anemometer provided the walls and surrounding objects are at or near the room temperature. Especially at low velocities it constitutes a useful instrument for readily detecting drafts.

The instrument is essentially an alcohol thermometer with a bulb approximately $\frac{5}{8}$ in. in diameter and $\frac{1}{2}$ in. long with a stem 8 in. long reading from 100 to 95 F, graduated to tenths of a degree. To take readings the bulb is heated in water until the alcohol expands and rises into a top reservoir. The time in seconds required for the liquid to fall from 100 F to 95 F is recorded with a stop watch and this time is a measure of the rate of cooling.

A dry Kata gives the cooling power by radiation and convection. A wet Kata, which has a cotton lisle wick fitted snugly around the bulb, gives the cooling power by radiation, convection and evaporation. For constant velocities the time of cooling of the dry Kata is a function of the dry-bulb temperature alone, while that of the wet Kata is a function of the wet-bulb temperature regardless of the dry-bulb temperature or the relative humidity. Due to the comparatively brief time of fall of the wet Kata-thermometer, the dry Kata-thermometer is far more accurate for measuring air motion since any probable error in recording the time of fall will only amount to a small fraction of the total period.

HUMIDITY MEASUREMENT

The sling psychrometer is the recognized standard instrument for determining humidities. In order to obtain accurate readings considerable skill is required on the part of the operator. The wicking must be clean, distilled water should be used, and the temperature of the water should be slightly above the wet-bulb temperature of the surrounding air. The psychrometer should be swung rapidly and two or three observations should be made to see that the wet-bulb temperature has become stationary before the final reading is noted. Standard psychrometric tables should be used.

In making wet-bulb measurements below 32 F the same procedure is followed as above 32 F. The water is liquid at the start, but as the sling is operated it will freeze rapidly enough so that in quickly giving up the latent heat of fusion, the indicated wet-bulb temperature may drop below the actual wet-bulb temperature. After the liquid on the bulb has