

Extensive test results comparing the characteristics of several pitot tube types are available in the published reports⁵ of the government.

Anemometer

The vane-type anemometer is most frequently used for test work. It consists of a small, delicate, fan-like rotor connected to a revolution counter. The instrument is held in the air stream where the velocity is to be measured. It is calibrated to read directly in linear feet. The velocity in feet per minute is obtained by dividing the reading (linear feet) by the elapsed time, in minutes.

The vane anemometer is delicate, requires frequent calibration and is suited only to low velocities (less than 3000 fpm). The vanes of the instrument should never be touched.

The following procedure for obtaining anemometer readings is based on research conducted at *Armour Institute of Technology* in cooperation with the A.S.H.V.E. Research Laboratory⁶.

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:

$$cfm = CV \frac{A + a}{2} \text{ or } \frac{CVA(1 + p)}{2} \quad (3)$$

where

- V = average of corrected anemometer readings, 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 there being 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 suf-

ficient time in each space to minimize the percentage of error. In the case of exhaust grilles it is found that the formula:

$$cfm = KVA \quad (4)$$

in which

- V = average indicated velocity obtained by the anemometer traverse.
- 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.

Direct Reading Velocity Meter

An instantaneous direct reading air velocity instrument available in a portable case is used for recording air movement on a calibrated scale. Air entering the meter actuates a vane movement to which is attached a pointer with control hair springs and a magnetic damping arrangement.

Velocity meters are available in either orifice, shutter or tube types. The orifice unit is used where the instrument can be placed in the air stream when obtaining a reading such as in rooms or large spaces or at unrestricted outlets of ducts. The use of the shutter type is similar to the orifice style except that it has means for changing the scale range. The shutter is adjusted so that the large ports are fully open for low velocity readings. For high range readings the shutter is turned until the large openings are closed and only a small port is open. The shutter is omitted in the tube type of meter and in place of this fitting a tube attachment is threaded to the case. A flexible rubber tube and specially designed metal jets are used for obtaining high range readings. Jets may be secured for unusual applications such as in obscure locations, surging air currents or leakage from ducts and similar requirements. Due to the connecting tube flexibility, the jet can be moved as required while the instrument is held stationary.

Where it is desired to obtain air velocity readings within a duct, special jet and additional meter fittings are used which indicate directly the true air velocity with no corrections being essential for static pressure conditions. Air enters the meter through one side of the jet and is discharged back into the duct through the other side of the jet.

Kata-Thermometer

The Kata-thermometer can be used to determine air velocities 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.

⁵Technical Notes No. 546, National Advisory Committee for Aeronautics, November, 1935.

⁶Measurement of the Flow of Air through Registers and Grilles, by L. E. Davies (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 201; Vol. 37, 1931, p. 619, and Vol. 39, 1933, p. 373).