

Substituting $\frac{Q_1}{V_1}$ for A_1 in Equation 4

$$X = \frac{K V_1 \sqrt{\frac{Q_1}{V_1}}}{V_r} = \frac{K \sqrt{Q_1 V_1}}{V_r} \quad (5)$$

The throw of an unrestrained jet is therefore proportional to the square root of the supply air quantity and initial velocity, and inversely proportional to residual velocity.

The proportionality factor K is a function of residual velocity and initial velocity.

Another variation of the formula (Equation 4) has been suggested² in which K_1 is suitable for all conditions;

$$X = K_1 \frac{V_1^{1.16}}{V_r^{0.72}} \sqrt{A} \quad (6)$$

The average velocity at the effective area can be obtained from the following equation.

$$V_1 = \frac{Q_1}{A_1} \quad (7)$$

where A_1 = effective area.

Jet Pattern From Round or Rectangular Openings in a Large Room

The relation between the shape of the discharge of a jet and the shape of the outlet has long been the subject of research. It has been proved to be incorrect to assume that the jet retains the outlet shape when it discharges into a free open space¹. Air streams from rectangular outlets having low aspect ratios develop a symmetrical or cone shape appearance within a few diameters from the outlet face. From there on, the jet continues to expand at fairly constant rate. Beyond 20 diameters there is very little difference between round and rectangular jets. The assumption can be made that the apex of the cone is in the same position for any jet having small aspect ratio. For the more usual problems of the conventional room with outlets near the ceiling, there are insufficient experimental data to justify a definite statement on the effect of aspect ratio.

If the round or rectangular opening is divided into a number of orifices having straight sides, the performance of the air stream will be similar to that of a plain opening.

Velocity Across Jets

Results of many tests¹ indicate that the ratio of centerline velocity to average velocity is about 3, irrespective of outlet size, shape or initial velocity. This statement is true for stream cross-sections located beyond 10 diameters from the outlet, and is fairly accurate for distances up to 50 diameters. Experimental data are lacking for distances beyond 50 diameters.

Guide Vanes

The average jet angle (included angle in both planes, see Fig. 1) for an air stream as it emerges from a rectangular outlet of any shape without spreading vanes is about 19 deg, plus or minus 5 deg, depending on the type of approach, type of outlet and velocity. The spread increases slightly with velocity. A vaned outlet discharging air uniformly forward

will result in a spread of about 14 deg. This is equivalent to a spread in any direction of about one foot in every 8 ft of blow.

Vanes should have a depth of one to two times the spacing between the vanes. If the ratio of vane depth to spacing is less than one, effective control by means of the vanes cannot be obtained. Little improvement is obtained by increasing the ratio beyond two. The effect of various types of vanes is as follows.

Straight Vanes

As mentioned previously, the included angle between both planes will be in the neighborhood of 14 deg, for a straight setting of the vanes as shown in Fig. 1.

Diverging Vanes

Such vanes set for an angular spread will have a marked effect on the direction and distance of travel of an air stream. An outlet having vertical vanes set straight forward in the center, with uniformly increasing

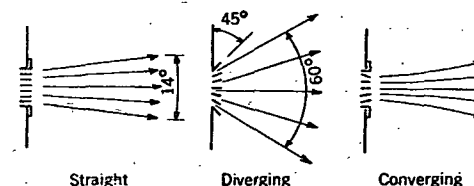


FIG. 1. SPREAD OF AIR STREAM WITH VARIOUS VANES

angular deflection to a maximum at each end of 45 deg, will produce an air stream with a horizontal included angle of approximately 60 deg as shown in Fig. 1. The throw will be reduced one-half for such a vane setting. Increasing the divergence of the vanes reduces the air quantity handled by an outlet for a given duct static pressure. The primary function of the vanes is to spread the air horizontally. Little is gained by spreading the air vertically.

Converging Vanes

The blow of an outlet may be somewhat increased by converging the vanes of an outlet as illustrated in Fig. 1. Even with converging vanes, the resultant angle of spread of an air stream will not be less than 14 deg. The air converges for a few feet in front of the outlet, and then diverges more than if the vanes had been set straight.

Both the horizontal and vertical vanes of an outlet are important. After an installation has been made, many conditions of draftiness or stuffiness can be alleviated by some vane adjustment, provided an independent means for regulation of static pressure behind the vanes is included.

Vertical Drop and Rise

The vertical distance the lower edge of an air stream moves between the outlet and the end of the blow is termed the drop or rise (H). This drop or rise is influenced by the difference in density between the air stream and the room air, resulting from the temperature difference and