

where

- Q = air flow, cubic feet per minute.
 A = free area of inlets or outlets (assumed equal), square feet.
 h = height from inlets to outlets, feet.
 t = average temperature of indoor air in height h , Fahrenheit degrees.
 t_o = temperature of outdoor air, Fahrenheit degrees.
 9.4 = constant of proportionality, including a value of 65 percent for effectiveness of openings. This should be reduced to 50 percent (constant = 7.2) if conditions are not favorable.

HEAT REMOVAL

In problems of heat removal, knowing the amount of heat to be removed and having selected a desirable temperature difference, the amount of

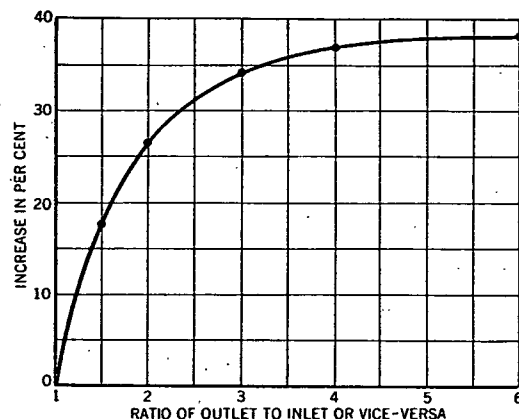


FIG. 3. INCREASE IN FLOW CAUSED BY EXCESS OF ONE OPENING OVER ANOTHER

air to be passed through the building per minute, to maintain this temperature difference, can be determined by means of Equation 5.

$$Q = \frac{H}{0.0175(t - t_o)} \quad (5)$$

where

- Q = air flow, cubic feet per minute.
 H = heat removed, Btu per minute.
 $t - t_o$ = inside-outside temperature difference, Fahrenheit degrees.

EFFECT OF UNEQUAL OPENINGS

The largest flow per unit area of openings is obtained when inlets and outlets are equal, and the preceding equations are based on this condition. Increasing outlets over inlets, or vice-versa, will increase the air flow, but not in proportion to the added area. When solving problems having an unequal distribution of openings, use the smaller area, either inlet or outlet, in the equations, and add the increase as determined from Fig. 3.

COMBINED FORCES OF WIND AND TEMPERATURE

Equations have already been given for determining the air flow due to temperature difference and wind. It must be remembered that when both forces are acting together, even without interference, the resulting air flow is not equal to the sum of the two estimated quantities. The flow through any opening is proportional to the square root of the sum of the heads acting on that opening.

When the two heads are about equal in value, and the ventilating openings are operated so as to coordinate them, the total air flow through the building is about 10 percent greater than that produced by either head acting independently under conditions ideal to it. This percentage de-

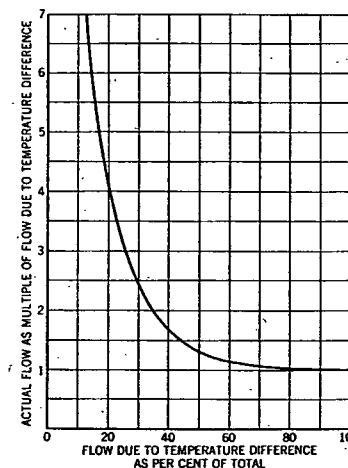


FIG. 4. DETERMINATION OF FLOW CAUSED BY COMBINED FORCES OF WIND AND TEMPERATURE DIFFERENCE

creases rapidly as one head increases over the other. The effect of the larger head will predominate.

The wind velocity and direction, the outdoor temperature, or the indoor distribution, cannot be predicted with certainty, and refinement in calculations is not justified; consequently, a simplified method can be used. This may be done by using the equations and calculating the flows produced by each force separately, under conditions of openings best suited for coordination of the forces. Then, by determining, as a percentage, the ratio of the flow produced by temperature difference to the sum of the two flows, the actual flow due to the combined forces can be approximated from Fig. 4.

Example 1. Assume a drop forge shop, 200 ft long, 100 ft wide, and 30 ft high. The cubical content is 600,000 cu ft, and the height of the air outlet over that of the inlet is 30 ft. Oil fuel of 18,000 Btu per lb is used in this shop at the rate of 15 gph (7.75 lb per gal). Desired summer temperature difference is 10 deg, and the prevail-