

corresponding to the various assumed velocities, there is one size which will cost least. Since the cost of a chimney structure, regardless of the kind of material used in the construction, varies as the volume of material in the structure, the cost criterion then may be represented by the approximate equation:

$$Q = \pi l H D \quad (8)$$

where

Q = volume of material, cubic feet.

l = average wall thickness, feet.

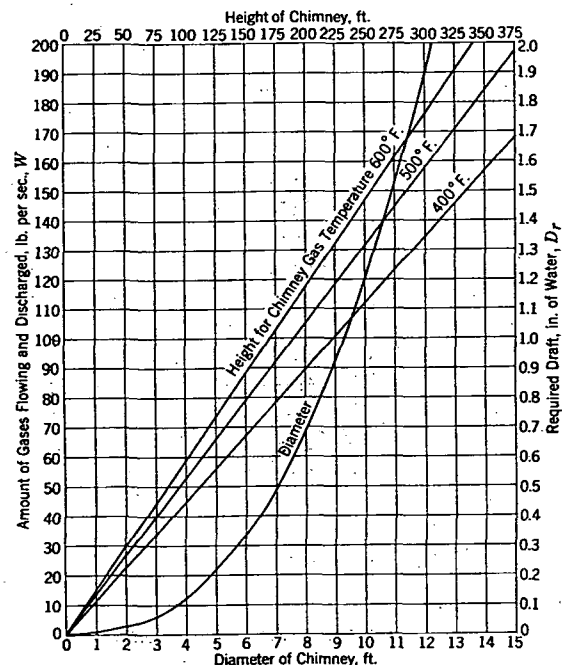


FIG. 7. ECONOMICAL CHIMNEY SIZES

For all practical purposes, the value of πl may be taken as a constant regardless of the size of the structure. Hence, in general, the volume, and consequently the cost, of a chimney structure may be based on the factor HD as a criterion. Therefore, the value of the chimney gas velocity which will result in the least value of HD for any one set of operating conditions will produce a structure whose cost will be least and, as a result, will be the most economical to use.

The problem at hand is to deduce an equation for the chimney gas velocity which will result in a combination of a height and a diameter whose product HD will be least. The solution is obtained by equating the product of Equations 3 and 4 to HD , differentiating this product with

respect to V and equating the resulting expression to zero. This procedure results in the following expression:

$$V_e = \left(\frac{0.772 T_c \left(\frac{W_o}{T_o} - \frac{W_c}{T_c} \right) \sqrt{\frac{W T_c}{B_o W_c}}}{f W_c} \right)^{2/5} \quad (9)$$

where

V_e = economical chimney gas velocity, feet per second.

Equation 9 gives the economical velocity of the chimney gases for any set of operating conditions and represents the velocity which will result in a chimney the size of which will cost less than that of any other size as determined by any other velocity for the same operating conditions. After the value of the economical velocity has been determined, the corresponding height and diameter can then be determined from Equations 6 and 7, respectively, and the economical size will then be attained. Equations 6, 7 and 9 may be simplified considerably for average operating conditions in an average size steam plant by assuming the following conditions:

Average chimney gas temperature, 500 F.....	$T_c = 960$
Mean atmospheric temperature, 62 F.....	$T_o = 522$
Average coefficient of friction, 0.016.....	$f = 0.016$
Average chimney gas density, 0.09.....	$W_c = 0.09$
Sea level elevation with barometer of 29.92.....	$B_o = 29.92$

Substituting these values in Equations 2, 3 and 5, respectively, and reducing:

$$V_e = 13.7 W^{1/5} \quad (10)$$

$$D = 1.5 W^{2/5} \quad (11)$$

$$H = 190 D_r \quad (12)$$

Fig. 7 gives the economical chimney sizes for various amounts of gases flowing and required draft intensities as computed from Equations 10, 11 and 12, and are based on the operating factors used in reducing Equations 6, 7 and 9 to their simpler form. The sizes shown by the curves in the chart should be used for general operating conditions only, or for installations where the required data necessary for an exact determination are difficult or impossible to secure. Whenever it is possible to secure accurate data, or the anticipated operating conditions are fairly well known, the required size should be determined from Equations 6, 7 and 9.

The recommended minimum inside dimensions and heights of chimneys for small and medium size installations are given in Table 1, which is taken from the A.S.H.V.E. Code of Minimum Requirements for the Heating and Ventilation of Buildings (edition of 1929).

GENERAL DRAFT EQUATION AND DRAFT LOSSES

The general draft equation for a steam producing plant may be stated as follows:

$$D_t - h_f = h_F + h_B + h_{Br} + h_v + h_{Bd} + h_C + h_O + h_E + h_R \quad (13)$$