

When the chimney is under static conditions and no gases are flowing, the available draft is equal to 1.27 in. of water, the theoretical intensity. As the amount of gases flowing increases, the available draft decreases until it becomes zero at a gas flow of 297 lb per second, at which point the draft loss due to friction is equal to the theoretical intensity. The point of maximum draft and zero capacity is called shut-off draft, or point of impending delivery, and corresponds to the point of shut-off head of a centrifugal pump. The point of zero draft and maximum capacity is called the wide-open point and corresponds to the wide open point of a centrifugal pump. A set of operating characteristics may be developed for any size chimney operating under any set of conditions by substituting the proper values in Equation 2 and then plotting the results in the manner shown in Fig. 1.

Fig. 2 is a typical chimney performance chart giving the available draft for various gas flow rates and sizes of chimney. This chart is based on an

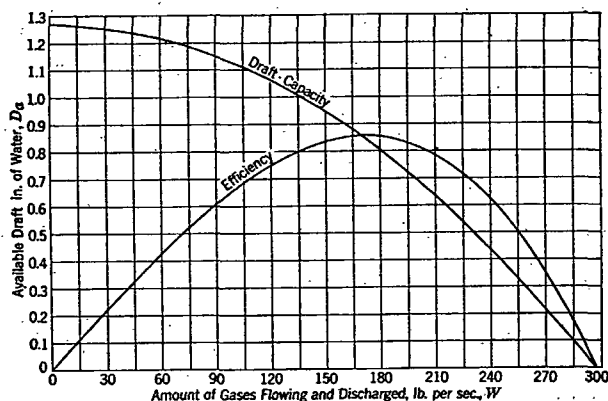


FIG. 1. TYPICAL SET OF OPERATING CHARACTERISTICS OF A NATURAL DRAFT CHIMNEY

atmospheric temperature of 62 F, a chimney gas temperature of 500 F, a unit chimney gas weight of 0.09 lb per cubic foot, sea level atmospheric pressure, a coefficient of friction of 0.016, and a friction duct length equal to the height of the chimney above the grate level. These curves may be used for general operating conditions. For specific conditions, a new chart may be prepared from Equation 2 or 3.

DETERMINING CHIMNEY SIZES

If the required performance for a proposed chimney is known and if a chimney-gas velocity is assumed, Equation 2 can be transposed to yield the necessary height and an equation can be developed for the required diameter. These operations result in the following equations:

$$H = \frac{D_r}{2.96B_o \left(\frac{W_o}{T_o} - \frac{W_g}{T_g} \right) - \frac{0.184fW_oB_oV^2}{T_o D}} \quad (6)$$

The weight of gas per second, $W = 12.075 \frac{D^2 V B_o W_o}{T_o}$ from which

$$D = 0.288 \sqrt{\frac{WT_o}{B_o W_o V}} \quad (7)$$

where

H = required height of chimney above grate, feet.

D = required minimum diameter of chimney, feet.

V = chimney gas velocity, feet per second.

D_r = total required draft, inches of water.

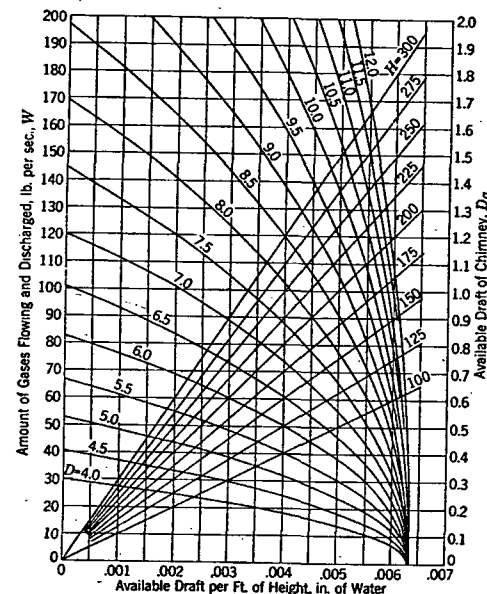


FIG. 2. CHIMNEY PERFORMANCE CHART

To solve a typical example: Proceed horizontally from a Weight Flow Rate point to intersection with diameter line; from this intersection follow vertically to chimney height line; from this intersection follow horizontally to the right to Available Draft scale. Starting from a point of Available Draft, take steps in reverse order.

For large chimneys, it is usual to assume that total construction cost is least when the product HD (height $\times$ diameter) is minimum. On this assumption, the product of Equations 6 and 7 can be differentiated and the differential set equal to zero to find the minimum. Solution for velocity then yields the following equation:

$$V_o = \left(\frac{0.772T_o \left(\frac{W_o}{T_o} - \frac{W_g}{T_g} \right)}{fW_o} \sqrt{\frac{WT_o}{B_o W_o}} \right)^{1/2} \quad (8)$$

where

V_o = economical chimney gas velocity, feet per second.