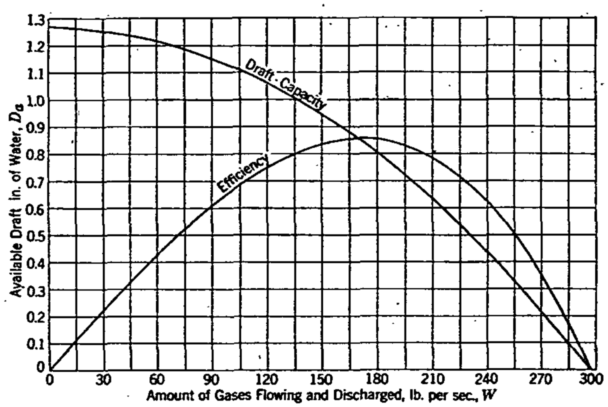

FIG. 1. TYPICAL SET OF OPERATING CHARACTERISTICS OF A NATURAL DRAFT CHIMNEY

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 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:

$$H = \frac{D_r}{2.96B_o\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right) - \frac{0.184fW_cB_oV^2}{T_cD}} \qquad (6)$$

The weight of gas per second, $W = 12.075\,\frac{D^2\,VB_o\,W_c}{T_c}$ from which

$$D = 0.288\sqrt{\frac{WT_c}{B_oW_cV}} \qquad (7)$$

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.

For large chimneys, it is usual to assume that total construction cost is least when the product HD (height × diameter) is minimum. On this assumption, the product of Equations 6 and 7 can be differentiated and

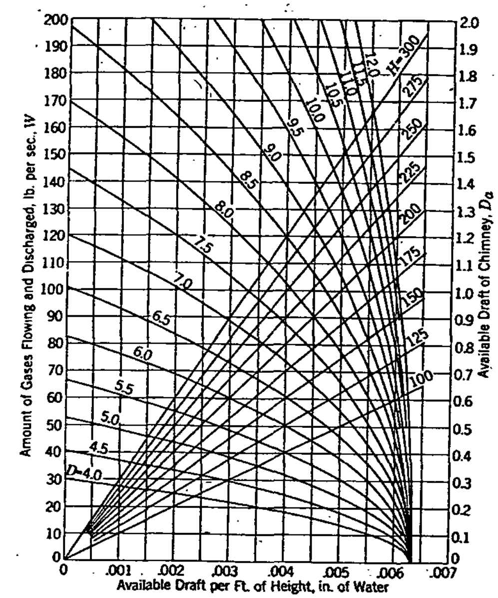

FIG. 2. CHIMNEY PERFORMANCE CHART

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.

the differential set equal to zero to find the minimum. Solution for velocity then yields the following equation:

$$V_e = \left(\frac{0.772T_c\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right)\sqrt{\frac{WT_c}{B_oW_c}}}{fW_c}\right)^{2/5} \qquad (8)$$

where V_e = economical chimney gas velocity, feet per second.

Equations 6, 7 and 8 can of course be simplified if values are assumed for some of the factors in it. Some typical figures for boiler plants are:

Average chimney gas temperature 500 F	T_c = 960 F absolute
Average atmospheric temperature 62 F	T_o = 522 F absolute
Average coefficient of friction 0.016	f = 0.016
Average chimney, gas density, 0 F, 1 Atmosphere	W_c = 0.09 lb per cubic foot
Barometer reading, sea level	B_o = 29.92 in. Hg

When these values are substituted in Equations 8, 7 and 6 respectively, the results are:

$V_e = 13.7W^{1/5}$ (9) $\quad D = 1.5W^{2/5}$ (10) $\quad H = 190D_r$ (11)

Fig. 3 gives the economical chimney sizes for various amounts of gases flowing and for required draft intensities computed from Equations 9, 10 and 11. They are based on the operating factors used in reducing Equations 6, 7 and 8 to their simpler form. The sizes shown by the curves in the chart should be used for general operating conditions only,