DETERMINING CHIMNEY SIZES FOR THE INDUSTRIAL CHIMNEY

If the required performance for a proposed chimney is known, and *if a chimney-gas velocity is assumed,* Equation 3 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:

$$H = \frac{D_t}{2.96B_o\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right) - \frac{0.184fW_cB_oV^2}{T_cD}} \qquad (7)$$

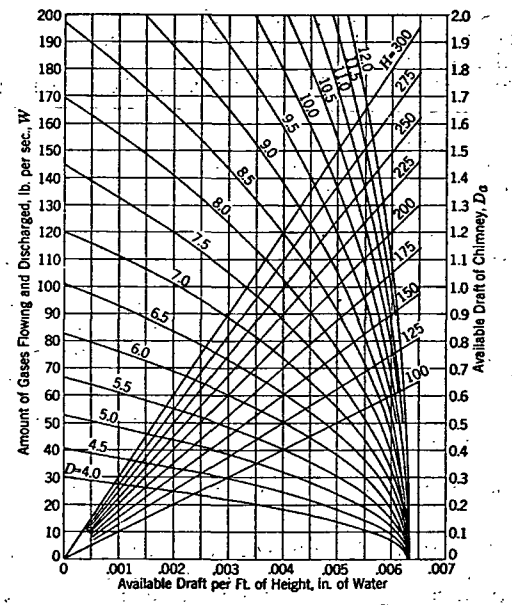

FIG. 3. CHIMNEY PERFORMANCE CHART

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

$$D = 0.288\sqrt{\frac{WT_o}{B_oW_oV}} \qquad (8)$$

where

H = required height of chimney above grate, feet.

D = required minimum diameter of chimney, feet.

V = chimney gas velocity, feet per second.

D_t = 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 7 and 8 can be differentiated, and the differential set equal to zero to find the minimum. Solution for velocity then yields the following equation:

$$V_o = \left(\frac{0.772T_o\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right)\sqrt{\frac{WT_o}{B_oW_o}}}{fW_o}\right)^{2/5} \qquad (9)$$

where

V_o = economical chimney gas velocity, feet per second.

Equations 7, 8 and 9 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_o = 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_o = 0.09 lb per cu ft
Barometer reading, sea level ..... B_o = 29.92 in. Hg

When these values are substituted in Equations 7, 8 and 9 respectively, the results are:

$H = 190D_t$ (10) $\qquad D = 1.5W^{2/5}$ (11) $\qquad V_o = 13.7W^{1/5}$ (12)

These equations should be used for general operating conditions only, or where the required data necessary for an exact determination are difficult or impossible to secure. Whenever it is possible to obtain accurate data, or the anticipated operating conditions are fairly well known, the required size should be determined from Equations 7, 8, and 9.

Additional construction data for large industrial chimneys, whether brick, concrete, or steel, may be found in *Kent's Mechanical Engineers' Handbook*[4] or the *Handbook of Building Construction*.[5]

DOMESTIC CHIMNEYS

A residential chimney, in order to provide satisfactory performance, must have adequate height, have adequate area, be of permanently tight construction, and should be as smooth internally as is practicable. The height of the residence or apartment chimney is generally limited by height of the building and by cost. Inasmuch as the desirable height, as well as location of the chimney, architecturally, may be unsatisfactory for the correct operation of the boiler or furnace, it is important to obtain the chimney requirements from the manufacturer of the fuel-burning appliance which is to be installed.

Most domestic chimneys are constructed of brick with a clay flue liner, but recently several lightweight, prefabricated chimneys have been marketed. These chimneys were primarily designed for use with gas equipment, but recently several have been approved by the *National Board of Fire Underwriters* for use with all types of fuels. The advantages of the lightweight, prefabricated chimney are ease of installation, somewhat lower cost, and reduced weight on the supporting structure.

It should be remembered that mechanically-fired devices, oil burners and stokers, are equipped with blowers so that, with these devices, the chimney