

be selected by size since surface conditions in service are always undeterminant. For sizes up to 3 ft in diameter, Curve C may be used; from 3 to 6 ft, Curve B; and from 6 ft upwards, Curve A. Thus for the previous example with $C_r = 698,000$ and 12 ft diameter, f would be taken from Curve A as 0.0039.

6. The length of the friction duct is the vertical distance between the bottom of the breeching opening and the top of the chimney. Ordinarily this distance is approximately equal to the height of the chimney above the grate level.

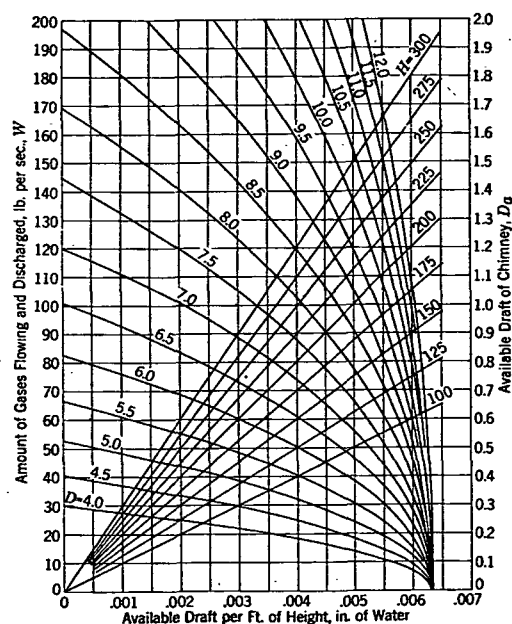


FIG. 6. CHIMNEY PERFORMANCE CHART^a

^aTo 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.

7. Assuming no air infiltration the amount of gases flowing and being discharged is, of course, equal to the amount of gases generated in the combustion chamber of the boiler. The total products of combustion in pounds per second for a grate-fired boiler may be computed from the equation:

$$W = \frac{C_g G W_{tp}}{3600} \quad (6)$$

where

C_g = pounds of fuel burned per square foot of grate surface per hour.

G = total grate surface of boilers, square feet.

$C_g \times G$ = total weight of fuel burned per hour.

W_{tp} = total weight of products of combustion per pound of fuel.

A similar computation may be made in the case of gas, oil, or stoker-fired fuel.

Fig. 6 is a typical chimney performance chart giving the available draft intensities for various amounts of gases flowing 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 operating conditions, a new chart should be constructed from Equation 1.

It has been the usual custom, and still is to a lamentably great extent, to select the required size of a natural draft chimney from a table of chimney sizes based only on boiler horsepower. After the ultimate horsepower of the projected plant had been determined, the chimney size in the table corresponding to this figure was then selected as the proper size required. Generally, no further attempt was made to determine if the height thus selected was sufficient to help create the required draft demanded by the entire installation, or the diameter sufficiently large to enable the chimney quickly, efficiently, and economically to dispose of the gases. Since the operating characteristics of a natural draft chimney are similar in all respects to those of a centrifugal pump, or a centrifugal fan, it is no more possible to select a proper size chimney from such a table, even with correction factors appended, than it is to select the proper size pump from tables based only on the amount of water to be delivered.

DETERMINING CHIMNEY SIZES

The required diameter and height of a natural draft chimney are given by the following equations:

$$H = \frac{D_r}{2.96 B_o \left(\frac{W_o}{T_o} - \frac{W_c}{T_c} \right) - \frac{0.184 f W_c B_o V^2}{T_c D}} \quad (7)$$

$$D = 0.288 \sqrt{\frac{W T_c}{B_o W_c V}} \quad (8)$$

where

H = required height of chimney above grate bar level, feet.

D = required minimum diameter of chimney, feet (constant for entire height).

V = chimney gas velocity, feet per second.

D_r = total required draft demanded by the entire installation outside of the chimney, inches of water.

Equations 7 and 8 give the required size of a natural draft chimney with all of the operating factors taken into consideration. Values for all of the factors with the exception of the chimney gas velocity may be either observed or computed. It is, of course, necessary to assume an arbitrary value for the velocity in order to arrive at some definite size. For any one set of operating conditions there will be as many sizes of chimneys as there are values of reasonable velocities to assume. Of the number of sizes corresponding to the various assumed velocities, there is one size which will be least expensive. Since the cost of a chimney structure, regardless