is not required to overcome the resistance of a fuel bed. Nevertheless, a draft in the firebox, of about 0.03 in. of water, is considered desirable so that any small openings in the firebox or flue passages will result in leakage of air inward, and not leakage of combustion products outward. This is not to be taken to condone leaks in fireboxes. Such leaks adversely affect plant efficiency.

AVAILABLE DRAFT FOR THE DOMESTIC CHIMNEY

The small domestic chimney does not appear to follow the same mathematical relations as the larger industrial chimney, because of increased friction losses (apparently caused by the extremely low flue-gas velocities which create eddies and reversal of flow); hence, a slightly different method of determining the available draft is required.

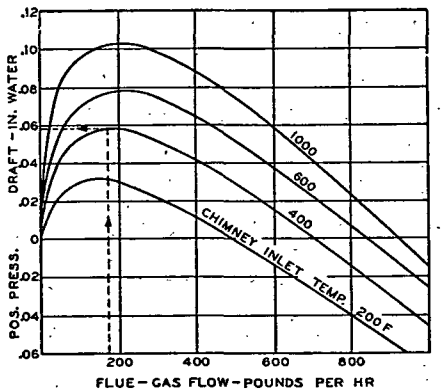


FIG. 4. AVAILABLE CHIMNEY DRAFT FOR 13 FT BRICK CHIMNEY[a, b]

[a] Square Flue Liner 6½ x 6½ in. inside.
[b] Barometric Pressure 29.92 in. Hg. Air Temperature 60F.

The most accurate method would be to use actual test data of the particular chimney in question. Fig. 4 is a graphical presentation of the available chimney draft over a wide range of flows for a 13-ft brick chimney with an 8 x 8-in. nominal-size flue;[6] whereas Tables 1 and 2 are the observed performances of various sizes and heights of brick chimneys.[7]

These data are from two different sources, and have been corrected to different temperatures, but they may be made comparable by the:

$$O_2 - O_1 = S_2 - S_1 \qquad (13)$$

where

S_1 = computed static draft at T_1 and B_1.
S_2 = computed static draft at T_2 and B_2.
O_1 = observed draft at T_1 and B_1.
O_2 = observed draft at T_2 and B_2.

It will be noted in Tables 1 and 2 that the observed draft exceeded the computed static draft at some points. A draft difference of 0.004 in. of water is equivalent to only 11 deg difference in temperature. It would therefore be assumed that the temperature measurement with unshielded

thermocouples indicated less than actual temperature in these cases. The data for Fig. 4 were obtained with a high-velocity shielded thermocouple.

The accurate determination of the available chimney draft for any particular chimney is a complicated problem. The following approximate method[6] is based on the assumption that, for small residential chimneys 10 to 25 ft in height, and with a cross-sectional area of 35 to 55 sq in., the chimney efficiency will vary within only plus or minus 15 percent among chimneys at the same flow and temperature conditions.

The available draft may be expressed as:

$$D_a = n_e D_t \qquad (14)$$

where

n_e = chimney efficiency taken from Fig. 5 at the desired conditions of temperature and flow.

D_t = theoretical draft. It may be calculated from Equation 1, assuming that the barometric pressure is 29.92 in. Hg, and the ambient air temperature is 60 F.

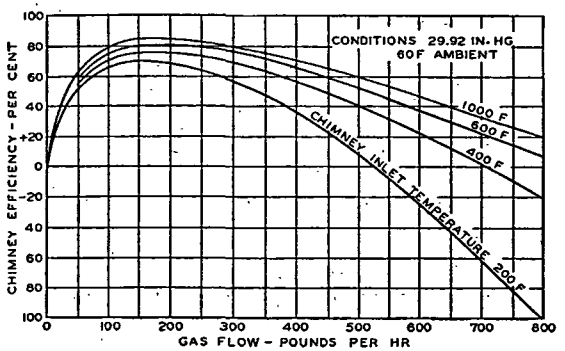


FIG. 5. EFFECT OF GAS FLOW ON CHIMNEY EFFICIENCY[a]

[a] Derived from temperature plots. Liner 8 x 8 in. outside, 6½ x 6½ inside. Height 13 ft.

Example 2. Determine the available draft of a 13-ft chimney; inside diameter, 7 in.; inlet temperature, 205 F; flow rate, 275 lb per hr; temperature of air surrounding chimney, 60 F; and barometric pressure, 29.92 in. Hg.

Solution. The theoretical draft from Equation 1 is:

$$D_t = 2.96 \times 13 \times 29.92\left[\frac{0.0863}{520} - \frac{0.0863}{665}\right] = 0.0415 \text{ in. water.}$$

From Fig. 5, $n_e = 0.60$

$D_a = 0.60 \times 0.0415$

$D_a = 0.0249$ in. water at 29.92 in. Hg and 60 F.

For calculations where the fuel rate, and the percentage CO_2 are the only known factors, Fig. 6 is included so that the flue-gas rate can easily be determined for coal, oil, and gas. By entering at percentage CO_2 moving vertically to the curve for the type of fuel, and then moving horizontally to the fuel rate, the flue-gas rate in pounds per hour may be determined for any fuel.

It should be noted that at the higher flows, simulating operation with stoker equipment, the error due to friction losses will increase as the flow