The clay-lined brick chimney is the most commonly used chimney, but recently other building materials have been used for reasons of economy or convenience. Investigations have established that the results shown in Figs. 4 and 5 for brick chimneys can be used, with slight error, for chimneys made of shale tile, concrete block, or cinder block.[8]

There are several lightweight chimneys that have recently been approved by the *National Board of Fire Underwriters* for use with all types of fuel. These chimneys are constructed of precast masonry or vitreous enameled steel surrounded by an insulating material. The characteristics of these chimneys can be assumed to be approximately those presented in Figs. 4 and 5.

DETERMINING RESIDENTIAL CHIMNEY SIZES

The flue sizes for small residential chimneys are governed by the National Building Code of the *National Board of Fire Underwriters* for gas-burning

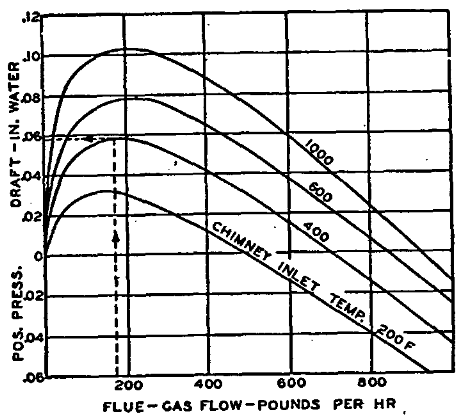

Fig. 6. Available Chimney Draft for 13 Ft Brick Chimney[a, b]

[a] Square Flue Liner 6¾ x 6¾ in. inside.
[b] Barometric Pressure 29.92 in. Hg. Air Temperature 60F.

appliances. Chimney areas for liquid- and solid-fuel-burning devices are selected primarily to meet the requirements of local building codes, but these requirements are not determined by any rigorous formula based on physical principles.

By calculating the available draft for the chimney in question, and comparing it with the performance values of the heating unit (either natural or forced draft type) at the desired output, it is possible to determine whether the chimney is adequate in height for the particular heating unit it serves.

For calculations where the fuel rate and the percentage CO_2 are the only known factors, the flue-gas rate can easily be determined for coal, oil and gas from Fig. 8. By entering Fig. 8 at the 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.[7]

Any of the described methods of determining available draft may be used, but a graphical solution to the problem may be had for the 8 × 8-in. chimney from Figs. 6, 7 and 8. This solution can be best explained by a numerical example.

Example 3: Determine if a 13-ft, 8 x 8-in. nominal-size flue is sufficient for a coal-heating unit rated at 0.03 in. of water draft at 400 F inlet temperature, fuel rate being 10 lb per hr of bituminous coal, with 10 percent CO_2.

Solution: From Fig. 8, a flue-gas rate of approximately 180 lb per hr is obtained. The available draft for a 180 lb per hr fuel rate, and an inlet temperature of 400 F, obtained from Fig. 6, is 0.056 in. of water. This indicates that the chimney is adequate.

The selection of chimney areas for liquid- and solid-fuel-burning devices is difficult because of the variability in efficiency of different models, the possibility that soot on the lining will restrict the chimney area, and the variation in combustion air requirements of different solid fuels. Figs. 6 and 7 show that a given chimney produces a maximum available draft and a maximum efficiency for some intermediate mass flow rate for any selected inlet flue-gas temperature. For mass flow rates lower than the optimum

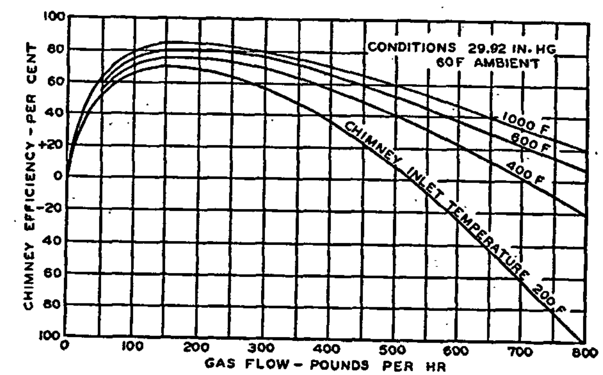

Fig. 7. Effect of Gas Flow on Chimney Efficiency[a]

[a] Derived from temperature plots. Liner 8 x 8 in. outside, 6¾ x 6¾ inside. Height 13 ft.

the greater cooling of the gases in the chimney causes lower available draft, whereas for mass flow rates above the optimum the greater friction losses reduce the available draft. A chimney for a given heating system should probably be designed to operate at its point of maximum efficiency and maximum available draft for its full rated output. A chimney would have an accelerating effect[9] on the combustion rate of a solid-fuel burning device if it were operating to the left of the optimum point in Fig. 6 because an additional increment in mass flow rate would increase the available draft a small amount and tend to increase the mass flow still more. On the other hand, a chimney operating to the right of the optimum point in Fig. 6 would tend to decelerate the combustion rate for any small increase in mass flow rate.

Data are not complete for the selection of proper chimney areas for heating plants of different capacities, but some information on the effect of cross-section area on the capacity of masonry chimneys is provided by recent tests[8, 10] on several chimneys with liners having nominal outside dimensions: 9 in. diameter, 12 in. diameter, 9 × 9 in., and 9 × 13 in. These tests showed that for flue gas rates up to 200 lb per hr, and entering flue gas temperatures from 200 to 1000 F, the 9-in. round liner provided an