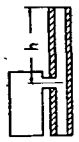
and the amount of exposure to the outdoor air. Experimental data are not sufficiently complete to tabulate efficiencies that take into account all of these variables. However, recommended values of efficiency for several sizes of domestic chimneys of masonry materials and of metal have been selected from the literature[6,7,8,9] and summarized in Table 1 for use with Fig. 8 in determining the available draft produced by short chimneys of 15 ft in height or lower. In parts A and B of Table 1 the value of efficiency chosen from the range cited should be increased as the chimney inlet temperature increases over the applicable range. In part C of Table 1 the efficiency values listed will yield the available draft for the range of mass flows, inlet flue gas temperatures, and chimney height shown within 10 percent.

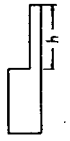
TABLE 1. EFFICIENCY OF SHORT CHIMNEYS

A. MASONRY CHIMNEYS



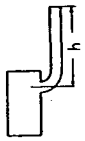
| Height h ft | Flue Gas Flow Rate lb/hr | Internal Liner Size, in. | | |
|---|---|---|---|---|
| | | Dia. 7 | 7 x 7 | 7 x 11 and Dia. 10 |
| | | Efficiency, Percent | | |
| 5 to 15 | 90 | 75–82 | 65–76 | 65–80 |
| | 200 | 83–84 | 67–85 | 82–88 |
| | 315 | 75–89 | 67–86 | 81–89 |
| | | (Inlet Flue Gas Temp 200 to 1000) | | |

B. UNINSULATED METAL CHIMNEYS



| Height h ft | Flue Gas Flow Rate lb/hr | Internal Diameter, in. | |
|---|---|---|---|
| | | 6 | 8 |
| | | Efficiency, Percent | |
| 4 to 8 | 90 | 90–100 | 85–95 |
| | 200 | [a] | 83–88 |
| | 315 | [a] | 70–80 |
| | | (Inlet Flue Gas Temp. 200 to 600 F) | |

C. METAL CHIMNEYS[b]



| Height h ft | Uninsulated | 1-in. insulation with dead air space around chimney | 1-in. insulation with 1-in. open air space around chimney |
|---|---|---|---|
| | Efficiency, Percent | | |
| 8 to 14 | 76 | 85 | 81 |

[a] Six-inch chimney not recommended for these flow rates.
[b] Internal dia. 6-in; flue gas flow rate 50 to 125 lb/hr; inlet flue gas temp. 200 to 1000 F.

In the application of short chimneys, observance of the following precautions will assist in obtaining the highest practicable draft and may cure unsatisfactory operation of the chimney and heating plant in certain instances:

1. Use a minimum length of horizontal smokepipe between the heater and chimney.
2. Insulate the smokepipe and the chimney itself, if made of metal. Insulation of the chimney liner in masonry chimneys reduces the heat loss from the flue gases and the infiltration of cold air.
3. Do not use an oversized chimney because larger chimneys produce greater cooling of the flue gases.



4. Avoid downdrafts by proper construction above the roof or by the use of a suitable chimney cap.
5. Avoid the use of barometric dampers in the smokepipe of natural-draft heaters since most barometric dampers permit enough cold air to leak into the chimney to reduce the draft appreciably.
6. Avoid air leaks in the smokepipe and chimney.
7. Avoid connecting more than one heating device to a single chimney.
8. Use construction materials of low heat capacity if the chimney draft must increase quickly for an intermittently-fired heating device.
9. Do not operate a kitchen exhaust fan unless an air intake of ample area is used to prevent lowering the house pressure.
10. Avoid tight utility closets so the chimney draft will not be required to do the added work of drawing combustion air into the closet from the surroundings.

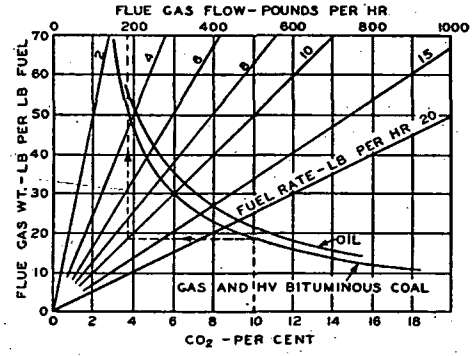



FIG. 9. GRAPHICAL EVALUATION OF RATE OF FLUE GAS FLOW FROM PERCENT $CO_2$ AND FUEL RATE[a]

[a] Average density gas 0.0845 lb per cu ft, 62 F. Average weight oil 7.08 lb per gal, 60 F.

## 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 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. 9. By entering Fig. 9 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 9. This solution can be best explained by a numerical example.