possibility of escape of flue gases into the room where they are installed. There are also limitations, since it is necessary that the unit be installed on or adjacent to an outside wall.

Current American Standards for approval of vented wall furnaces for installation in trailer coaches and mobile homes require that such heaters not take combustion air from occupied space, and that draft hood relief and combustion air relief be in the same pressure zone. The net result is that a sealed combustion system is the only practical solution.

Current revisions to *American Standards for Appliance Installation* (Z21.30) and most of the recently revised heating and installation codes exempt appliances with sealed combustion systems from standard venting practices, and allow them to be installed in accordance with the approved manufacturer's installation instructions.

REFERENCES

[1] *I = B = R Testing and Rating Code for Low Pressure Cast-Iron Heating Boilers* (Institute of Boiler and Radiator Manufacturers, June, 1958).

[2] Testing and rating code for boiler-burner units (*Engineering Standards Part II*, Mechanical Contractors Association of America, 1956).

[3] *I = B = R Ratings for Cast-Iron Boilers* (Institute of Boiler and Radiator Manufacturers, May 10, 1955).

[4] Net load recommendations for heating boilers (*Engineering Standards Part II*, Mechanical Contractors Association of America, 1956).

CHAPTER 53

CHIMNEYS AND DRAFT

Draft Definitions, Factors Affecting Natural Draft, Available Draft, Required Draft; General Considerations, Industrial Chimneys, Residential Chimneys, Short Chimneys, Gas Appliance Venting; Available Draft for the Industrial Chimney, Determining Industrial Chimney Sizes; Chimney Sizes for Heating and Process Boilers, Determining Residential Chimney Sizes, Draft Requirements of Appliances, Recommendations of the National Board of Fire Underwriters

DRAFT is the pressure difference associated with the movement of flue gases through a chimney. Natural draft is caused and measured by the difference in weight of a column of flue gas within the chimney and a corresponding column of air of equal dimension outside the chimney. Natural draft is always negative and is expressed in inches of water gage.

When the movement of air is supplied by a fan, the draft is said to be forced or induced. When the fan is located so as to push the flue gases through the chimney, the draft is forced. When the fan is located so as to draw the flue gases through the combustion unit, the draft is induced.

FACTORS AFFECTING NATURAL DRAFT

The theoretical natural draft is directly proportional to the height of the chimney and is dependent upon the absolute mean temperature of the gases within the chimney. It is also directly proportional to the density of the air outside the chimney although the effect of this factor is minor.

The formulas for theoretical natural draft are based on mean or average temperature which is one half of the sum of the entering and exit temperature. Since the difference in exit and entering temperatures, or the temperature gradient in the chimney, is due to the escape of heat through the walls of the chimney, the heat transfer characteristics of the chimney construction affect draft. Heat transfer is also affected by the rate of flow of the flue gases through the chimney, so draft is also directly affected.

The flow of flue gases through the chimney is retarded by friction which varies with the friction coefficient of the chimney surface, and with the rate of flue-gas flow. The friction loss may be estimated by means of one of the formulas for ducts, such as the Fanning equation, or it may be estimated with sufficient accuracy by the method used for air ducts, using a roughness value of 0.01 (see Chapter 31).

The height of the chimney is measured from the point of entrance of the flue gases to the top of the chimney.

AVAILABLE DRAFT

The available draft produced by any chimney is equal to the theoretical natural draft minus the friction loss. Given the height, the heat transfer characteristics of the chimney construction, the entering temperature of the flue gases and their volume, and the friction coefficient of the chimney and its dimensions, the available draft is readily calculable.

The efficiency of a chimney is defined as the ratio of the observed or available draft produced by the chimney for a given inlet temperature and flow rate, to the ideal draft that would be observed if the same quantity of flue gases traversed the chimney without cooling and without friction. The chimney efficiency may be calculated as follows:

$$\text{Efficiency} = \frac{\text{final measured draft}}{\text{ideal draft calculated from the inlet temperature}}$$

REQUIRED DRAFT

Before the proper chimney for a particular installation can be selected or designed, the required draft of the combustion unit must be known. The required draft is equal to the sum of all of the resistances to gas flow from the point at which combustion air enters the unit, up to and including the chimney connection. This is based on the assumption that air for combustion is available without restriction (such as would be caused by tightly enclosed building construction) at that point of entrance to the unit. Particularly in residences, unrestricted supply of combustion air must be assured.

Fig. 1 presents information on the fuel-bed draft loss for various kinds of coal burned at different rates. The draft tension required in the firebox for oil firing or for stoker firing should be determined from the supplier of the oil burner or stoker, and the designer should be sure that the value selected is in compliance with all controlling laws or ordinances. In the absence of more accurate data, the values presented in Table 1 may be used.[1,2]

Breechings or smoke pipes should be designed without

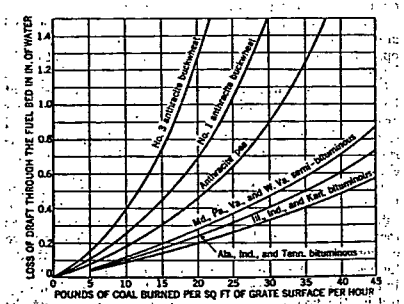

Fig. 1.... Draft Required at Different Rates of Combustion for Various Kinds of Coal

The general responsibility for this chapter is assigned to TC 3.5, Combustion and Fuels.