PROBLEMS IN PRACTICE

1 ● a. What is the maximum heat transmission for a flat roof located in Pittsburgh (latitude 40 deg) exposed to the sun with the outdoor and indoor temperature 95 F and 80 F, respectively? The roof is of uninsulated 6 in. concrete with its underside exposed, and with a black upper surface. b. What time of day will maximum cooling load due to the roof exist?

a. $H_t + H_R = [A\,U\,(t_o - t)] + [A\,F a I]$ (Formulas 1 and 2).

U for roof $= 0.64$ (Table 11, Wall 4 A, Chapter 5).
$F = 0.147$ (Fig. 2).
$a = 0.9$ (Table 6).
$I = 293$ (Table 4).
$H_t + H_R = [1 \times 0.64\ (95\text{-}80)] + [1 \times 0.147 \times 0.9 \times 293] = 48.5$ Btu per square foot per hour.

b. Maximum sun intensity occurs at noon (Table 4). Maximum effect in cooling load will occur at 3 p.m. (Table 7).

2 ● a. What is the maximum rate of heat delivered to a room through a bare window in the west wall of a building located in New Orleans (30 deg latitude)? b. What time of day will it occur? c. What will maximum rate be if window is protected by awning?

a. $H_G = A_G f I$ (Formula 3).
$I = 205$ (Table 2).
$H_G = 1 \times 1 \times 205 = 205$ Btu per square foot per hour.

b. At 4 p.m. (Table 2).

c. $205 \times 0.28 = 57.4$ Btu per square foot per hour (Table 8).

3 ● What is the heat gain per cubic foot of outside air introduced, under the following conditions if the barometric pressure is 29.5 in. Hg? Outdoor temperatures, 90 F dry-bulb and 75 F wet-bulb. Inside temperatures, 78 F dry-bulb and 65 F wet-bulb.

Density of air at 90 F dry-bulb, 75 F wet-bulb and 29.5 in. Hg. is 0.0705 lb per cubic foot (Table 4, Chapter 1).

Dew-point of outdoor air is 68.2 F (psychrometric chart).

Pressure of saturated vapor at 68.2 F is 0.6946 in. Hg (Table 6, Chapter 1).

$W = 0.622 \left(\frac{e}{B - e}\right) = 0.622 \left(\frac{0.6946}{29.5 - 0.6946}\right) = 0.015$ lb water vapor per pound dry air (Formula 5a, Chapter 1).

$\frac{1}{1 \text{ plus } 0.015} = 0.985$ lb dry air per pound outside air.

$d_o = 0.0705 \times 0.985 = 0.06944$ lb dry air per cubic foot outside air.

Heat content outside dry air at 75 F wet-bulb $= 38.46$ Btu per pound.

Heat content inside dry air at 65 F wet-bulb $= 29.96$ Btu per pound.

Total heat, $H = 0.06944\ (38.46 - 29.96) = 0.59$ Btu per cubic foot.

4 ● A 7 × 4 ft west window is equipped with an inside aluminum finished Venetian blind which is adjusted to fully cover the window when the sun shines. The net glass area is 75 per cent of the total area of the window. What is the cooling load due to the window at 10 a.m. and 4 p.m.? Temperatures are: 10 a.m., outside 85 F and inside 77 F; 4 p.m., outside 95 F and inside 80 F. Latitude 40 deg.

10 a.m.: $H_t = 28 \times 1.13\ (85\text{-}77) = 253$ Btu per hour (Equation 1, and Table 13A, Chapter 5).

4 p.m.: $28 \times 0.75 = 21$ sq ft net glass area.

$H_G = 21 \times 0.58 \times 211 = 2570$ Btu per hour (Tables 4 and 8).

Chapter 9

COMBUSTION AND FUELS

Principles of Combustion, Classification of Coals, Firing Methods for Coals, Firing Methods for Coke, Dustless Treatment of Coal, Classification of Oils, Combustion of Oil, Classification of Gas, Combustion of Gas

THE data given in the first part of this chapter are of general application to the various fuels used in domestic heating which are coal, coke, oil and gas. The choice of fuel is a question of dependability, cleanliness, fuel availability, economy, operating requirements and control.

FUNDAMENTAL PRINCIPLES OF COMBUSTION

Combustion may be defined as the chemical combination of a substance with oxygen with a resultant evolution of heat. The rate of combustion depends partly upon the specific rate of reaction of the combustible substance with oxygen and partly upon the rate at which oxygen is supplied and the surrounding conditions as they define the temperature.

Complete combustion is obtained when all of the combustible elements in the fuel are oxidized with all of the oxygen with which they can combine. All of the oxygen supplied may not be utilized.

Perfect combustion is defined as the result of supplying the required amount of oxygen for combination with all of the combustible elements of the fuel and utilizing all of the oxygen so supplied.

The oxygen required for the process of combustion is obtained from air which is a mechanical mixture of oxygen, nitrogen and small amounts of carbon dioxide, water vapor and inert gases. These inert gases are generally included with the nitrogen, and for engineering purposes the values given herewith may be used.

	By Volume Per Cent	By Weight Per Cent
Oxygen, O_2	20.9	23.15
Nitrogen, N_2	79.1	76.85

The combination of oxygen with the combustible elements and compounds of a fuel is in accordance with fixed laws. In the case of perfect combustion the reactions and resultant combinations are shown in Table 1.

The most important condition governing the process of combustion is temperature. It is necessary to bring a combustible substance to its