a person is normally at rest, as in a theater, or doing very light work, as in a restaurant or residence, the total amount of heat given off will average about 400 Btu per hour. Part of this is latent heat due to the evaporation of 700 to 1200 grains of moisture per hour. Examples illustrating heat and moisture loss calculations for human beings are given in Chapter 10.

All sources of heat must of course be considered in designing the conditioning system. The heat gain due to various devices is given in Table 5.

Moisture evaporated by appliances must be included in the total latent heat load. In some cases only a small part of the heat from lights immediately affects the cooling load. Tests[15] show that with lights placed near the ceiling under some conditions the electricity used for illumination has little effect on the cooling load in an office cooled during the usual short period. The air heated by the lights stratifies closely to the ceiling and the temperature of the lower layers of air is raised only a small amount after a considerable lapse of time.

An example of cooling load calculation is given in Chapter 10. Another method of determining the heat gain of air conditioning loads, is given in a paper[16] presented before the Society which outlines solar effect and absorption coefficients to apply to walls facing several directions at various latitudes and at different times of the day.

[15]Loc. Cit. Note 11.

[16]A Rational Heat Gain Method for the Determination of Air Conditioning Cooling Loads, by F. H Faust, L. Levine and F. O. Urban (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, August, 1935).

PROBLEMS IN PRACTICE

1 ● In buildings such as an office building which is cooled intermittently, will the maximum cooling load occur coincidently with the maximum dry-bulb temperature?

Not necessarily. Tests indicate that particularly for east and south exposures the maximum rate of cooling occurs shortly after the equipment is started in the morning. This extra heat is that which was absorbed by the building during the preceding day and also during the *off* period. The rapid lowering of the room temperature after the cooling equipment is started causes this stored up heat to flow quickly from wall and floor surfaces to the room air.

2 ● The outdoor and indoor temperatures are 90 F and 78 F, respectively. What is the amount of heat transmitted per hour through a 7 ft by 4 ft north window?

$H_t = 28 \times 1.13 \cdot (90 - 78) = 380$ Btu per hour.

(Equation 1, Chapter 8 and Table 13, Chapter 5.)

3 ● What are the proper design temperatures for a Detroit store?

Outdoor dry-bulb, 93 F; wet-bulb, 73 F. (Table 1, Chapter 8.)

Indoor dry-bulb, 79.2 F; wet-bulb, 64.8 F. (Table 2, Chapter 3.)

4 ● a. What is the maximum heat transmission for a flat roof 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. If the temperatures specified were the maximum for the day and occurred at 12 o'clock, at what time would the maximum cooling load due to the roof exist?

a. $H_t = 1 \times 0.64\ (95 + 45 - 80) = 38.4$ Btu per hour per square foot.

(Equation 1 and Table 2, Chapter 8, and Table 11, Chapter 5.)

b. At 3 p.m. (Table 3, Chapter 8.)

5 ● For south windows equipped with plain canvas awnings, what is the maximum amount of heat delivered to a room when the outdoor temperature is 90 F and the indoor temperature is 78 F?

$115 \times 0.28 = 32.2$ Btu per square foot of glass (Fig. 1 and Table 4, Chapter 8; note that glass transmission can be neglected).

6 ● What is the heat gain per cubic foot of outside air introduced, under the following conditions if the barometric pressure is 29.50 in. Hg:

Outdoor temperatures, 90 F dry-bulb and 75 F wet-bulb.

Inside temperatures, 78 F dry-bulb and 65 F wet-bulb.

The relative humidity of the outdoor air is 50 per cent (Psychrometric Chart).

Pressure of saturated vapor at 90 F $= e_t = 1.4211$ in. Hg. (Table 6, Chapter 1.)

Pressure of vapor in the mixture $= 1.4211 \times 0.5 = 0.71055$ in. Hg.

Pressure of dry air in the mixture $= 29.50 - 0.71055 = 28.7895$ in. Hg.

From Equation 4a, Chapter 1,

$$d_a = \frac{29.50 - 0.7105}{0.753\ (90 + 460)} = \frac{28.79}{0.753 \times 550} = 0.06945 = \text{weight of dry air in 1 cu ft of the mixture.}$$

$$d_v = \frac{0.71055}{1.21\ (90 + 460)} = \frac{0.71055}{1.21 \times 550} = 0.001067 = \text{weight of vapor in 1 cu ft of the mixture at 50 per cent relative humidity.}$$

Weight of 1 cu ft of the mixture $= 0.06945 + 0.001067 = 0.0705$ lb.

$H_i = 60\ Qd_o\ (\Theta_o - \Theta)$. (From Equation 2, Chapter 8).

$\Theta_o = 38.46$ and $\Theta = 29.96$ (Table 6, Chapter 1). The total heat of any air-vapor mixture may be obtained from the last column in Table 6, Chapter 1, by considering the temperatures to be wet-bulb readings, since the total heat of a mixture is constant for a given wet-bulb temperature.

$H_i = 0.0705\ (38.46 - 29.96) = 0.598$ Btu per cubic foot.

7 ● If there are twenty 200-watt lights in use in a room, what is the cooling load due to lights?

$200 \times 20 = 4000$ watts $= 4$ kw.

$3413 \times 4 = 13{,}652$ Btu per hour (Table 5, Chapter 8).

8 ● a. If a restaurant has two 10-gal coffee urns, what is the cooling load due to them?

b. What is the cooling load due to four 1350-watt burners on an electric range?

a. $16{,}000 \times 2 = 32{,}000$ Btu per hour (Table 5, Chapter 8).

b. $4 \times 1350 = 5400$ watts $= 5.4$ kw.

$5.4 \times 3413 = 18{,}430$ Btu per hour (Table 5, Chapter 8).

9 ● Why may the heat gain by transmission through glass on the sunny exposures be neglected?

Solar radiation on a glass surface during peak hours will cause the outer surface of the