sary for the ventilating requirements. The heat required to raise this air to the conditions maintained in the room must be provided by the tempering coils, preheater coils, and reheater coils. If a positive pressure is not maintained in the room or space to be conditioned, the normal infiltration of outside cold air will take place in this room, and the outlet temperature, together with the required air volume at this temperature, must be sufficient to provide for both infiltration and transmission losses.

Volume of Outside Air

The volume of outside air required for ventilation or air conditioning purposes may be determined from data in Chapter 3. In no case shall less than 10 cfm per person be introduced.

The heat required to warm the outside air introduced for ventilation purposes (H_o) may be determined by means of the following formula:

$$H_o = 0.24\ (t - t_o)\ M_o \qquad (1)$$

where

0.24 = specific heat of air at constant pressure.
t = room temperature, degrees Fahrenheit.
t_o = outside temperature, degrees Fahrenheit.
M_o = weight of outside air to be introduced per hour, in pounds = $60\ d_oQ_o$.
Q_o = volume of outside air to be introduced, cubic feet per minute.
d_o = density of air at t_o, pounds per cubic foot.

Example 1. A building in which the temperature to be maintained at 70 F requires 10,000 cfm. If the outside temperature is 20 F, how much heat will be required to warm the air introduced for ventilation purposes to the room temperature?

Solution. 10,000 × 60 = 600,000 cfh; d_o = 0.08273 (Table 1, Chapter 1); M_o = 0.08273 × 600,000 = 49,656 lb; t = 70 F; t_o = 20 F; H_o = 0.24 × (70 − 20) × 49,656 = 595,872 Btu per hour.

Temperature of Air Leaving Registers

If the system is to function only as a heating system, that is, entirely as a recirculating one, the temperature of the air leaving the register outlets must be assumed. For public buildings, these temperatures may range from 100 to 120 F, whereas for factories and industrial buildings the outlet or register temperature may be as high as 140 F. In no case should the outlet temperature exceed these values.

For ventilating or conditioning systems, the temperature of the air leaving the supply outlets may be estimated by means of the following formula:

$$t_y = \frac{H}{60\ d\ Q \times 0.24} + t \qquad (2)$$

where

t_y = outlet temperature, degrees Fahrenheit.
H = heat loss of room or space to be conditioned, Btu per hour.
Q = *total* volume of air to be introduced at the temperature t, cubic feet per minute.
d = density of air, pounds per cubic foot.

If the outlet temperature (t_y) as determined from Equation 2 exceeds 120 F for public buildings, or 140 F for factories or industrial buildings,

these respective outlet temperatures should be used as factors in the following equation to determine the volume of air to be introduced into the room or space:

$$Q = \frac{H}{60\ d \times 0.24\ (t_y - t)} \qquad (3)$$

Example 2. The heat loss of a certain auditorium to be conditioned is 100,000 Btu per hour. The ventilating requirements are 1,500 cfm and the room temperature 70 F. Determine the outlet temperature.

Solution. Substituting in Formula 2,

$$t_y = \frac{100{,}000}{60 \times 0.07492 \times 1500 \times 0.24} + 70 = 131.7\ \text{F}$$

Inasmuch as this temperature is excessive, it will be necessary to assume an outlet temperature, which will be taken as 120 F, and to calculate the amount of air to be introduced into the room at this temperature to provide for the heat loss. Substituting in Equation 3,

$$Q = \frac{100{,}000}{60 \times 0.07492 \times 0.24\ (120 - 70)} = 1850\ \text{cfm (at temperature } t)$$

Weight of Air to be Circulated

The total weight of air (M) to be introduced into the room or space to be heated or conditioned is given by the following formulae:

$$M = \frac{H}{0.24(t_y - t)} = 60\ dQ \qquad (4)$$

$$M = M_o + M_r \qquad (5)$$

$$M_o = 60\ d_oQ_o \qquad (6)$$

where

d = density of air at temperature t, pounds per cubic foot.
d_o = density of air at temperature t_o, pounds per cubic foot.
Q_o = volume of outside air at temperature t_o, cubic feet per minute.
M_o = weight of outside air, pounds per hour.
M_r = weight of recirculated air, pounds per hour.

Example 3. Using the data of Example 2 and an outside temperature of 20 F, what will be the values of M, M_o and M_r?

Solution. d = 0.07492; d_o = 0.08273; Q = 1850; Q_o = 1500; H = 100,000.

$$M = \frac{100{,}000}{0.24 \times (120 - 70)} = 8{,}333\ \text{lb}$$

$$M_o = 0.08273 \times 60 \times 1500 = 7{,}448\ \text{lb}$$

$$M_r = M - M_o = 8{,}333 - 7{,}448 = 885\ \text{lb}$$

Temperature Loss in Ducts

The allowances (t_z) to be made for temperature drop through the duct system are as follows:

1. When the duct system is located in the enclosure to which the air is being delivered, as in a factory, it may be assumed that there is no loss between the reheater coil and the point or points of discharge into the enclosure.