

W = weight of air circulated, pounds per hour.
 0.24 = specific heat of air at constant pressure.

From Equations 1, 2 and 3:

$$H_t = H + 0.24 d_0 60 Q (t - t_o) \quad (4)$$

Example 1. The heat loss of a certain room is 24,000 Btu per hour, and the ventilating requirements are 1000 cfm. If the room temperature is to be 70 F and all air is taken from the outside at zero, what will be the total heat demand on the unit if it is required to provide for both the heating and ventilating requirements (combined system)?

Solution. $H = 24,000$; $d = 0.075$ $Q = 1000$ cfm; $t = 70$ F; $t_o = 0$ F.

Substituting in Equation 4:

$$H_t = 24,000 + 0.24 \times 0.075 \times 60 \times 1000 (70 - 0) = 99,600 \text{ Btu}$$

$$t_y = \frac{24,000}{0.24 \times 0.075 \times 60 \times 1000} + 70 = 92.2 \text{ F}$$

When part of the air handled by the unit is taken from the room and the remainder from the outside,

$$H_t = 0.24 W_o (t_y - t_o) + 0.24 W_i (t_y - t) \quad (5)$$

where

W_o = weight of air, pounds per hour taken from out-of-doors.

W_i = weight of air, pounds per hour taken from the room.

$$W_o = d_o 60 Q_o \quad (6)$$

$$W_i = d_i 60 Q_i \quad (7)$$

where

d_o = density of air, pounds per cubic foot at temperature t_o .

d_i = density of air, pounds per cubic foot at temperature t .

Q_o = volume of air taken in from the outside, cubic feet per minute.

Q_i = volume of air taken in from the room, cubic feet per minute.

$$t_y = \frac{H}{0.24 (W_o + W_i)} + t \quad (8)$$

$$H_t = H + 0.24 d_o 60 Q_o (t - t_o) \quad (9)$$

Equations 5, 6, 7, 8, and 9 may be used in the same manner as is illustrated above for Equations 1, 2, 3, and 4. It may be noted in Equation 9, representing the total heat requirements, that as the quantity Q_o is diminished the heat requirements for the unit diminish very materially.

In Example 1, if the quantity of air taken in from the outside is reduced to zero, or all of the air handled by the unit is recirculated, the total heat requirements H_t reduce from 99,600 Btu to 24,000 Btu, or to about one fourth. Such a unit handling one third of its air volume from the outside and two thirds from the room would show a total heat requirement of $24,000 + \frac{99,600 - 24,000}{3} = 59,200$ Btu. Units designed and operated

on this principle show an average heat requirement and, therefore, a boiler capacity requirement of less than 50 per cent of that required for units taking all their air from the outside.

If all of the air is recirculated, the total heat required is the same as the heat loss of the room, or

$$H_t = H = 0.24 W (t_y - t) \quad (10)$$

If the heat loss of the room is to be taken care of by the direct heating surface, the unit ventilators will be required to warm the air introduced for the ventilating requirements. Therefore:

$$H_v = 0.24 W (t_y - t_o) \quad (11)$$

In this case t_y should be equal to or slightly higher than t . If the unit ventilator were of such capacity as to exactly provide for the ventilating requirements, the direct radiation would be selected on the usual basis. However, it is necessary to employ a unit which may not exactly meet the ventilating requirements, since standard units are usually rated in terms of the volume of air that will be delivered at a certain temperature t_y for an initial temperature of t_o . Therefore a certain amount of heat (H_h) may be available from the unit ventilator for heating purposes, as previously stated, and the amount of equivalent direct heating surface may, if desired, be deducted from the amount required for heating the room.

COOLING UNITS

Cooling units as applied to industrial product conditioning and processing are similar in construction to unit heaters except that the heat transfer surface is supplied with refrigeration instead of with steam or hot water. They are normally installed within the space to be served, or at least closely adjacent thereto. Occasionally they are provided to receive outside air in which case this air is invariably filtered or washed to prevent any possible contamination of the product.

Cooling units are provided in two major types similar to unit heaters, either floor mounted with housed fan, or suspended with propeller type fans. Normally, air outlet velocities are lower than for heating, due largely to the effect of high velocities on the product. Cooling units are normally of the free delivery type although they occasionally are supplemented with duct work to provide more careful air distribution.

Product cooling originally was accomplished by means of stationary pipe coils. This was later supplemented with the forced fan bunker systems in which air was passed over banks of coils. The present trend in this field is toward a more accurate control of both temperature and humidity, thus placing these units in the classification of complete air conditioning units as discussed in the next section. However, in the majority of these cases dry-bulb temperature is controlled separately from the control of humidity, thus classifying these units as cooling units.

The principal field for cooling units is in cold storage plants, fur storage, fruit packing houses, provision stores, brewery fermentation and stock rooms, candy plants, and other industrial process work. In replacing bunker and wall coils in meat storage plants, cooling units give distinct