

Substituting in Equation 4:

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

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

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 to 24,000 Btu per hour, 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 per hour. 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.

### Applications

Items to be considered in the application of unit ventilators include the following:

1. Combination with other means of heating.
2. Location of units.
3. Method of venting.

In a *split* system the unit is used primarily for ventilation. Air is delivered to the room at very near the room temperature, and enough separate direct heaters are placed in the room to warm it to the desired temperature, independently of the unit. Their principal advantage lies in offsetting the cooling effect of window and wall surfaces long before these can be heated to room temperature and in retaining heat for this purpose after the ventilation is shut down.

Where the unit ventilator selected has a capacity more than sufficient to warm the air needed to meet the ventilating requirements, a corresponding reduction may be made in the amount of direct heating surface installed. The greater the amount of excess capacity of the unit, the more efficient will be the temperature regulation of the room. The split system permits the heating of the room during failure of electric current, since the direct radiators will furnish heat, but it permits a careless operator to avoid operating the ventilating equipment.

A combined system employs the unit ventilator alone, its capacity being sufficient both for ventilation and for supplying the heat loss. Direct heating surface is omitted altogether. It becomes necessary then that the fan be running whenever the room is to be heated but this also gives assurance of ventilation, especially if automatic dampers are used in the air intake from out-of-doors and in the recirculating intake arranged so as to give a certain quantity of air from the outside (commensurate with weather conditions) whenever the unit is operating and after the room is heated. The cost of installation of a combined system is usually less than that of a split system and there is less danger of overheating, but if the electric energy fails there will be practically no heating.

The location of the unit ventilator in a room is important. Wherever possible it should be placed against an outside wall. It is difficult to obtain proper air distribution if the unit is erected either on an inside wall or in a corner of the room. Standard units discharge the air stream upward, but for special cases units may be installed to discharge air horizontally. Units may be set away from the wall or partially recessed into the wall to save space without materially affecting the results. The air inlet may enter the cabinet at the back at any point from top to bottom.