can be varied, as in a cold water system, the performance of the unit may to a certain extent be varied with the weather and load changes.

REHEATING DEHUMIDIFIED AIR

Table 2 (Example 2) indicates that the amount of reheating necessary to raise the dry-bulb temperature to the selected room inlet condition of 68 F, is greater in the case of the spray type dehumidifier than with the surface-type unit. The reheating process is a simple addition of sensible heat, and the calculation for the spray-type unit is as follows:

Example 3. Find the capacity of the reheater required in connection with the spray dehumidifier in Example 2.

Solution. The heat to be supplied in Btu per hour by reheaters equals sensible heat to raise air from 60.7 to 68 F = 0.24 × 7720 × 0.075 × 60 × (68 − 60.7) = 60,900. Surface coils of this capacity must therefore be selected.

By-Pass System

Example 4. The total sensible heat gain in a restaurant when the dry-bulb temperature is held at 80 F is 200,000 Btu per hour. The conditioned space shown in Fig. 6,

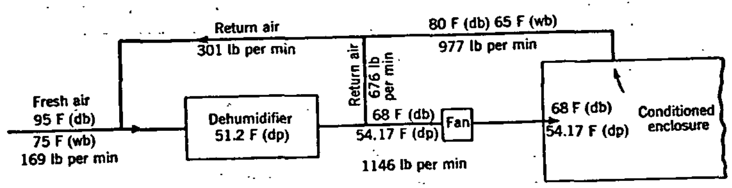

FIG. 6. DIAGRAM OF BY-PASS METHOD

also has a moisture gain of 384,000 grains per hour, and an outside air ventilation requirement of 2250 cfm. Assume (as in Examples 1 and 2), a 12 F dry-bulb temperature differential between the entering air and the room temperature, which is the same as assuming the dry-bulb temperature of the entering air to be 68 F. It is required to maintain the room conditions at 80 F dry-bulb, 65 F wet-bulb, 56.5 F dew-point. Calculate the air capacity of the system, the amount of return air to be by-passed, and the dew-point temperatures at room inlet and dehumidifier outlet.

Solution. In this system, instead of passing all of the air through the dehumidifier for cooling and dehumidifying, a portion of the return air is mixed with the conditioned air at the leaving end of the dehumidifier. The mixture is proportioned so that the resultant conditions are those required at the room inlets, (neglecting losses).

As in Example 1, the sensible heat load which can be absorbed by one pound of air is 2.88 Btu, and the total air quantity required is then: 200,000/2.88 × 60 = 1146 lb per minute, or about 15,300 cfm.

From Table 6, Chapter 1, the grains per pound of saturated air at 56.5 F is 68.0. The latent heat load is already expressed in terms of grains of moisture, hence the moisture to be added to each pound of air is: 384,000/1146 × 60 = 5.6. This gives the moisture content in the entering air which equals 68.0 − 5.6 = 62.4 grains per pound, corresponding to a dew-point at the room inlet, of 54.17 F.

The quantity of air to be dehumidified, the quantity to be by-passed, and the apparatus dew-point temperature may be approximately calculated as follows:

Let

X = percentage of air to be by-passed.
Y = percentage of air to be passed through the dehumidifier.
t_d = apparatus dew-point temperature, degrees Fahrenheit.

The quantity X of 80 F air must mix with the quantity Y of dehumidified air to produce air with a resultant 68 F dry-bulb temperature. Also, X quantity of air at 56.5 F dew-point must be mixed with Y quantity of dehumidified air to give a resultant dew-point temperature of the mixture of 54.17 F. It is assumed that the air passing through the dehumidifier is saturated.

Solving simultaneous equations,

$$\begin{array}{rl} 80.0X + Yt_d &= 68.00 \qquad (1) \\ 56.5X + Yt_d &= 54.17 \qquad (2) \\ \hline 23.5X + 0 \quad &= 13.83 \end{array}$$

$$X = \frac{13.83 \times 100}{23.5} = 59 \text{ per cent, air by-passed.}$$

$$Y = 100 - X = 41 \text{ per cent, air passed through dehumidifier.}$$

The second step is to determine the apparatus dew-point temperature. Substitute X in either Equation 1 or Equation 2, and solve for t_d:

$$80 \times 0.59 + t_d \times 0.41 = 68$$

$$t_d = \frac{68 - 47}{0.41} = 51.2 \text{ F, the apparatus dew point.}$$

PROBLEMS IN PRACTICE

1 ● What is meant by the term evaporative cooling?

Evaporative cooling, or adiabatic saturation of the air, is only effective when the air to be cooled is very dry. It is accomplished by passing the air in an unsaturated condition through a water spray which evaporates a part of the water at the expense of the sensible heat. In this adiabatic transfer the total heat content of the air remains constant while the dew point rises and the dry-bulb falls until the air is saturated.

2 ● In central systems for cooling and dehumidifying what factors fix the quantity of air required?

The weight or volume of air required depends wholly on the sensible heat gain in the room conditioned and on the difference between the dry-bulb temperature of the air at the room inlets and the dry-bulb temperature maintained in the room.

3 ● In central systems for cooling and dehumidifying can the dry-bulb temperature change be fixed arbitrarily?

No, because the change depends on factors at both the conditioner and the room. At the conditioner, temperature of the available water supply may limit the dry-bulb temperature of the leaving air. At the room, the dry-bulb temperature of the entering air may be further limited by: 1. The duct and supply grille arrangement permitted by architectural and structural requirements for the particular space, *e.g.*, ceiling height and obstructions on ceilings, such as beams. 2. The state of activity of the occupants. 3. The velocity at the inlet grille, as limited by noise level requirements. 4. The direction of the jet relative to the occupants.

4 ● What factors determine the dew-point of the air entering the space?

The maximum dew-point desired in the conditioned space, and the moisture gain in the space per unit weight of air supplied.

5 ● Why must the air leaving a dehumidifying type air washer often have its dry-bulb temperature raised before delivery to the occupied zone of room?

The air leaves the dehumidifying air washer saturated at a relatively low temperature which in most cases is lower than the allowable delivery dry-bulb temperature as fixed by factors outlined under Question 3. Also, the air may possibly be carrying a small amount of entrained water which might settle out in the ducts near the washer and cause corrosion difficulties.