

The air enters from above, is drawn through the head, charged with moisture, and cooled to the wet-bulb temperature. It then escapes from the opening below at a high velocity in a complete and nearly horizontal circle. The spray is quickly evaporated and the resulting vapor is rapidly and thoroughly diffused. This effective distribution of fine spray over the maximum possible area insures complete and extremely rapid vaporization even at the highest humidities.

Spray Humidifiers

This type of humidifier consists of an impact spray nozzle in a cylindrical casing with a drainage pan below it. The aspirating effect of the spray nozzle induces a moderate air current through the casing which distributes the entrained spray. The general method of circulating and returning the water is similar to that employed for high-duty humidifiers. A suitable pump and centrally-located filter tank are required.

The spray and high-duty types of humidifiers have many features in common but the latter, because of its finer spray and greater capacity, is often considered better adapted for producing high humidities.

Self-Contained Humidifiers

The self-contained or centrifugal humidifier has the ability to generate and distribute spray without the use of air compressors, pumps, or other auxiliaries. These may be used either singly or in groups. In large installations, where suitable connections are provided to permit the cleaning and servicing of individual units without affecting the room as a whole, group control of the water and power may be employed.

Humidifiers and air washers are also described in Chapter 11.

Where large quantities of power are generated in a limited space and where a comparatively high relative humidity is required, it is often feasible and economical to use a combination of direct and indirect humidification. The indirect humidification provides the desired quantity of ventilation and cooling, and the additional direct humidification provides for increase in humidity without interfering with the ventilation or the cooling effected by the indirect system.

In general, it may be stated that direct humidification is most satisfactory where high humidities are desired but where little cooling, ventilation or air motion is required. Therefore, the indirect system is most applicable where either low or high relative humidities are desired with maximum cooling and ventilation effect. For conditions that require an unusually large amount of heat to be absorbed by ventilation, together with the maintenance of high humidities, it is often preferable to make use of the combination system of indirect and direct humidification. If the indirect system alone were used it would mean an unusually large volume of air to be handled, which might interfere, due to air motion, with production, even though it would result in greater cooling effect. If direct humidification alone were used, no ventilation would be obtained, with consequently higher room temperatures.

Dehumidifiers, which are similar in design and appearance to indirect humidifiers and air washers, are described in Chapter 11. The main differences are found in the internal construction of the dehumidifier, in

the use of refrigeration or of heat as required for controlling the water temperature, and in differences in the general methods of control.

PROBLEMS IN PRACTICE

- 1 ● A condition of 75 F dry-bulb temperature and 55 per cent relative humidity is being maintained in a cigarette manufacturing department. What will be the regain and moisture content of the tobacco?

$$\begin{aligned}\text{The regain, from Table 1} &= 17.75 \text{ per cent.} \\ \text{The moisture content} &= \frac{17.75 \times 100}{100 + 17.75} = 15.1 \text{ per cent.}\end{aligned}$$

- 2 ● A 1-lb sample taken from a 100-lb batch of material is found to have a bone dry weight of 0.89 lb. This material is to be processed under atmospheric conditions which should produce a regain of 15 per cent. Compute the finished weight for each original 100-lb batch.

Let W equal the number of pounds of moisture in a finished batch.

$$\begin{aligned}\frac{W}{89} &= \text{regain} = 15 \text{ per cent} = \frac{15}{100} \\ W &= 13.35 \\ 89 + 13.35 &= 102.35 \text{ lb finished weight.}\end{aligned}$$

- 3 ● A bundle of sea island cotton is found to have a bone dry weight of 9.26 lb. What is the proper relative humidity at 75 F to produce a weight of 10 lb at equilibrium?

$$\begin{aligned}\text{Desired conditioned weight} &= 10.00 \text{ lb} \\ \text{Bone dry weight} &= 9.26 \text{ lb} \\ \text{Weight of moisture required} &= 0.74 \text{ lb} \\ \text{Regain} &= \frac{0.74}{9.26} \times 100 = 7.9 \text{ per cent.}\end{aligned}$$

From Table 1, the proper relative humidity required is 60 per cent.

- 4 ● Compute the bone dry weight of 1000 lb of manila rope which has been stored for a considerable period of time in a conditioned room at 75 F dry-bulb temperature and 50 per cent relative humidity.

Assuming that this material has come to equilibrium under the atmospheric conditions given, Table 1 shows a regain of 8.5 per cent.

Let W equal the total weight of moisture in pounds.

$1000 - W$ = bone dry weight in pounds.

$$\begin{aligned}\frac{W}{1000 - W} &= \text{regain} = 8.5 \text{ per cent} = \frac{8.5}{100} \\ W &= 78.3 \text{ lb moisture} \\ 1000 - 78.3 &= 921.7 \text{ lb bone dry weight.}\end{aligned}$$

- 5 ● An egg evaporating plant wishes to dry 2000 lb of egg whites (85 per cent water) to crystalline form each 24 hours. The maximum permissible air delivery temperature in the dryer is 140 F. What air volume will be required, assuming that outside air is at 95 F dry-bulb and 78 F wet-bulb and that air leaves the dryer 70 per cent saturated?

Moisture to be removed = $2000 \times 0.85 = 1700$ lb. Using psychrometric chart and starting at the intersection of the vertical 95 F dry-bulb temperature line and the 45 per cent humidity line, move horizontally to the right to the intersection with the 140 F vertical temperature line at 10 per cent relative humidity; then move along the constant