

4 • 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.

$$\frac{W}{89} = \text{regain} = 15 \text{ per cent} = \frac{15}{100}$$

$$W = 13.35$$

$$89 + 13.35 = 102.35 \text{ lb finished weight.}$$

5 • 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?

$$\begin{aligned} \text{Desired conditioned weight} &= 10.00 \text{ lb} \\ \text{Bone dry weight} &= 9.26 \text{ lb} \end{aligned}$$

$$\text{Weight of moisture required} = 0.74 \text{ lb}$$

$$\text{Regain} = \frac{0.74}{9.26} \times 100 = 7.9 \text{ per cent.}$$

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

6 • 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.

$$\frac{W}{1000 - W} = \text{regain} = 8.5 \text{ per cent} = \frac{8.5}{100}$$

$$W = 78.3 \text{ lb moisture}$$

$$1000 - 78.3 = 921.7 \text{ lb bone dry weight.}$$

7 • 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 = $2000 \times 0.85 = 1700 \text{ lb}$. Using psychrometric chart and starting at the intersection of the vertical 95 F dry-bulb temperature line and the 46 per cent humidity line, move horizontally to the right to the intersection with the 140 F vertical temperature line at 13 per cent relative humidity; then move along the constant heat (or wet-bulb line) to its intersection with the 70 per cent relative humidity curve and read 97.5 F dry-bulb, which will be the temperature of the air leaving the dryer.

$$\begin{aligned} \text{Moisture per cubic foot at 97.5 F and 70 per cent relative humidity} &= 13.2 \text{ grains} \\ \text{Moisture per cubic foot at 95 F and 78 F wet-bulb} &= 8.3 \text{ grains} \end{aligned}$$

$$\text{Moisture added per cubic foot of air handled} = 4.9 \text{ grains}$$

$$\frac{1700 \times 7000}{24 \times 60 \times 4.9} = 1685 \text{ cfm.}$$

No allowance is made for heat lost in the transmission to and from the dryer or for the heat required to raise the product from its entering temperature to that maintained in the dryer. This would necessitate a trial and error solution common to all drying problems.

Chapter 41

DRYING SYSTEMS

Drying Methods, Driers, Mechanism of Drying, Moisture, General Rules for Drying, Equipment, Humidity Chart, Combustion, Design, Estimating Methods

DRYING, in its broader sense, refers to the removal of water, or other volatile liquid from either a gaseous, liquid, or solid material. In practice, the process of direct drying gaseous material is referred to generally as dehumidifying, or condensing, and in some cases chemicals are used in the adsorption or absorption of moisture. Drying a liquid is called evaporation or distillation. The common usage of the word *drying* refers to the removal of water or other liquid, such as a solvent, by evaporation from a solid material.

When the solid to be dried contains large amounts of free water, the actual drying process is frequently preceded by the removal of part of the water by some mechanical means, such as filtration, settling, pressing or centrifuging. Removal of as much water as possible by such methods is usually advisable, as the cost of these operations, per pound of water removed, is generally much less than by evaporation.

DRYING METHODS

Drying may be accomplished in any one or combination of the following methods:

1. Radiation.
2. Conduction, or direct contact.
3. Convection.

Radiation

The source of heat for radiation may be either the sun, or heated surfaces. Sun drying is practiced where danger from rain is slight, and where sufficient time can be allowed. Where a strict adherence to a schedule is necessary, or where dusty atmosphere is present, this method is not in favor. Fruits are often dried in the sun.

Radiation from hot surfaces (heated by steam, electricity, or other means) furnishes generally, from one-third to one-half the total heat required for evaporation. Convection currents set up by these hot surfaces and the cooler materials carry the balance of the heat.