

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?

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

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

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

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 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 heat (or wet-bulb line) to its intersection with the 70 per cent relative humidity curve and read 94 F dry-bulb, which will be the temperature of the air leaving the dryer.

$$\begin{array}{l} \text{Moisture per cubic foot at 94 F and 70 per cent relative humidity} = 11.8 \text{ grains} \\ \text{Moisture per cubic foot at 95 F and 78 F wet-bulb} = 8.0 \text{ grains} \end{array}$$

$$\text{Moisture added per cubic foot of air handled} = 3.8 \text{ grains}$$

$$\frac{1700 \times 7000}{24 \times 60 \times 3.8} = 2170 \text{ cfm.}$$

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

Definition, Methods of Drying, Types of Dryer Construction, Mechanism of the Drying, Control of the Drying Operation, Dryer Design, Dryer Arrangement and Construction, Experimental Technique

DEFINITION OF TERMS

THE term drying, in its broader sense, refers to the removal of water or other volatile liquid from a gaseous liquid, or solid material. Except in the case of solids, the term is not ordinarily used unless the water or other liquid removed is present in a relatively small amount. In a more restricted sense, drying is the removal of water by vaporization from a non-volatile liquid or solid.

Where the solid material 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 filtration, settling, pressing, centrifuging, or other mechanical means. 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 in general much less than by vaporization.

METHODS OF DRYING

Classification of Methods According to Heat Supply

Drying methods may be classified basically in accordance with the means by which heat is supplied to the material to be dried. Thus, in some cases, as in *air current dryers*, the heat of vaporization is transferred to the material from the atmosphere surrounding it. In *natural air dryers*, this heat is merely the sensible heat of the outdoor atmosphere; while in so-called *artificial air dryers* heat is added to the air by means of radiators or the addition of a heated gas such as superheated steam or products of combustion, the air being almost entirely displaced by such gases in some drying processes. Where products of combustion can be used, a particularly high overall efficiency of the dryer is possible.

In other types of dryers, known as *contact dryers*, heat is supplied by direct contact between the material and a heated surface such as a pan or shelf, such surfaces being heated by products of combustion, steam, hot water, heated oil, or electrical resistance. In both air dryers and contact dryers, additional heat may be supplied by direct radiation from hot surfaces which are *in sight* of the material. In the *sun drying* of raisins and other fruits, this radiant heat comes from the sun, while in artificial dryers it is derived from heated surfaces such as steam coils.