tures may run from 250–300 F up as high as 1200 F. Drying is almost instantaneous because of the minute particle size. The dry powder is separated from the air by cyclone separators which are sometimes followed by cloth bags or scrubbing towers.

Because of the high inlet temperatures and the relatively large volume of air required the efficiency of the spray dryer is not too good and consequently is seldom used for dilute solutions (less than 30 per cent solids).

Figure 13 shows a typical arrangement for a spray drying system.[4]

A common and important feature of all spray processing is the direct conversion of the spray liquid to a granular product suitable for packaging without grinding or other intermediate handling. Another aspect is the unusually high rate of drying attained. In a well designed system 15 to 30 seconds is a fair time for the passage of the sprayed partical through the drying zone; the partical temperature need not rise materially above the wet bulb temperature of the liquid solution. This makes the process particularly adapted to the drying of heat sensitive material, some of its most important applications being the drying of milk, eggs, potato flour, soap and blood.[3]

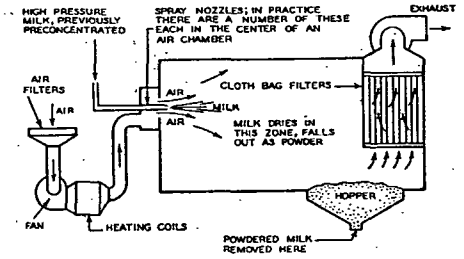


FIG. 13. SPRAY DRYER OF THE PRESSURE-SPRAY ROTARY TYPE[4]

DRYER CALCULATIONS

The calculations for drying during the constant-rate period are different from those applying to the falling-rate period, and in contrast are subject to relatively simple mathematical analysis.

The rate of drying by air passing over a wet surface is directly proportional to the vapor pressure difference, and also proportional to the 0.8 power of the air velocity. For practical calculations, the wet surface is assumed to attain the wet-bulb temperature of the air passing over it, and evaporation takes place at constant rate under equilibrium conditions. The equation may then be expressed in three forms:

$$R = C\,A\,V^{0.8}\,(\Delta P) \quad (1)$$

$$R = C'\,A\,V^{0.8}\,(\Delta H) \quad (2)$$

$$R = C''\,A\,V^{0.8}\,(\Delta t) \quad (3)$$

where

R = rate of drying during constant-rate period, pounds of moisture per hour.

A = area of bed or material in contact with air, square feet.

V = air velocity over material, feet per minute.

ΔP = difference between vapor pressure at wet-bulb (surface) temperature and at dew-point of air.

ΔH = difference between humidity ratio of saturated air, at the surface temperature, and the actual humidity ratio of the air stream, pounds of water per pound of dry air.

Δt = difference between dry-bulb and wet-bulb temperatures of air, *i.e.*, the wet-bulb depression.

C, C', C'' = proportionality constants (for numerical values consult references).

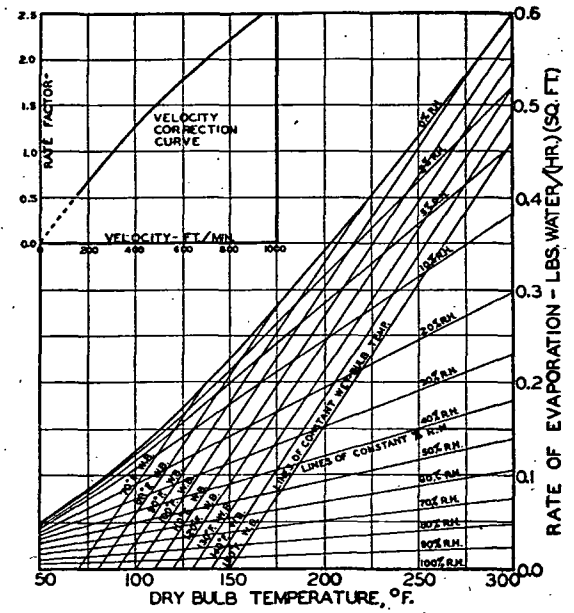


FIG. 14. RATE OF EVAPORATION CHART[5]

These equations are useful mainly for computing the effects of changes in operating conditions, such as changes in air velocity, air temperature, humidity and surface area. The equations assume that the material is in equilibrium at the wet-bulb temperature of the air. If equilibrium has not been reached, or if heat is being added to the charge by radiation or conduction, such conditions must be taken into account. For large tray dryers or continuous surfaces, the logarithmic mean difference should be substituted for the simple difference in ΔP, ΔH and Δt.

Figure 14 permits a ready estimate to be made of the relative rates of drying for various air temperatures and humidities. The chart is based on the difference between the dry-bulb and wet-bulb temperatures of the entering stream of air and on air velocity of 300 fpm. It may be assumed satisfactory for any material in the constant-rate drying period.