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CHAPTER 47

INDUSTRIAL DRYING SYSTEMS

Drying Terminology, Mechanism of Drying, Internal and External Conditions, Periods of Drying, Approximate Equations for Estimating Drying Time, Equilibrium Moisture Content, Applications of Hygrometry to Drying, Dryer Calculations, Drying Methods and Equipment; Radiant, Conduction and Convection Drying; Solution of Drying Problem

THE term *drying*, in a broad sense, encompasses the removal of water, and occasionally other liquids, from gases, liquids, or solids. However, the common usage of the word confines the meaning principally to the removal of water or solvent from solids by thermal means. *Dehumidification* is the term that is commonly assigned to the drying of gases. This is usually accomplished by condensation or adsorption by various drying agents, and is treated in Chapter 38. *Distillation*, and more particularly *fractional distillation*, is associated with the drying of liquids.

It is usually more economical to employ, whenever possible, mechanical means of separating as much water as is practicable from the solid materials before undertaking drying or dehydration steps. These mechanical methods such as filtration, screening, pressing, centrifuging, or settling usually require much less power, and frequently less capital outlay, thereby making the operation cheaper in terms of cost per pound of water removed.

DRYING TERMINOLOGY[1]

The generally accepted definitions of terms used in drying technology follow:

Bound moisture refers to liquid (held by a solid) which exerts a vapor pressure less than that of the pure liquid at the same temperature. Liquid may become *bound* by retention in small capillaries, by solution in cell or fiber walls, by homogeneous solution throughout the solid, and by chemical or physical adsorption on solid surfaces. Bound moisture can be removed from a solid only under specific conditions of humidity in the external surroundings.

Capillary flow refers to the flow of liquid through the interstices and over the surface of a solid. It is caused by liquid-solid molecular attraction.

Commercial dry basis expresses the moisture content of a product as pounds of water per pound of solid as it leaves the dryer, *i.e.*, per pound of commercially dry solid.

The constant-rate period is that drying period during which the rate of water removal per unit of drying surface is constant.

The critical moisture content is that obtaining when the constant-rate period ends and the falling-rate period begins.

Dry basis indicates the moisture content of a wet solid as pounds of water per pound of bone-dry solid. The advantage of using this basis is that the absolute amount of moisture loss is obtained simply by subtracting the moisture contents before and after drying. (See definition of *Wet Basis*.)

Dryer efficiency is that fraction of the total heat, supplied by fuel, used to evaporate water. *Overall efficiency* is sometimes used to distinguish overall system efficiency from the *efficiency of the drying space* or *evaporative efficiency*.

Equilibrium moisture content is that to which a given material can be dried under specific conditions of air temperature and humidity.

Evaporative efficiency compares the amount of evaporation actually obtained in a dryer with that which would obtain by saturation of the air.

The falling-rate period is that drying period during which the instantaneous drying rate continually decreases.