to flow through the system to the discharge stack. Natural draft should not be depended on to remove harmful or dangerous gases, fumes, mists, dusts, or other matter when it is imperative that such matter be removed from the work place or room atmosphere.

The principal types of air moving equipment are chimney exhausts, venturi ejectors, centrifugal exhaust fans, disc or propeller fans, and axial flow fans[16].

Manufacturers generally provide special fans for the collection of various industrial wastes. These are available for the collection of coal dust, wood shavings, wool, cotton and many other substances. When substances having an abrasive character are conveyed, the fan blades and housing should be protected from wear. This may be accomplished by placing a collector on the negative side of the fan or by lining the housing and blades with rubber.

PROTECTION AGAINST CORROSION

The removal of gases and fumes in many chemical plants requires that metals used in the construction of the exhaust system be resistant to chemical corrosion. A list of the materials which may be used to resist the action of certain fumes is given in Table 9. Hoods and ducts, when short, may frequently be constructed of wood and be quite effective. Rubberized paints are available and may be applied as protective coatings in handling such gases and fumes as chlorine and hydrochloric acid.

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Chapter 47

DRYING SYSTEMS

Mechanism of Drying, Omissions in Drying Cycle, Factors Influencing Drying Rates, Drying Methods and Equipment, Radiant Drying, Conduction Drying, Convection Drying, Calculation and Design, Estimating Methods

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. 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.

MECHANISM OF DRYING

The course of drying of any substance under constant conditions of temperature, humidity, and air velocity and distribution, follows a definite pattern which can be represented by a graph such as Fig. 1, which is that for a slab of whiting, wherein the rate of drying is plotted against the moisture content. The drying cycle may then be divided into three components: (1) Constant rate period. (2) Uniform falling rate period. (3) Varying falling rate period.

One or more of these components may be missing for a substance under a particular set of conditions.

During the *constant rate* period, water is being evaporated from the surface of the material at a rate comparable to that of a free water surface and moisture is being supplied by diffusion or capillarity to the surface at a rate equal to or greater than the evaporative rate. However, a point is reached at which the moisture reaches the surface at a rate less than the potential evaporative rate. The moisture content of the substance at which this occurs is known as the *critical moisture*. Up to this point the material is generally considered to assume the wet bulb temperature of the air. This is not strictly true as in many cases radiant heat is absorbed or some heat is supplied by conduction.

During the *uniform falling rate* period, moisture is still evaporating from the surface, but the area of wet surface is constantly diminishing.

During the *varying falling rate* period the water is vaporized beneath the surface and escapes as the vapor. As the thickness of the dried material increases, it becomes more difficult for the vapors to escape.

Finally all drying stops at the *equilibrium moisture content*, where the vapor pressure of water in the air is equal to the vapor pressure of water in the material. The *equilibrium moisture content* varies with the humidity