previously stated, the medium may be directly in contact with the air (as water, brine, or ice), or indirectly through a barrier wall (as cooling surface). When the latter method is used, and the surface temperature is held above the air dew-point, only cooling occurs without moisture interchange.

Evaporative Cooling involves the adiabatic exchange of heat between air and a water spray or wetted surface. The water assumes the wet-bulb temperature of the air, which remains constant during its traverse of the exchanger. No heat is added or abstracted from the medium (water), which is continually recirculated. Cooling of the air occurs due to the temperature difference between entering air, and water at the wet-bulb temperature. Humidification occurs as a result of the vapor pressure exerted by the water which is higher than that corresponding to the entering air dew-point. Since this is an adiabatic exchange, the enthalpy of the air remains constant, while the dew-point rises and the dry-bulb falls, and the loss of sensible heat exactly equals the gain in latent heat (neglecting radiation losses). The maximum available temperature reduction is the total difference between entering dry- and wet-bulbs (wet-bulb depression). Equipment achieving the complete reduction is termed *completely* saturating or 100 per cent efficient, since the air leaves in a saturated state. Equipment utilizing only a portion of the wet-bulb depression is termed *partially* saturating.

Evaporative cooling is being used advantageously in many parts of the country. It is particularly applicable (1) in districts where the relative humidity is normally low during the cooling season, and (2) in applications where the cooling load is principally a sensible load.

Dehumidification of air, in its broadest connotation, means simply the removal of moisture. Usage in the art has restricted the application of the term, so that the former broad meaning is now properly covered by the complementary names dehumidification and dehydration. *Dehumidification* usually refers to the *condensation* of water vapor from air due to its contact with a chilled medium (see Cooling). This type of heat exchange invariably includes temperature reduction due to removal of sensible heat, which reduction may be considered a by-product effect.

Dehydration refers specifically to the removal of water vapor from air due to its contact with a dehydrating agent. The primary distinction between dehumidification and dehydration is the vapor pressure exerted at the surface of the contacting medium. In the case of dehumidification, this surface vapor pressure is always the same as that which would be exerted by a body of water (or ice) at that same surface temperature. In the case of a dehydrating agent, the surface vapor pressure is always *lower* than that exerted by water at the same temperature, and the effectiveness of the medium as a dessicant is largely a function of the amount by which this vapor pressure can be lowered at the working temperature involved.

Thus it is evident that the primary function of a dehydrating agent is to establish a vapor pressure difference between the air and the medium in order to secure thereby a removal of moisture (latent heat) from the air. In the simplest type of process, no heat is abstracted from the medium itself, and the process is essentially an adiabatic one in which the latent heat lost by the air is converted to sensible heat which raises the air temperature by an equivalent amount. This process is therefore an energy exchange, similar to, but the reverse of, adiabatic saturation.

Combination Methods. It is evident that two or more of the above processes—cooling, evaporative cooling, dehumidification and dehydration—may be combined by the proper application of interchangers in sequence. Such combinations are dictated by the availability of prime sources of energy and the economic justification of each.

This chapter discusses in detail the engineering and economic principles involved in the application of dehydration. For similar discussion of the other processes, refer to the following material: Cooling and dehumidification by the use of surface interchangers (cooling coils), see Chapter 26. Cooling, dehumidification and evaporative cooling with air washers, see Chapter 27. For sources of cooling involving city and well water and cooling towers, see Chapter 27, while for mechanical refrigeration and ice, refer to Chapter 25. For the thermodynamics of evaporative cooling, see Chapter 1.

DEHYDRATING AGENTS

Dehydrating agents may be divided into two general classifications:

1. *Adsorbent*—A material which has the ability to condense water vapor on its surface without itself being changed physically or chemically. Certain solid materials, such as silica gel, activated alumina and activated carbon have this property.

2. *Absorbent*—A material which has the ability to take up water vapor but which changes physically, chemically, or both, during the cycle. Calcium chloride is an example of a solid material while liquid materials include lithium chloride, calcium chloride, lithium bromide and ethylene glycol.

Adsorbents

These substances are characterized by a physical structure containing a great number of extremely small pores but still retaining sufficient mechanical strength to resist the wear and handling to which they are subjected. To be suitable for dehydration purposes such substances must fulfill the following requirements:

1. Possess suitable vapor pressure characteristics.
2. Be available at an economical cost.
3. Adsorb sufficient moisture per pound of material to avoid excessive bed dimensions.
4. Be chemically stable, resisting contamination from impurities.
5. Physically rugged to resist breakdown from handling, abrasion, etc.
6. Withstand breakdown from indefinitely repeated reactivation cycles.
7. Possess practical and efficient reactivation temperatures.

Aluminum Oxide (Alumina), in a porous, amorphous form is a solid adsorbent frequently called by the common name activated alumina. It contains small amounts of hydrated aluminum oxide, very small amounts of soda, and various metallic oxides. A good grade of activated alumina will show 92 per cent of Al_2O_3, and its soda content will be combined with silica and alumina into an insoluble compound. This substance also has the property of adsorbing certain gases and certain vapors other than water vapor—a property which is sometimes useful in air conditioning installations. It is available commercially in granules ranging from a fine powder to pieces approximately 1.5 in. in diameter. It has high adsorptive capacity per unit of weight and is non-toxic. It may be repeatedly re-activated after becoming saturated with adsorbed moisture without practical loss of its adsorptive ability. In the grade frequently used for air drying the re-activation may be accomplished at temperatures under 350 F. Specific gravity is 3.25 and the pores are reported to occupy 58 per cent of the volume of each particle. For most estimating purposes the volume-weight relation on a dry basis may be taken as 50 lb per cubic foot although in the smaller sizes the packed weight may be as much as 64 lb per cubic foot.

Silicon Dioxide (Silica), in a special form obtained by suitably mixing sulphuric acid with sodium silicate, is another solid adsorbent and is commonly called silica gel. Its capillary structure is exceedingly small, so small that its exact structure has to be deduced rather than observed. The gel is available commercially in a wide variety of sizes of granules ranging from 4 to 300 mesh. It has high adsorptive capacity per unit of weight, it is non-toxic, and may be repeatedly re-activated without