

From Equation 12,

$$h = 0.24 (t - 0) + Wh_s$$

where

$$h_s = 1059.2 + 0.45t \text{ (Empirical equation derived from Keenan's Steam Tables).}$$

$$t = 75 \text{ F.}$$

$$W = 0.01873 \text{ lb of water vapor (Table 6).}$$

$$h = 0.24 (75 - 0) + 0.01873 [1059.2 + (0.45 \times 75)].$$

$$h = 38.46 \text{ Btu per pound of dry air.}$$

7 • A building requires 50,000 cu ft of air per hour to be raised from -10 F dry-bulb and 75 per cent relative humidity to 72 F dry-bulb and 30 per cent relative humidity. Determine the amount of heat and the weight of water which it is necessary to supply per hour if the temperature of the supply water is 50 F and the barometric pressure is 28.75 in. Hg.

Assume air volume to be dry air at 70 F.

$$\text{Weight of air} = 0.075 \times 50,000 = 3750 \text{ lb per hour.}$$

From Table 6,

$$\text{Pressure of vapor in the mixture, outside air} = 0.75 \times 0.0221 = 0.0166 \text{ in. Hg.}$$

$$\text{Specific humidity, outside air} = 0.622 \left( \frac{0.0166}{28.75 - 0.0166} \right) = 0.0003589 \text{ lb.}$$

From Table 6,

$$\text{Pressure of vapor in the mixture, inside air} = 0.30 \times 0.7906 = 0.2372 \text{ in. Hg.}$$

$$\text{Specific humidity, inside air} = 0.622 \left( \frac{0.2372}{28.75 - 0.2372} \right) = 0.005174 \text{ lb.}$$

$$\text{Water to be added} = 3750 (0.005174 - 0.0003589) = 18.06 \text{ lb per hour.}$$

$$\text{Heat content, inside air} = 0.24 \times 72 + 0.005174 [1059.2 + (0.45 \times 72)] = 22.925 \text{ Btu per pound.}$$

$$\text{Heat content, outside air} = 0.24 \times (-10) + 0.0003589 [1059.2 + (0.45 \times -10)] = -2.021 \text{ Btu per pound.}$$

$$\text{Btu added incident to the water per pound of dry air.}$$

$$(0.005174 - 0.0003589) (50 - 32) = 0.0867 \text{ Btu per pound.}$$

$$\text{Heat requirement per hour} = [22.925 - (-2.021 + 0.0867)] \times 3750 = 93,221 \text{ Btu.}$$

8 • Determine the amount of heat and water that must be extracted to cool 3750 lb of air (weighed dry) from 95 F and 60 per cent relative humidity to 50 F and 100 per cent relative humidity with a barometric pressure of 28.75 in. Hg.

$$\text{Pressure of vapor in the mixture, outside air} = 0.6 \times 1.659 = 0.995 \text{ in. Hg.}$$

$$\text{Specific humidity, outside air} = 0.622 \left( \frac{0.995}{28.75 - 0.995} \right) = 0.0223 \text{ lb.}$$

$$\text{Specific humidity, inside air} = 0.007626 \text{ lb.}$$

$$\text{Weight of water to be extracted per hour} = (0.0223 - 0.007626) \times 3750 = 55.03 \text{ lb.}$$

$$\text{Heat content, outside air} = 0.24 \times 95 + 0.0223 [1059.2 + (0.45 \times 95)] = 47.37 \text{ Btu per pound.}$$

$$\text{Heat content, inside air} = 0.24 \times 50 + 0.00764 [1059.2 + (0.45 \times 50)] = 20.26 \text{ Btu per pound.}$$

$$\text{Heat to be extracted} = (47.37 - 20.26) \times 3750 = 101,662 \text{ Btu.}$$

## Chapter 2

# REFRIGERANTS AND AIR DRYING AGENTS

Properties of Refrigerant Substances, Selection Factors, Solid Adsorbents, Liquid Absorbents, Nature of Processes, Temperature Pressure Concentration Relations

BOTH cooling and dehumidification of air are usually desirable at certain times. Cooling may be regarded as the extraction of sensible heat while dehumidification necessitates the removal of latent heat. By a suitable selection and combination of methods and equipment these two processes may be accomplished simultaneously or they may be secured independent of each other and at different times as desired. On occasion, the desired result can be secured by extracting sensible heat only while in other cases drying alone will produce the end conditions sought. Suitable substances must be available for use in every particular case.

Generally, when both cooling and dehumidification are sought current practice makes use of artificially produced refrigeration in some form. The substances used as the heat-carrying agents in these applications are called refrigerants. Air drying agents are substances which permit dehumidification of air as a process separate and independent of the extraction of sensible heat from it. Refrigerants and air drying agents are treated separately in this chapter where the aim is to present a statement of the properties of these substances which are of especial importance in air conditioning work. Little mention is made here of methods, systems, or equipment whereby these substances may be applied, which information may be found in Chapter 24.

## REFRIGERANTS

Since air cooling and dehumidification are frequently accomplished by evaporating a liquid under circumstances which will permit the heat necessary to be extracted from the air, the refrigerants are substances which are capable of being changed into liquids or vapors within workable temperature and pressure ranges. There are many substances which might be so used but in practice the choice is limited by a wide variety of considerations including availability, cost, safety, chemical stability and adaptability to the type of refrigerating system to be used.

In this chapter detailed consideration is limited to six substances, viz: ammonia, carbon dioxide, dichlorodifluoromethane ( $F_{12}$ ), methyl