$$\frac{P_2}{P_1} = \frac{T_2}{T_1};\quad P_2 = \frac{T_2 P_1}{T_1}$$

$$P_2 = \frac{(96 + 460)\ (29.92 \times 0.491 \times 144)}{(78 + 460)\ (0.491 \times 144)} = 30.90 \text{ in. Hg.}$$

8 ● Given saturated air at a temperature of 75 F and a barometric pressure of 29.92 in. Hg; determine the heat content of the mixture per pound of dry air, including the heat content of the liquid above 32 F.

From Equation 12,

$h = 0.24\ (t - 0) + W\ (1059.2 + 0.45t).$

where

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

$t = 75$ F.

$W = 0.01873$ lb of water vapor (Table 5).

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

$h \doteq 38.47$ Btu per pound of dry air.

9 ● 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.

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

From Table 5,

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

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

From Table 5,

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

Specific humidity, inside air $= 0.622 \left(\frac{0.2372}{28.75 - 0.23718}\right) = 0.005174$ lb.

Water to be added $= 3750\ (0.005174 - 0.0003589) = 18.06$ lb per hour. Heat content, inside air $= 0.24 \times 72 + 0.005174\ (1059.2 + 0.45 \times 72) = 22.925$ Btu per pound.

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

Btu added incident to the water per pound of dry air.

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

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

10 ● 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.

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

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

Specific humidity, inside air $= 0.007626$ lb.

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

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

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

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

Chapter 2

REFRIGERATION

Classification of Systems, Refrigerants, Mechanical Compression Systems, Theoretical Cycle, Refrigerating Effect per Pound, Coefficient of Performance, Steam Ejector System, System Characteristic, Closed Absorption System, Open Adsorption Systems, Reverse Cycle

THE various types of refrigeration systems most commonly used for air conditioning purposes may be classified fundamentally as follows:

1. Compression Systems.
   a. Mechanical—Reciprocating, Rotary, and Centrifugal.
   b. Ejector.
2. Absorption Systems.
   a. Closed.
   b. Open.

Of these, the mechanical systems are the most extensively used at the present time and will be given complete consideration in the following discussion.

REFRIGERANTS

The common refrigerants are volatile liquids which produce refrigeration by their evaporation under reduced pressure. Factors usually influencing the choice of refrigerant are safety, chemical stability, operating pressures and adaptability for the type of system to be used.

Of the six refrigerants whose properties are listed in Tables 1 to 6, ammonia, carbon dioxide, dichlorodifluoromethane (F_{12}) and methyl chloride are used in reciprocating and rotary mechanical compression systems. Monofluorotrichloromethane (F_{11}) and water are used in centrifugal compression systems. Water is used almost to the exclusion of other refrigerants in ejector systems. Closed absorption systems may use ammonia, methyl chloride, water, or others as the refrigerant.

MECHANICAL REFRIGERATION SYSTEMS

While the mechanical refrigeration systems differ in the methods used for compression of the refrigerant vapor, they are all fundamentally similar. Refrigerant vapor, usually saturated or slightly superheated, is drawn into a compressor (see Fig. 1). It is then compressed and discharged at a higher pressure to a condenser. The vapor is condensed as it contacts a heat transfer surface over which is flowing a cooling medium such as water, air or a combination of the two. The liquid refrigerant