Air-Vapor Properties

Composition of air

	By volume	By weight	Molecular mass
Nitrogen	79%	76.8%	28.02
Oxygen	21%	23.2	32.00
Air (dry)	-	-	28.97

Ideal Gas Law

$$pV = nRT$$

Where:

P = absolute pressure (Pa)

V = volume (m^3)

n = number of kg-moles

T = absolute temperature (K)

R = universal gas constant, 8.314 x 10^3 Pa m^3/kg-mole K

Dalton's Law:

Each component in a mixture of gases exerts the same pressure it would exert if it alone occupied the same volume at the same temperature and that the total pressure is equal to the sum of partial pressures:

$$p = p_1 + p_2 + p_3 + \ldots$$

mass of mixture is the sum of masses of components:

$$m = m_1 + m_2 + m_3 + \ldots$$

Mass of particular component:

$$m_1 = n_1 M_1$$

where:

m_1 = mass of component 1 (kg)

n_1 = number of moles of component 1 (kg-moles)

M_1 = molecular weight of 1 (kg/kg-mole)

Then

$$n_1 = \frac{m_1}{M_1}$$

$$p_1 V_1 = \frac{m_1 R T_1}{M_1}$$

or

$$m_1 = \frac{p_1 V_1 M_1}{R T_1}$$

Then

$$m = \frac{p_1 V_1 M_1}{R T_1} + \frac{p_2 V_2 M_2}{R T_2} + \frac{p_3 V_3 M_3}{R T_3} + \ldots$$

For a mixture of gases, all components occupy the same volume and are at the same temperature:

$$m = (p_1 M_1 + p_2 M_2 + p_3 M_3 + \ldots)\frac{V}{RT}$$

or

$$\frac{RTm}{V} = p_1 M_1 + p_2 M_2 + p_3 M_3 + \ldots$$

For a mixture,

$$pV = \frac{mRT}{M}$$

where M is the effective molecular weight for the mixture

$$pM = \frac{mRT}{V}$$

$$pM = p_1M_1 + p_2M_2 + p_3M_3 + \ldots$$

or

$$M = \left(\frac{p_1}{p}\right)M_1 + \left(\frac{p_2}{p}\right)M_2 + \left(\frac{p_3}{p}\right)M_3 + \ldots$$

Psychrometric terms:

1. Vapor Pressure (P_v) - water vapor pressure is the partial pressure exerted by water vapor molecules.

2. Relative humidity (ϕ) - ratio of the mole fraction (or vapor pressure) of water vapor in the air to the mole fraction (or vapor pressure) of the water vapor in saturated air at the same temperature and atmospheric pressure.

Psyschrometric terms:

3. Humidity ratio (W) or absolute humidity or specific humidity – mass of water vapor contain in moist air per unit mass of dry air.

4. Dry-bulb temperature (T) – temperature of moist air indicated by an ordinary thermometer)

5. Dew point temperature (T_{dp}) - temperature at which condensation occurs when air is cooled at constant humidity ratio and constant atmospheric pressure.

Psyschrometric terms:

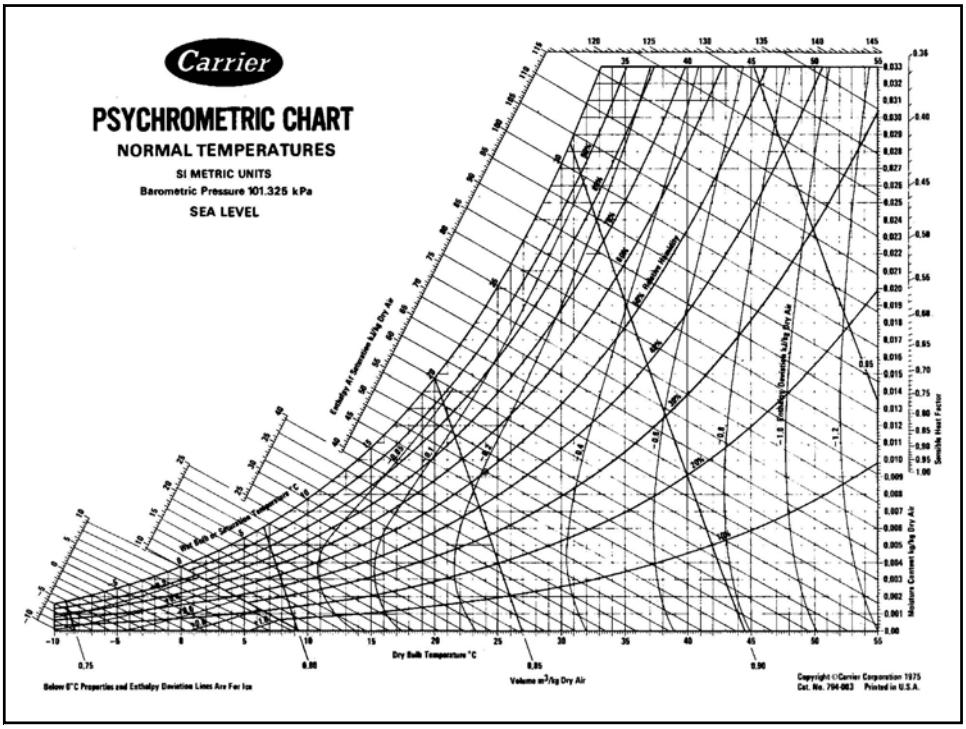
6. Wet-bulb temperature (T_{wb}) - temperature of moist air indicated by a thermometer whose bulb is covered with a wet wick (psychrometric T_{wb}). The airflow passing over the wick should have a velocity of at least 4.6 m/s.

Thermodynamic T_{wb} is the temperature reached by moist air and water is the air is adiabatically saturated by the evaporating water.

Psychrometric terms:

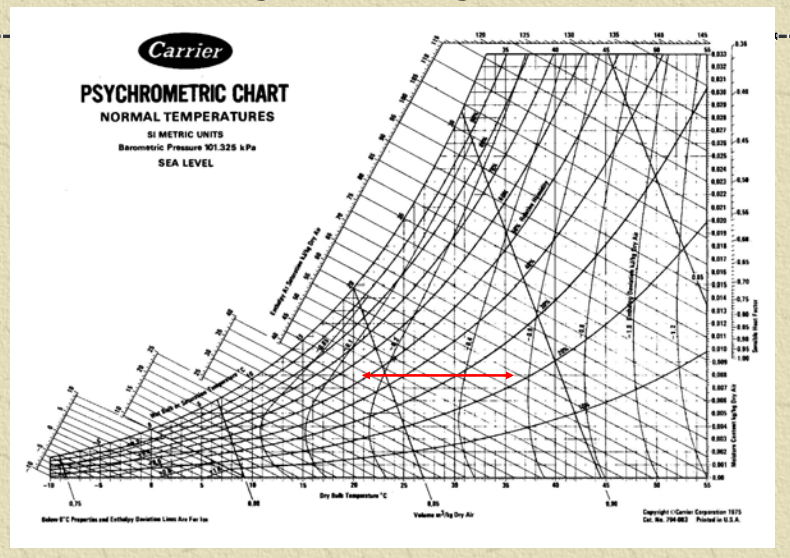
7. Enthalpy (h) of a dry air-water vapor mixture – heat content of the moist air per unit mass of dry air above a certain reference temperature, ie. 0°C.

8. Specific volume (v) of moist air – volume per unit mass of dry air.



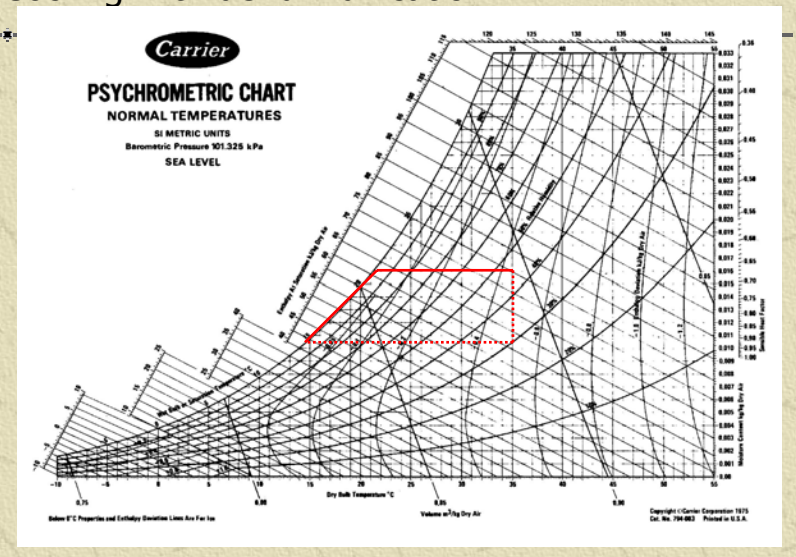
PSYCHROMETRIC PROCESSES

Sensible heating and cooling



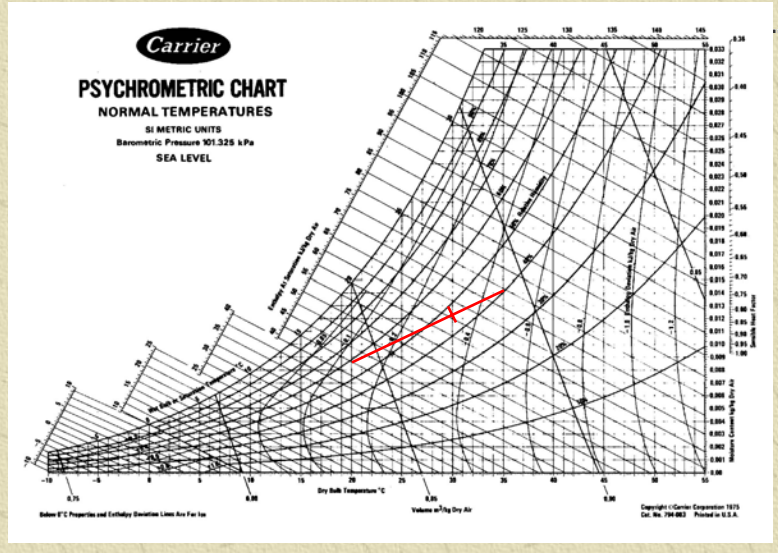
PSYCHROMETRIC PROCESSES

Cooling with dehumidification



PSYCHROMETRIC PROCESSES

Adiabatic mixing



PSYCHROMETRIC PROCESSES

Drying