ROHINI COLLEGE OF ENGINEERING & TECHNOLOGY

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AI3001 REFRIGERATION AND COLD STORAGE

UNIT III

Psychrometry is the study of the properties of mixtures of air and water vapour. Atmospheric air is a mixture of many gases plus water vapour and a number of pollutants. The amount of water vapour and pollutants vary from place to place. The concentration of water vapour and pollutants decrease with altitude, and above an altitude of about 10 km, atmospheric air consists of only dry air. The pollutants have to be filtered out before processing the air. Hence, what we process is essentially a mixture of various gases that constitute air and water vapour. This mixture is known as moist air. The moist air can be thought of as a mixture of dry air and moisture

PSYCHROMETRIC PROPERTIES:

The definitions of different psychrometric properties of air are given below :

a) Dry air

The dry a ir is considered as a mixture of nitrogen and oxygen and small percentage s of other gases. The volumetric composition of air is 79% nitrogen and 21 % oxygen and the molecular weight of dry air is taken as 29 approximately .

b) Moist air

It is a mixture of dry air and water · vapour . The quantity of water vapour present in the air depend s upon the temperature of the air and its quantity may change from zero to maximum (the maximum amount depends on saturation condition).

c) Water vapour

The moisture present in the form of vapour is known as water vapour. The relative humidity of air is an important factor in all air - conditioning systems.

d) Dry bulb temperature

The temper a ture of air measured by ordinary thermometer i s known as dry bulb temperature (dbt). : . .

e) Wet-bulb temperature

The temperature me asu red by the thermometer when its bulb i s c overed with wet c loth and is exposed to a current of moving air is known as wet bulb temperature (wbt) . The difference between the dry bulb and wet bulb temperature is known as wet bulb depression (wbd) . Wet bulb depression becomes zero when the air is fully saturated.

f) Dew Point temperature

The temperature of the air is reduced by continuous cooling than the water vapour in the air will start condensing at a particular temperature. The temperature at which the condensing starts is known as Dew , -point temperature. Dew point temperature is equal to the steam table saturation temperature corresponding to the actual partial pressure of the water vapour in the air . The difference between dry bulb temperature and dew point temperature is known as dew point depression (dpd).

g) Specific humidity (Humidity ratio)

It is defined as the mass of water yapour present per kg of dry air . It is expressed as g/kg dry air or kg/ kg dry air.

h) Absolute humidity

The weight of water vapour present in unit volume of air is known as absolute humidity.

i) Degree of Saturation

The degree of saturation is defined as the r atio of mass of water vapour associated with unit mass of dry air to mass of water vapour associated with unit mass of dry air saturated at the same temperature.

j) Relative Humidity

The relative humidity is defined as the ratio of actual mass of water vapour in a given .volume to the mass of water vapour if the air is fully saturated at the same temperature .

k) Sensible Heat of air

The quantity of heat which can be measured by measuring the dry bulb temperature of the air is known as sensible heat of the air.

i) Total heat of air

The total heat of the humid air is the sum of the sensible heat of the dry air and sensible and latent heat of water vapour associated with dry air.

m) Humid specific volume:

The volume of the air per kg of dry air in the mixture is known as humid specific volume of the air. It is expressed as m3/kg dry air.

DEGREE OF SATURATION (μ)

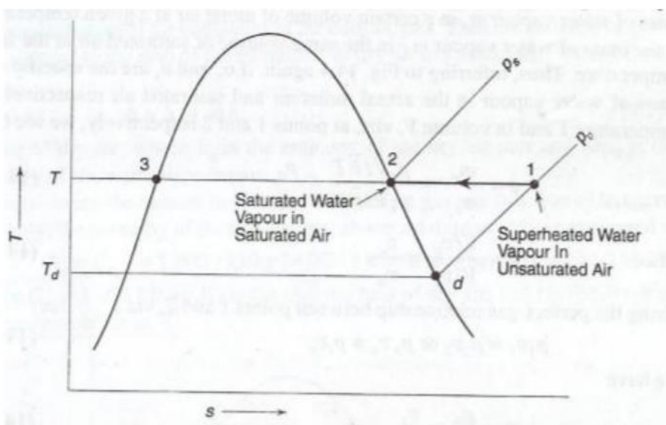
Where, ωs is the specific humidity of air when air is fully saturated.

$$\mu = \frac{\text{mass of water vapour in unit mass of dry air}}{\text{mass of water vapour in saturated unit mass of dry air}} = \frac{\omega}{\omega_s}$$

Where, ω_s is the specific humidity of air when air is fully saturated.

$$\therefore \mu = \frac{0.622\left(\frac{P_v}{P_t - P_v}\right)}{0.622\left(\frac{P_{vs}}{P_t - P_{vs}}\right)} = \frac{P_v}{P_{vs}}\left(\frac{P_t - P_{vs}}{P_t - P_v}\right) = \frac{P_v}{P_{vs}}\left[\frac{1 - \frac{P_{vs}}{P_t}}{1 - \frac{P_v}{P_t}}\right]$$

Consider the water vapour in the super heated thermodynamic state 1 in unsaturated moist air representing the control volume V. the water vapour exists at the dry bulb temperature T of the mixture and partial pressure pv as shown in the Figure Where, Pvs is the partial pressure of water vapour when the air is fully saturated at the same temperature of the air. This can be calculated from steam table corresponding to the dry-bulb temperature of the air.



Now consider that more water vapour is added in this control volume V at temperature T itself. The partial pressure pv will go on increasing with the addition of water vapour until it reaches a value ps corresponding to state 2 in Figure 6.4 after which it cannot increase further as ps is the saturation pressure or maximum possible of water at temperature T. the thermodynamic state of water vapour is now saturated at point 2. the air containing moisture in such a state is called saturated air. In this state the air is holding the maximum amount of water vapour(the specific humidity being ωs, corresponding to the partial pressure ps) at temperature T of the mixture. The maximum possible specific humidity, ωs at temperature T is thus

$$\omega_s = 0.622 \frac{p_s}{p - p_s}$$

RELATIVE HUMIDITY (ø)

As per the definition of relative humidity,

$$\phi = \frac{\text{mass of water vapour in a given volume}}{\text{mass of water vapour in same volume if saturated at the same temperature}}$$

$$= \frac{m}{m_{vs}} = \frac{\dfrac{P_v V}{R_v T}}{\dfrac{P_{vs} V}{R_v T}} = \frac{P_v}{P_{vs}}$$

Relative humidity plays very important role in comfort air conditioning and deciding the performance of many unit operations such as drying, evaporative cooling etc.

ENTHALPY OF MOIST AIR

The enthalpy of moist air is the sum of the enthalpy of one dry air and the enthalpy of water vapour associated with one kg dry air