PSYCHROMETRICS

OBJECTIVE:
To use mathematical expressions and a psychrometric chart to determine properties of air-water vapor mixtures

PROPERTIES OF DRY AIR:

Specific Volume of Dry Air:

Using ideal gas laws

$$V'_a = \frac{R_a T_A}{p_a}$$

where p_a = partial pressure of dry air
R_a = gas constant
T_A = absolute temperature

Specific Heat of Dry Air:

At 1 atm (101.325 kPa) the specific heat of dry air varies from 0.997 to 1.022 KJ/kg C, use an average value of 1.005 kJ/kg C

Enthalpy of Dry Air:

Using 0 C as the datum temperature,

Dry Bulb Temperature, Ta:

PROPERTIES OF WATER VAPOR

Atmospheric air almost always contains some moisture. The vapor in the air is essentially superheated steam. Air containing suspended water droplets is called "foggy".

Specific Volume of Water vapor:

$$V'_w = \frac{R_w T_A}{p_w}$$

where p_w = partial pressure of water vapor
R_w = gas constant for water vapor

Specific Heat of Water Vapor:

Enthalpy of Water Vapor:

Dew Point Temperature:

When an air-vapor mixture is cooled at constant pressure and constant moisture content, a temperature is reached when the mixture becomes saturated. Further lowering of the temperature results in condensation of moisture.

Humidity Ratio (Specific Humidity, or Moisture Content)

Humidity ratio is defined as the mass of water vapor per unit mass of dry air, expressed as kg water/ kg of dry air

$$W = \frac{0.622\, p_W}{p_a}$$

Relative Humidity

Ratio of mole fraction of water vapor in a given moist air sample to the mole fraction in an air sample saturated at same temperature and pressure

relative humidity =

where

p_W = partial pressure of water vapor

p_{WS}= partial pressure of water vapor at saturation.

Humid heat of an Air-Water Vapor Mixture:

amount of heat required to raise the temperature of 1 kg dry air plus the water vapor present by 1 K

$$c_S = 1.005 + 1.88\, W$$

Specific Volume

volume of 1 kg dry air plus water vapor in the air

$V_m = (0.082\, T_a + 22.4)\,(1/29 + W/18)$

Wet Bulb Temperature:

Temperature recorded by a sensor when the measuring component is covered with a thin film of water.

Psychrometric Chart