Sensible Heating:-

Adding the heat at constant moisture content (w/o change of sp. Humidity Moisture), which increases the DBT of air, the process is called sensible heating.

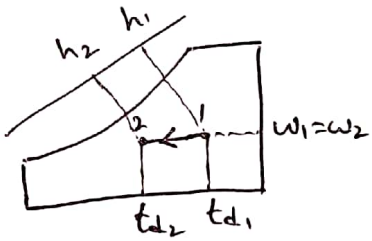
$S.H = H.A = h_2 - h_1$

Sensible Cooling:-

Removing the heat (cooling of air) at constant moisture content (w/o change of sp. Humidity), which decreases the DBT of air, the process is called sensible cooling.

$S.H = H.R = h_1 - h_2$

or $H.R = h_2 - h_1$



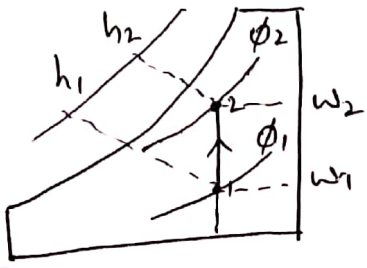
Humidification:-

Addition of Moisture without changing the DBT of air is called humidification

$L.H = h_2 - h_1$

$= h_{fg}(W_2 - W_1)$

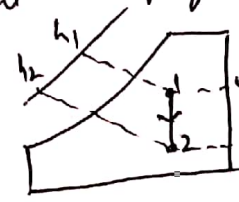
L.H of vaporization at DBT



$w_2 > w_1 \quad \phi_2 > \phi_1$

Dehumidification:-

Removing the moisture without changing the DBT of air is called Dehumidification

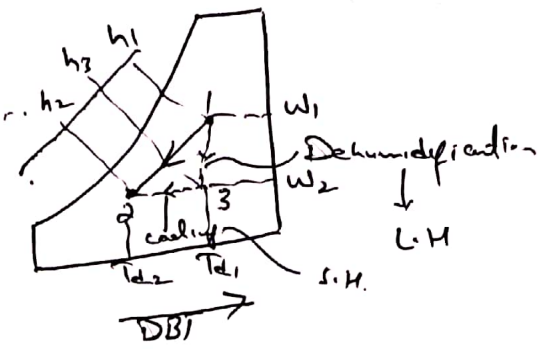


$w_2 < w_1, \phi_2 < \phi_1$

Cooling with Dehumidification

Used in ——— Air Conditioning - - - - - - - - - - - -

Removing the moisture as well as removing the heat is called - - - - - -



T.H = $q_v = h_1 - h_2$

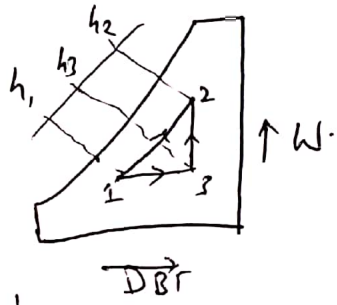
$TH = (h_1 - h_3) + (h_3 - h_2)$

= L.H + S.H.

Heating with Humidification

Used in ——— Air Conditioning - - - - - - - - - -

Adding the Moisture as well as addition of heat is called —



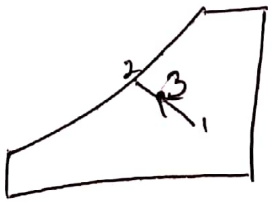
Evaporative Cooling (Cooling ~~with Adiabatic~~ and Humidification by water injection).

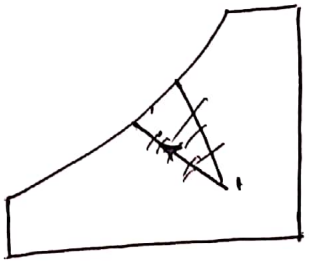
Of unsaturated is passed continiously through a spray of recirculating water, the sp humidity of air increases and DBT of air decreases. This process is called cooling with adiabatic humidification or Evaporative Cooling.

Humidity increases of unsaturated air till becomes saturated (100% RH)

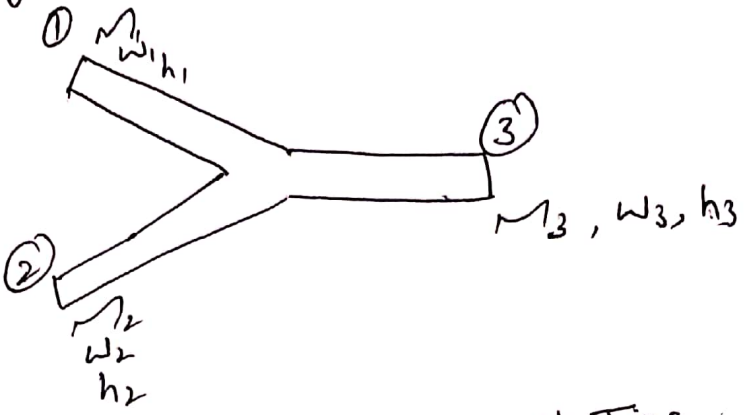
$$\eta = \frac{\text{Actual drop in DBT}}{\text{Ideal drop in DBT}}$$

$$= \frac{T_{d1} - T_{d3}}{T_{d1} - T_{d2}}$$





Mixing of Two streams



$\dot{m}$ = Mass of air flow per unit Time

w = Sp. Humidity

h = Enthalpy.

Assume that During Mixing, there is no loss of heat.

Apply mass balance on Air

$$\dot{m}_1 + \dot{m}_2 = \dot{m}_3 \rightarrow (1)$$

Apply energy balance on Air.

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3 \rightarrow \text{II} \quad (KJ/sec)$$

For mass balance of water vapours.

$$\dot{m}_1 w_1 + \dot{m}_2 w_2 = \dot{m}_3 w_3 \rightarrow \text{III}$$

Apply eq I on eq II we get

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = (\dot{m}_1 + \dot{m}_2) h_3$$

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_1 h_3 + \dot{m}_2 h_3$$

$$\dot{m}_1 h_1 - \dot{m}_1 h_3 = \dot{m}_2 h_3 - \dot{m}_2 h_2$$

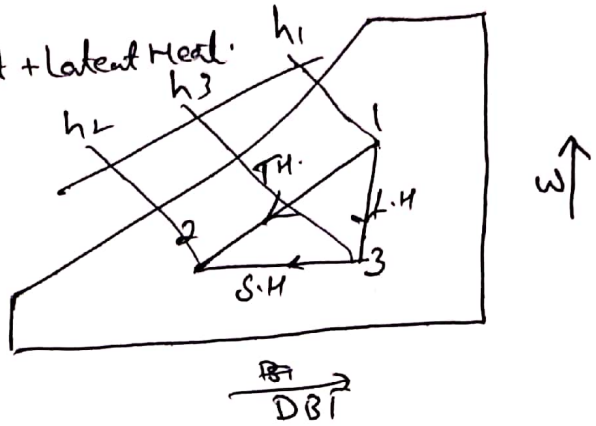
$$\frac{\dot{m}_1}{\dot{m}_2} = \frac{h_3 - h_2}{h_1 - h_3}$$

Similarly Apply Eq I on eq II we get

$$\frac{\dot{m}_1}{\dot{m}_2} = \frac{w_3 - w_2}{w_1 - w_3}$$

$$\boxed{\frac{\dot{m}_1}{\dot{m}_2} = \frac{h_3 - h_2}{h_1 - h_3} = \frac{w_3 - w_2}{w_1 - w_3}}$$

Total heat = Sensible heat + Latent Heat.



Sensible Heat Factor = (SHF)

It is the ratio of sensible heat to total heat.

$$SHF = \frac{SH.}{LH.} = \frac{SH}{SH + LH}$$

$$= \frac{h_3 - h_2}{h_1 - h_2}$$

If $LH = 0$

then $SHF = \underline{1}$

Room Sensible Heat Factor

$$RSHF = \frac{RSH}{RSH + RLH}$$

Latent Heat Factor = (LHF)

It is the ratio of latent heat to total heat.

$$LHF = \frac{LH}{SH + LH} = \frac{LH}{TH}$$

$$= \frac{h_1 - h_3}{h_1 - h_2}$$

Room Latent Heat Factor

$$RLHF = \frac{RLH}{RSH + RLH.}$$

Room Latent Heat:

→ Moisture rejected by the person in room.

→ Steam load supplied eg moisture producing devices.

Room Sensible Heat:

→ Occupancy load

→ Lighting

→ Electrical / Mechanical appliances

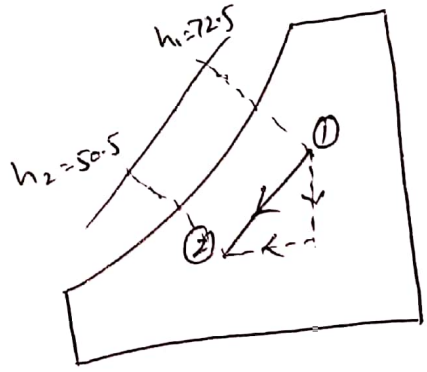
→ Solar radiations coming from windows / walls

Note

Conditioned Air supplied to the room must have the capacity to take room sensible heat and room latent heat simultaneously.

Numerical

How many TR are required to cool $100 m^3/min$ at $30^\circ C$ DBT with $\phi_1 = 60\%$ to $20^\circ C$ DBT with $\phi_2 = 80\%$.



Sp. volume $= 0.88 m^3/kg$

Mass of air per min $(\dot{m}) = \frac{100}{0.88}$

$= 113.63 kg/min$

Total heat removed per kg of Air $= h_1 - h_2$

$= 22 kJ/kg$

Also $TH = \dot{m}(h_1 - h_2) = 113.63 \times 22 = 2495.8 kJ/min$

Since $1 TR = 211 kJ/kg min$ Hence

$TR = \frac{2495.8}{211} = ---$

The following data related to air conditioning plant as follows

- cooling load = 10TR

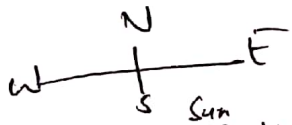
Desired Room conditions :- DBT = 27°C , ϕ = 55%.

Supplied Air conditions = DBT = 17°C , WBT = 15%.

Find out sensible Heat Factor??

Factors to Consider for heat/cooling load calculations

→ Building orientation/Location



→ Door/Windows Direction & quantity — Max Radiation

How many doors and windows are exposed to radiation.

Cross ventilation

→ Outside Conditions

Temp & Humidity.

Degree Days

It is the unit of estimation of outside conditions.

HDD (Hot Degree Day) It occurs in the month of June

CDD (Cold " ") " " " " " December.

→ Inside Conditions

Comfort Zone

Cooling Load

Rate of heat energy that is removed by the Refrigeration System.