MT SM

- **Humidification**:- The process of adding moisture without changing its dry bulb temperature.
- dehumidification :- reverse of humidification
- Both heat and mass transfer occurs in humidification

Absolute humidity (Y) (grosvenor humidity)

$$Y = \frac{y_A}{y_B} \quad \frac{\text{moles}}{\text{moles}} \qquad y_A = \text{moles of A} \Rightarrow \text{water vapour}, \quad y_B = \text{moles of B} \rightarrow \text{air}$$

{ air water system

$$Y' = \frac{\text{mass of A}}{\text{mass of B}}$$

- gas v/s vapour

Percent humidity :-

$$\%\text{ humidity} = \frac{Y'}{Y'_s} \times 100$$

Y' → absolute humidity

Y'_s → humidity of saturated air at same T and P

$$Y'_s = \frac{P_A^v}{P - P_A^v} \times \frac{M_A}{M_B}$$

P_A^v → antoine eqn (100% saturated)

$$Y' = \frac{M_A}{M_B} \frac{P_A}{P - P_A}$$

Relative humidity (RH) (does not give moisture content) (but gives degree of saturation)

$$\%\text{ RH} = 100 \frac{P_A}{P_A^v}$$

- Humid volume
- Humid heat

$Y' = \frac{M_A P_A}{M_B P_B}$

$Y = \frac{P_A}{P_B}$ — P_A: water vapour; P_B: air

→ humidity affects AC
will double the cooling load.
high humidity, (WBT, DBT) will be closer.
∴ Can't cool air without condensing

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Dry bulb temperature :-
True temperature of air measured by thermometer freely exposed to air. Normal air temperature.

DBT − WBT = degree of saturation

Wet bulb temperature (It will measure the min temp upto which water can be cooled)
Steady state temperature attained by a small amt of evaporating water. It is the temperature read by a thermometer covered in water-soaked cloth over which air is passed. (air is being cooled) ✓.

DBT ≥ WBT

At 100% RH → DBT = WBT

- latent heat is supplied by air to water for evaporation
- wet bulb depression = DBT − WBT
- low WBT → air is drier (low humidity) and can hold more water vapour
- It depends on velocity of air, humidity, DBT, shape of thermometer.
- ~~sling thermometer~~

$(H_s - H_0)\lambda = (T_0 - T_s) C_s$ — H: humidity; C_s: humid heat

WBT, DBT will give the measure of RH

- sling psychrometer → used to measure.
- a closer DBT, WBT → more humid the air
  farther DBT, WBT → more dry (low humidity)
- ~~will~~ WBT will help in the design of heat exchangers (eg cooling tower) HVAC appliance (AC design)

how?

Dew point temperature
Temperature at which vapour-~~gas~~ gas mix must be cooled to become saturated (const humidity → absolute)
- air must be cooled to reach 100% RH

T↓ P_v↓ → vapour P
~~temp~~ RHT ✓

Book (s1, 13)

Be better

→ WBT is lowest temp to which air can be cooled by evaporation of H₂O into air at const pressure.

Psychrometer — Combination of DB, WB

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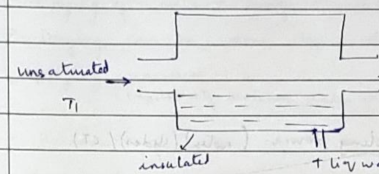
Adiabatic saturation temperature :



adiabatic evaporation of water

$T < T_1$

$T_{as} = T$

temp at which "no vacancy of H_2O" → AST

$H_i = C_H(T_1 - T_{as}) + \lambda_s Y'$

$H_o = \lambda_s Y_s'$

$H_i = H_o$ at equilibrium

→ relation between DBT, WBT
→ " " WBT, AST] slide ✓

→ Lewis number $= \left(\frac{Sc}{Pr}\right)^{0.567} = \frac{h_G}{C_H K_y}$ — h_G: heat transfer coeff; K_y: mass transfer coeff

→ Le ≈ 1 → ~~gases~~ air-water system ∴ WBT = AST

→ WBT v/s AST → slide ⇒ ✓ notes

→ psychrometric chart

→ **Vapour pressure** :- Pressure exerted by the gas in equilibrium with ~~its~~ its liq in a closed container at a temp

→ **Partial pressure** :- The pressure exerted by an individual gas in a mix.

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→ adiabatic process → no transfer of heat between system and surroundings

Cooling Tower

Cooling tower (notes) (slides) (CT)

- Classification based on air draft
  - Atmospheric
  - Natural
  - Mechanical
    - induced
    - forced
- classification based on flow.
  - Crossflow
  - counterflow.

→ Special type of heat exchanger in which warm water and air are brought in direct contact for evaporative cooling

→ (refer notes) (nadhun) (slides)

→ evaporation v/s Boiling

- evaporation: surface phenomena. Occurs at all temp
  - When the molecules of liq collide, they transfer energy to each other based on how they collide
  - → When a molecule near the surface ~~absorbs enough~~ energy, evaporation takes place
- Boiling: at a particular temp
  - all the molecules overcome potential energy
  - → bulk phenomena.

→ temp of liq reduces (cooling)

↓ becoz energy is taken away by the molecules when they convert from liq to gas

evaporation :- heat can be taken from the surroundings or from water itself

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Drying of wet solids

→ Drying of milk → spray chamber → milk powder

→ Drying can be done by direct heating with hot gas or applying vacuum. (expulsion of moisture under vacuum)

→ Removal of water due to vapourization

→ Vapourization → ~~Drying boiling or sublimation~~ below BP
- → transitional phase of a compound
- may be solid to gas / liq to gas
- all the water turns to gas

→ latent heat of vapourization → heat required to change one mole of liq ~~at~~ ~~BP~~ to gas under standard atmospheric ~~condition~~ pressure

→ latent heat: energy released or absorbed to change phase without change in temp

~~→ evaporation is not drying~~

→ separation of water from solution → not drying → evaporation

→ drying of gas

→ Heat and mass transfer occurs during drying.
Heat is required for solvent evaporation. Mass transfer for transfer of vapour to gas surrounding.

→ equilibrium → between moisture content of a solid and humidity of drying medium

→ If the moisture content in the solid > equilibrium → then vapourization occurs

MTC depends on Diffusivity of solute and other hydrodynamic properties

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ADSORPTION

Selective concentration of one or more components of a mixture on a solid surface.

- Interaction between adsorbate molecules and the surface
- Sorption = adsorption + absorption
- → Physical adsorption = force of interaction is weak
- chemical adsorption = forces are very strong. chemical bond might form
- Reverse of adsorption = desorption
- → Adsorption arises due to presence of unbalanced or residual forces at the surface of liq or solid
- → Weak Vanderwaal forces of attraction → driving force.
- → <u>selectivity</u> : due to difference in rate of diffusion and adsorption
- → rate of adsorption = rate of desorption → equilibrium