Chapter 2.4

Air conditioning

Learning outcomes

1. Air condition depends on temperature and water vapour content, which is called humidity
2. Dry air at temperature T, can absorb water as a vapour until the partial pressure of the water vapour is the p_{sat} of water at the temperature, T.
3. Proportion of p_{sat} reached is relative humidity, Greek symbol ϕ
4. Absolute mass of vapour per kg of dry air is absolute or specific humidity, Greek symbol ω
5. Dew point is when T of air is T_{sat} of vapour
6. Wet bulb thermometer measures humidity
7. Psychrometric chart is used for air condition

The atmosphere is not only made up of dry air (N_2, O_2, CO_2, and some other gases in very small proportion). Water vapour is a significant component in the atmosphere. Here is a photo of morning dew on plants, the moisture was in the air as vapour and condensed onto the cold surfaces

The weather on day or recording

Before and after collection – mass of water collected, 4 g

Heat gained by grass due to the dew is $m.h_{fg}$ at 8˚C, which is 0.004×2481.9
Q = 9.93 kJ per 0.04 m^2, therefore 248 $kJ.m^{-2}$

Motivation

- Comfort air conditioning for people.
  - Have limited comfort zone due to requirement for steady core body temperature of 37°C.
  - Produce heat and moisture into atmosphere.
  - Heat at ~80W resting, 120W office work, up to 400W physical working.
  - Produce sweat at varying rates and 100% humid air during respiration.
- Control conditioning for computers.
  - Have limited 'comfort' zone requirement for steady core temperature and dry conditions.

Air condition

- Dry air
  - Composed of nitrogen, N_2 and oxygen, O_2 in approximate proportions by mass: 76.7% N_2 and 23.3% O_2; by volume, 79% N_2 and 21% O_2.
- Humid or ***atmospheric air***
  - Water can evaporate into the air until its ***partial pressure*** equals its ***saturation pressure*** at the temperature of the local air.

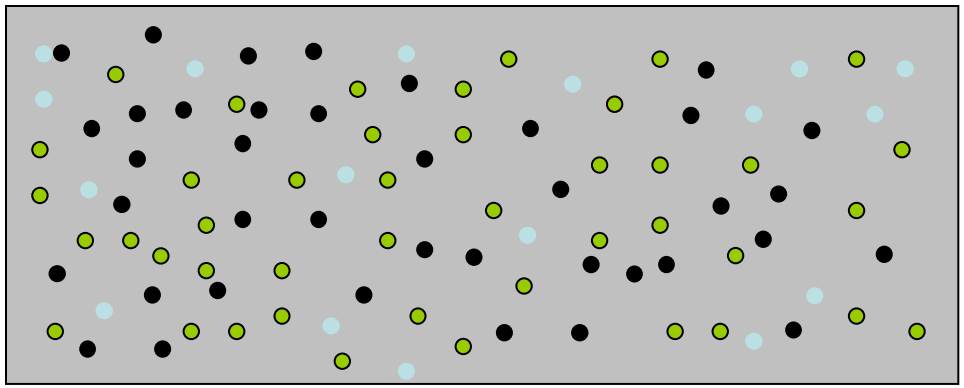
Evaporating vs boiling

https://www.youtube.com/watch?v=slygeF9Kz5Y

Gibbs Dalton Law of Partial pressure - the key to comfortable air

The pressure of a mixture of gases, p, is equal to the sum of pressures of individual constituents, that is their ***partial pressure***, when each occupies a volume equal to that of the mixture at the temperature of the mixture.

$$p = \sum p_i$$

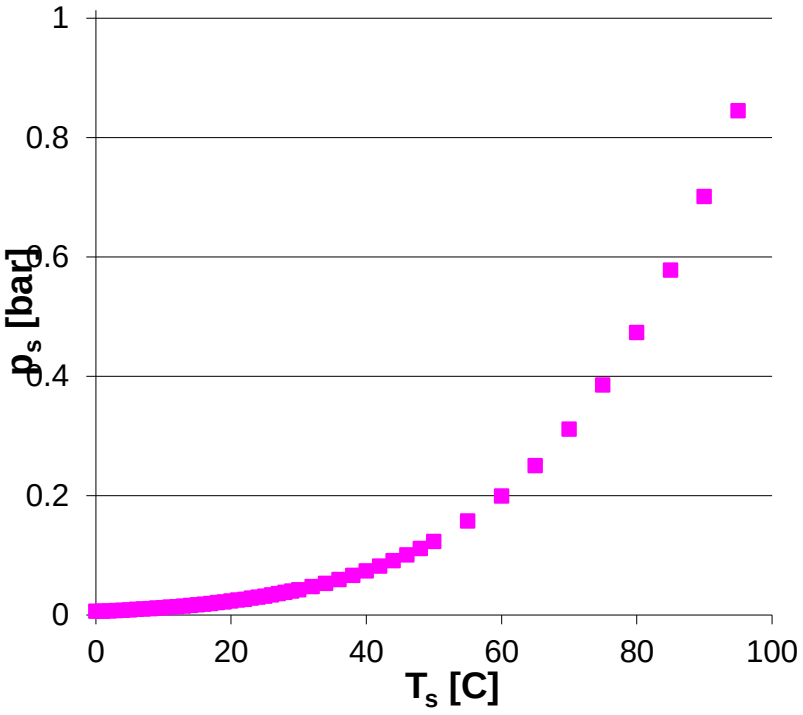


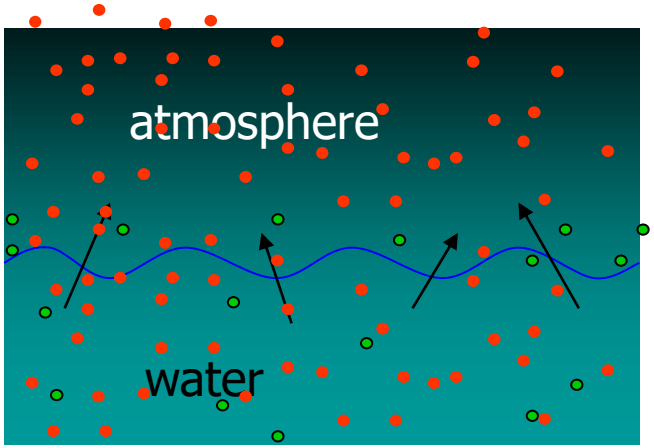
Dry air

- Approximately 79% by volume nitrogen and 21% by volume oxygen
- So in a room of approximately 3 m deep by 4 m wide by 3 m high, volume is 36 m^3
- Of this 0.79x36=28.4 m^3 is nitrogen and 0.21x36=7.6 m^3 is oxygen
- Also by mass, air is 23.3% oxygen and 76.7% nitrogen

Water vapour at less than b.p.

- At lower temperatures, p_s is correspondingly lower.
- At the lower temperatures, free surface water can evaporate until the partial pressure in the atmosphere is p_s.
- After this point, only equal exchange of vapour between atmosphere and free liquid water surface occurs.
- That is then saturated air, 100% humid.





Points to remember

- Dry air is not atmospheric air
- Atmospheric air is dry air and water vapour
- Maximum water vapour is in air when the partial pressure of water vapour is p_{sat} at the temperature of the air
- Water p_{sat} rises sharply after 60°C and since earth surface temperatures are generally lower than that, water is stable in the atmosphere in a cycle