ME 405 Fall 2006 Professor John M. Cimbala Lecture 16 10/13/2006

Today, we will:

- Finish our discussion of **evaporation rates** in **Sections 4.5.6** and **4.5.7**
- Discuss **evaporation in confined spaces** in **Section 4.5.8**
- Begin discussion of **general ventilation** in **Section 5.1**
- Discuss **thermodynamics of evaporation** in **Section 5.2**
- Do Candy Questions for Candy Friday

Sec. 4.5.8 Evap. in confined spaces

e.g. tank or container that is enclosed or confined

Suppose it is sitting here a long time

What is P_j in the tank? (in the air in the tank)

- If $x_j = 1$ (pure liquid) → $P_j = P_{v,j}$ (saturated)
- If $x_j < 1$ → Use:
  - Henry's law for very small x_j
  - Raoult's law for very large x_j [$x_j \sim 1$]
  - Use tables or graphs if in between [Equilibrium Isotherms]

  Can calculate P_j

☆ Entering a closed container can be very dangerous!!

Skim rest of Ch. 4

☆ CHAPTER 5 – General ventilation ☆

☆ - General → whole rooms or buildings (Ch. 5)
- Local → deal with hoods (Ch. 6)

Two main types:

☆ · Dilution ventilation (most popular in the US)

· Displacement ventilation (more popular in Europe)

→ mix the air up as much as possible (assume room air is "well mixed")

→ use natural convection as an aid to remove contaminants. Do not assume well-mixed air

See PDF file on website for more details

Sec. 5.2 Thermodynamics of Unventilated enclosures

This is material from end of Ch. 4 + Sec. 5.2

Let's look @ T-s diagrams from thermodynamics

☆ [☆ When dealing with a gas mixture, the same T-s diagram is still valid, but use P_j (partial pressure) instead of total pressure]

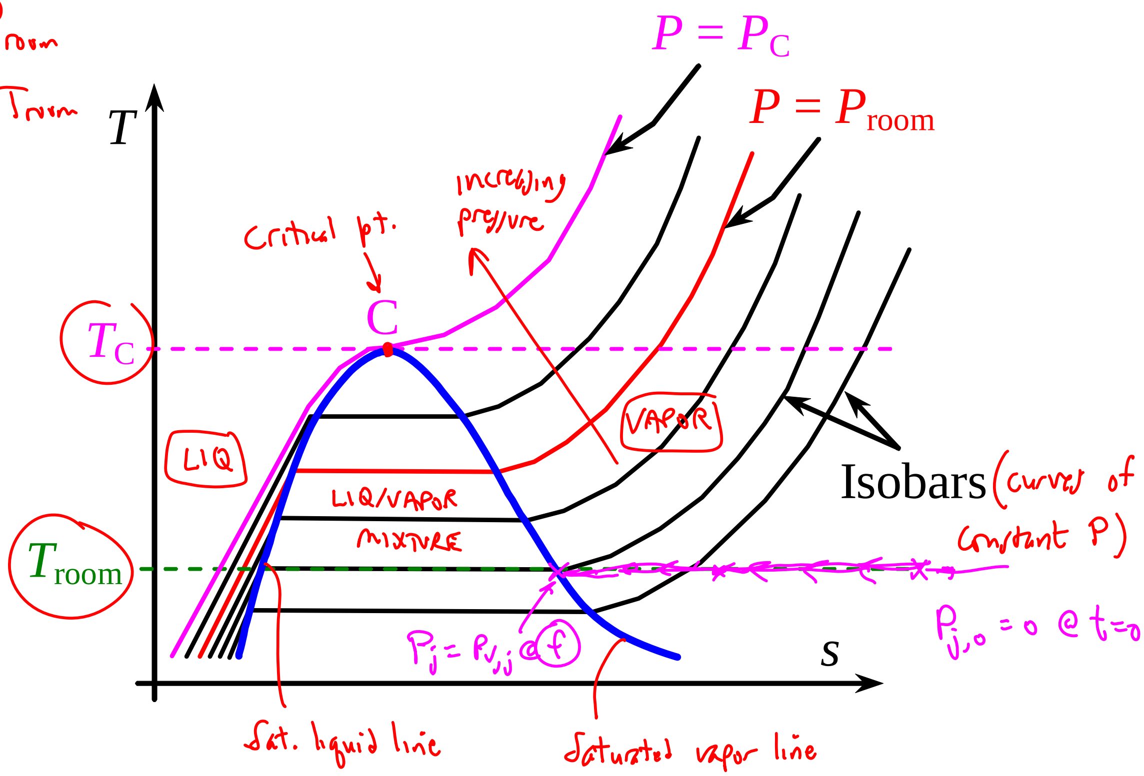
CATEGORY 1: ✱ $P_c > P_{room}$ & $T_c > T_{room}$

Critical pt., T_c & P_c → see App. A.10

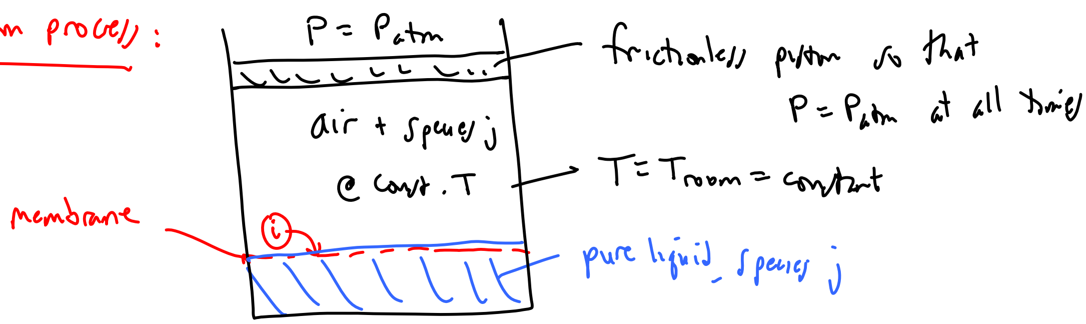
Recall the "steam dome" [we learned it for steam (H_2O) in thermo class, but is similar for other chemicals]

$P_c > P_{room}$

$T_c > T_{room}$



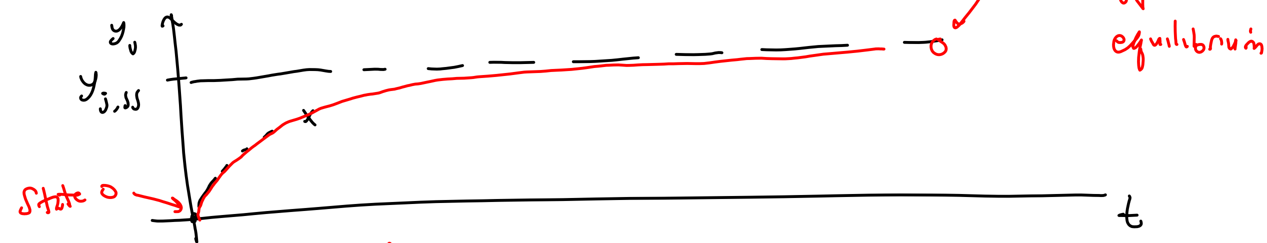
Evaporation process:



At $t=0$, remove a membrane at the interface so that evaporation starts.

Assume an <u>isothermal process</u>

Plot y_j in the air vs. t



$$y_{j,ss} = \frac{P_{v,j}}{P}$$ ✩ ← THIS IS AN <u>UPPER LIMIT</u>

(assuming we have enough liquid to begin with)

If ALL the liquid does not evaporate ✩

If there is not enough liquid to reach $y_j \to y_{j,ss}$,

then
$$y_{j,max} = \frac{n_j}{n_j + n_{air}} < y_{j,ss}$$

If ALL the liquid evaporates ✩

On the T-v diagram, this process goes from right to left @ constant Temp

[see diagram above] ↑