Vapor Pressure

- Why does a wet sidewalk become dry on a cold day if water boils at 212°F?
- Why does a 2-liter bottle of Sprite stay fizzy until you open it for the first time?
- Why is humid air so uncomfortable in the summer?
- Why do swamp coolers work in the desert but not in the swamp?
- Why does a wet finger dry faster when I blow on it?
- What happens to the steam plume from a power plant?

So What Is Vapor Pressure?

- P_i^*
- Measure of the volatility of a species
- For pure component:
  - The pressure of the vapor above a liquid at equilibrium

Vapor Pressure Chart

(which compounds have highest vapor pressure?)

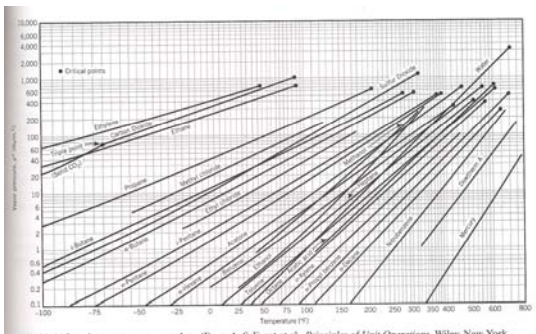

Figure 6.1-4 Cox chart vapor pressure plots. (From A. S. Foust et al., *Principles of Unit Operations*, Wiley, New York, 1960, p. 550.)

Antoine Equation

Table B.4 Antoine Equation Constants[a]

$$\log_{10} P^* = A - \frac{B}{T + C}$$

P^* in mm Hg, T in °C

Example: The vapor pressure of acetaldehyde at 25°C is determined as follows:

$$\log_{10} P^*_{C_2H_4O}(25°C) = 8.00552 - \frac{1600.017}{25 + 291.809} = 2.9551$$

$$\Longrightarrow P^*_{C_2H_4O}(25°C) = 10^{2.9551} = 902 \text{ mm Hg}$$

Compound	Formula	Range (°C)	A	B	C
Acetaldehyde	C_2H_4O	−0.2 to 34.4	8.00552	1600.017	291.809
Acetic acid	$C_2H_4O_2$	29.8 to 126.5	7.38782	1533.313	222.309
Acetic acid*	$C_2H_4O_2$	0 to 36	7.18807	1416.7	225
Acetic anhydride	$C_4H_6O_3$	62.8 to 139.4	7.14948	1444.718	199.817
Acetone	C_3H_6O	−12.9 to 55.3	7.11714	1210.595	229.664
Acrylic acid	$C_3H_4O_2$	20.0 to 70.0	5.65204	648.629	154.683
Ammonia*	NH_3	−83 to 60	7.55466	1002.711	247.885
Aniline	C_6H_7N	102.6 to 185.2	7.32010	1731.515	206.049
Benzene	C_6H_6	14.5 to 80.9	6.89272	1203.531	219.888
n-Butane	n-C_4H_{10}	−78.0 to −0.3	6.82485	943.453	239.711
i-Butane	i-C_4H_{10}	−85.1 to −11.6	6.78866	899.617	241.942

DIPPR Database

- Click on class web page
  http://www.et.byu.edu/~tom/classes/273/273.html
- Click on ChEn 273 Learning Resource Center
- Click on pocketknife (tools)
- Click on DIPPR database (this only works on campus)

Review

- 1 species with both liquid and vapor present
  $P_{tot} = P_i^*$
- 1 species in liquid, 2 or more species in gas phase
  $P_i = P_i^*$ (where $P_i = y_i P_{tot}$, and y_i is mol frac)
- Multiple species in liquid and gas phases
  $P_i = x_i P_i^*$ (where x_i is mole fraction in liquid)

Homework

- **6.2** – T, P*, and V given
  - P_{tot} (easy!)
  - Wanted m_{tot}
    - calculate m_{liq} from density and volume
    - calculate m_{vapor} from ideal gas law & MW
- **6.6** – from manometer, get P* vs T
  - Check with Clausius Clapeyron eqn.
- **6.9** – (a) Gibbs phase rule; (b) find P*
  - Please use both Antoine and DIPPR to find P*
  - $y_i = P_i^*/P_{tot}$