PGE 480
Production Engineering Laboratory

Determination of liquids vapor pressure

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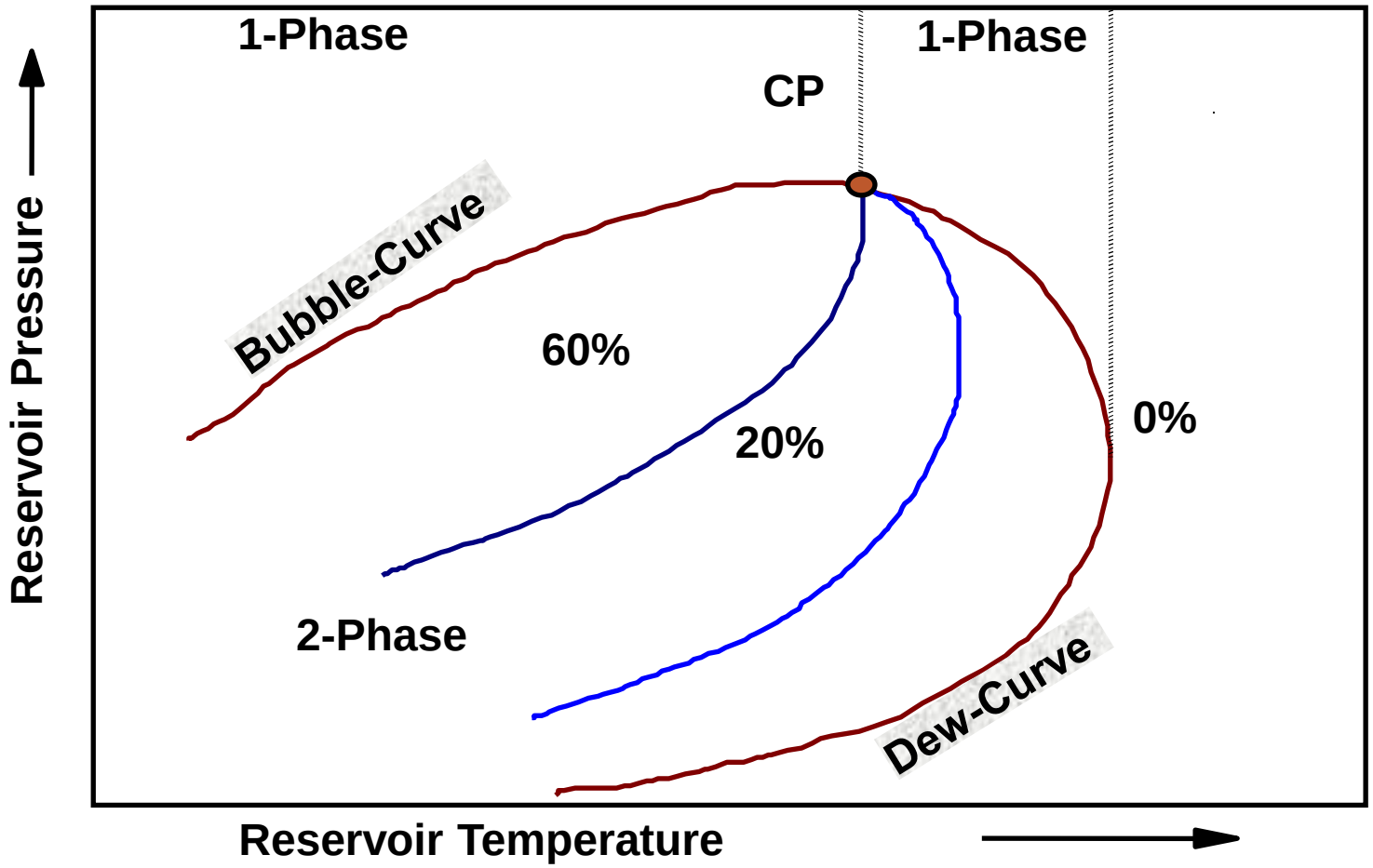
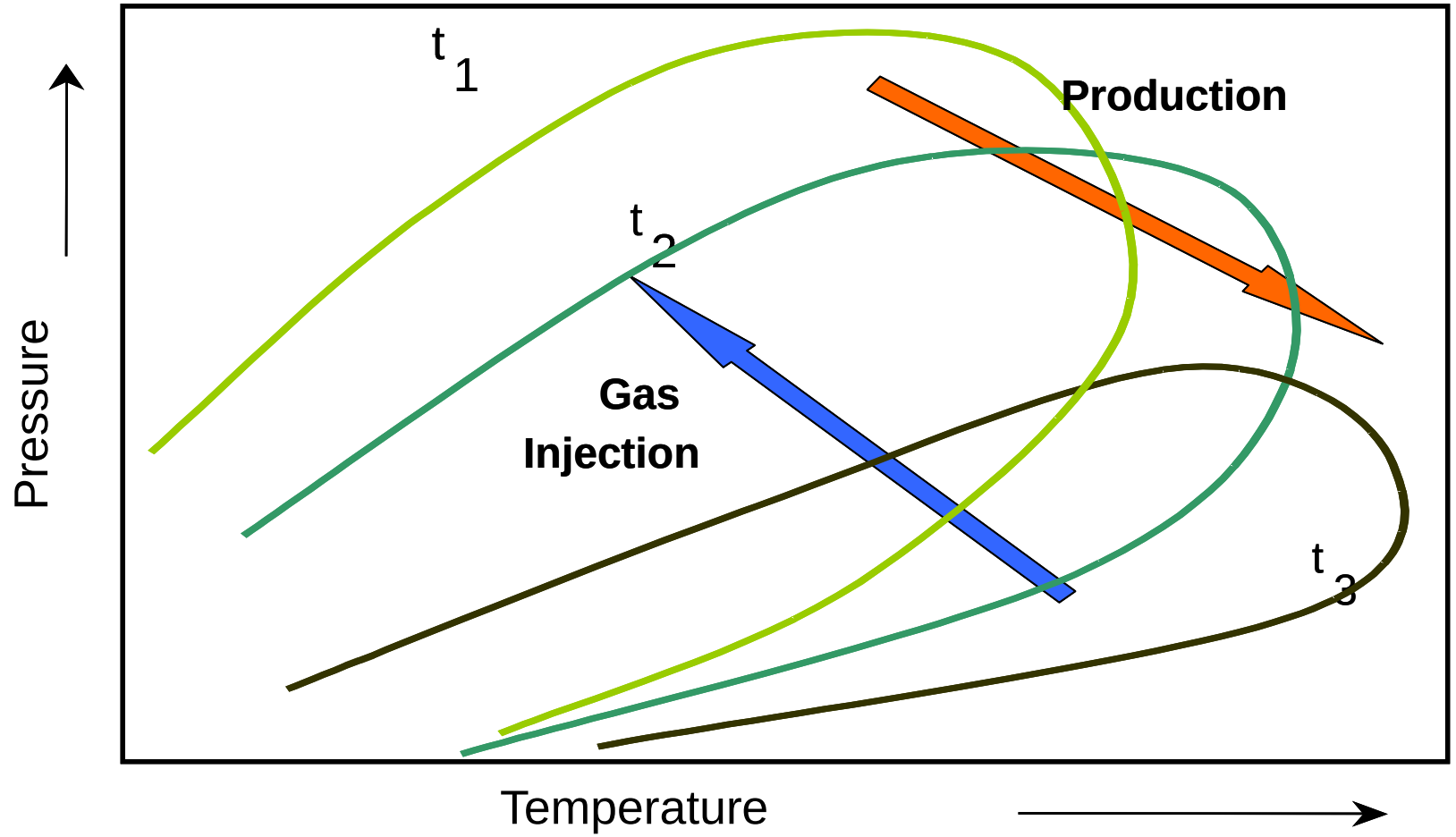
Pressure-Temperature Diagram for Multicomponent Systems

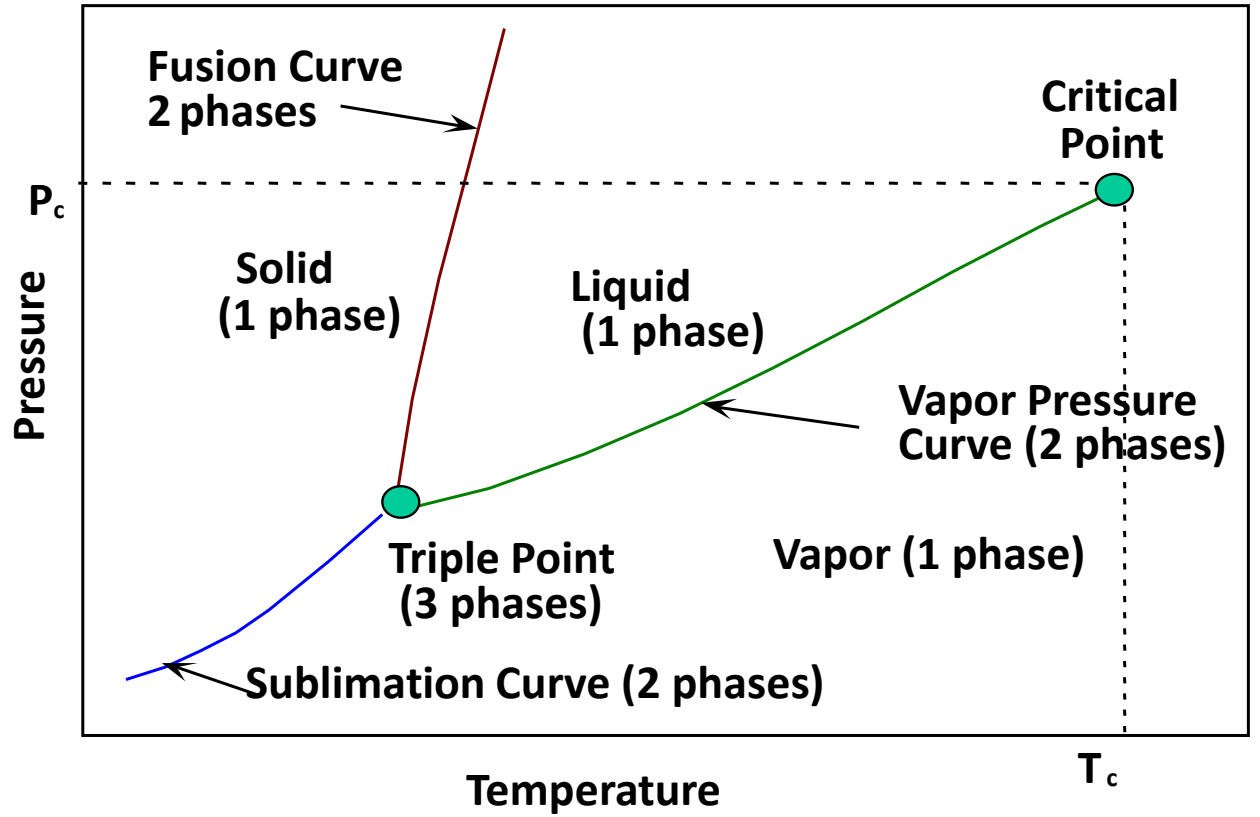


Importance of Pressure-Temperature Diagram



Phase Diagram

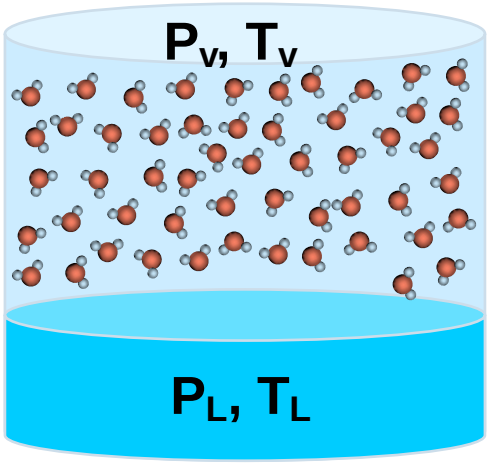
- **Types of phase diagrams for a single component (pure substance)**
  - Pressure-Temperature (PT)
  - Pressure-Volume (PV) or (Pρ)
  - Temperature-Volume (TV) or (T ρ)



Vapor Pressure of Pure Substance

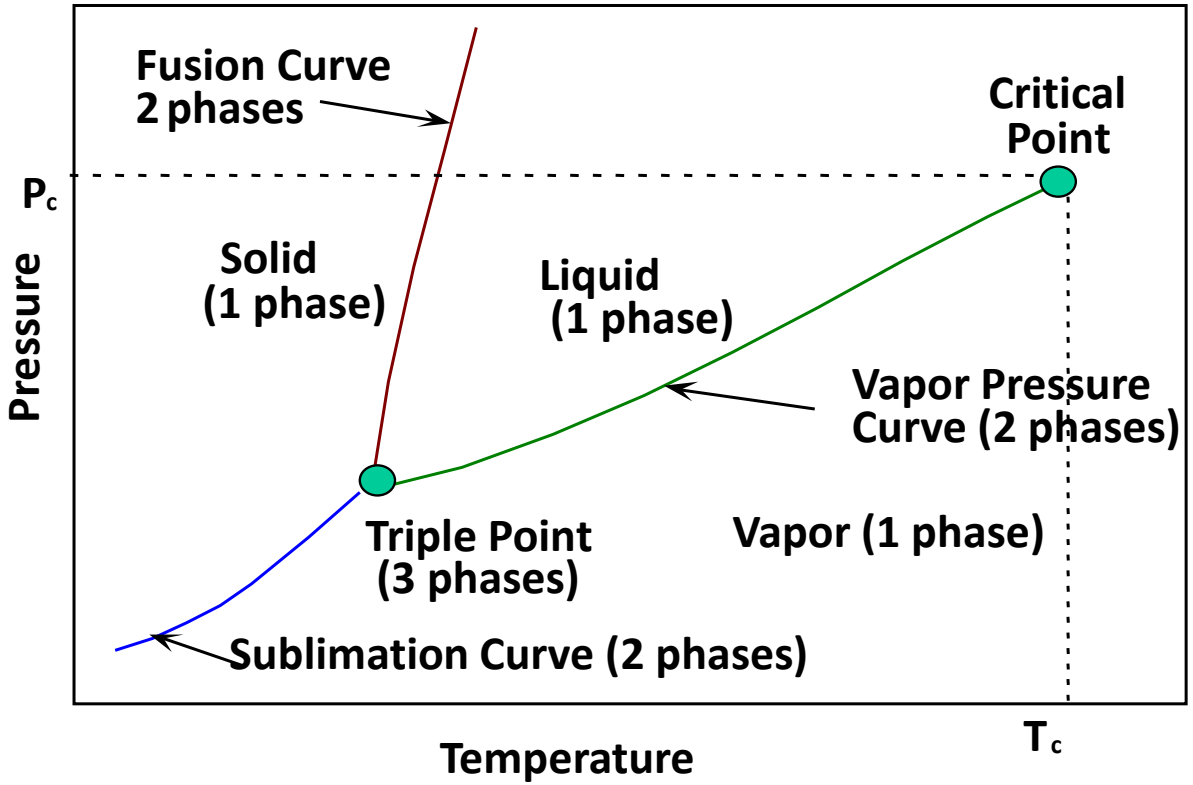
- **Definition**

The pressure exerted by a vapor in equilibrium with its liquid.



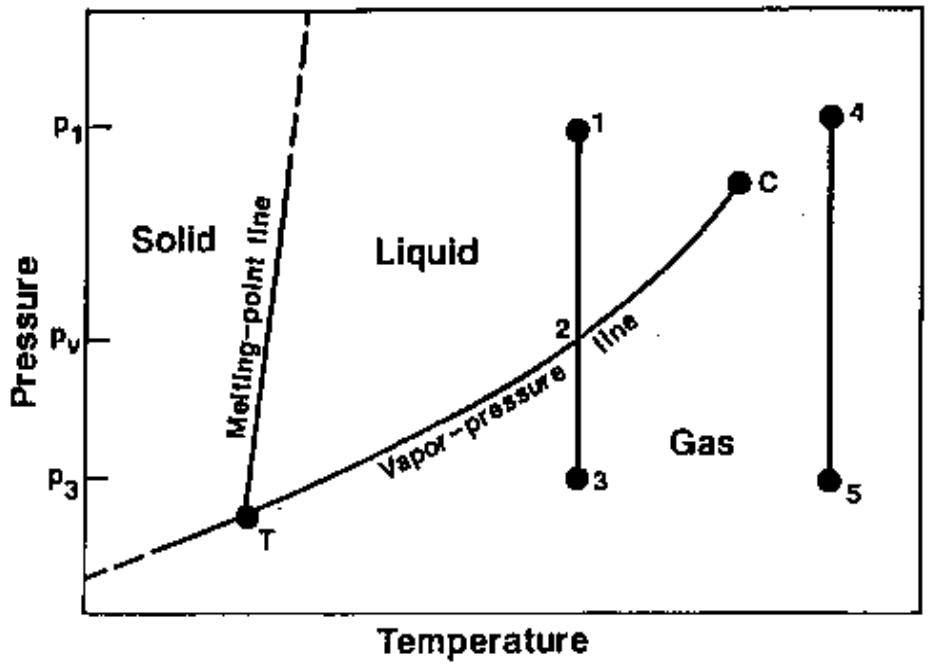
$$P_V = P_L$$

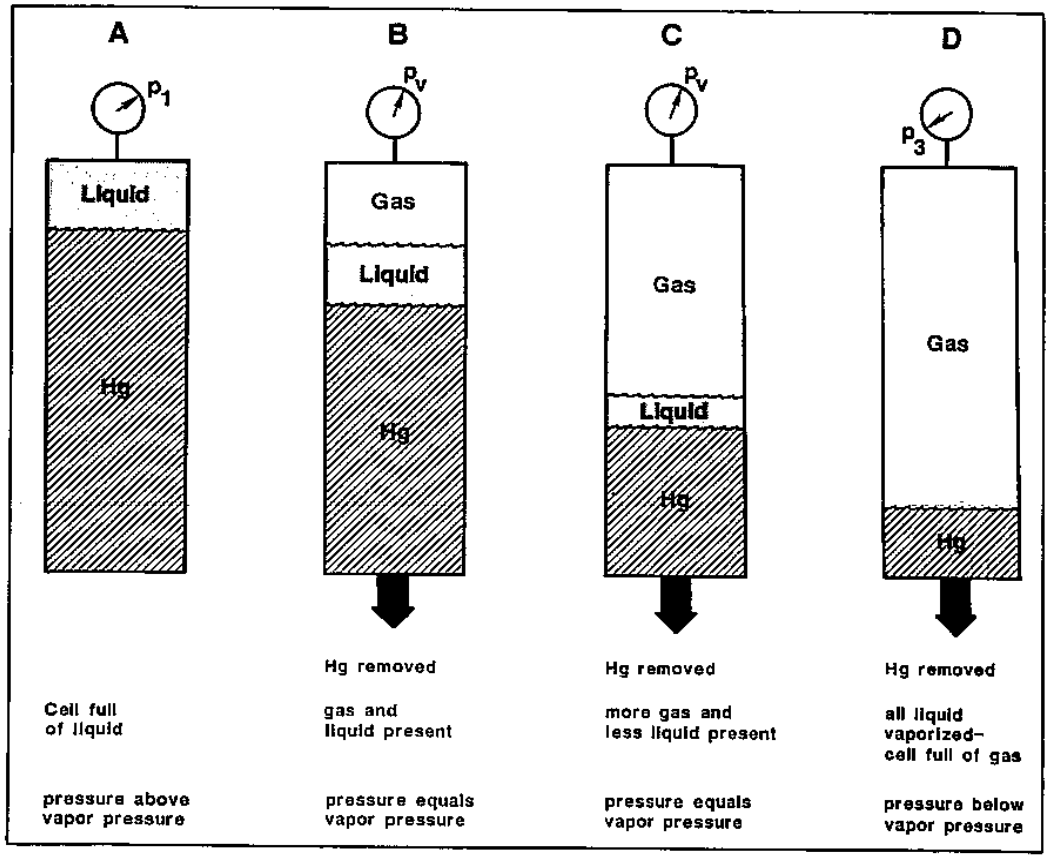
$$T_V = T_L$$



Vapor Pressure of Pure Substances

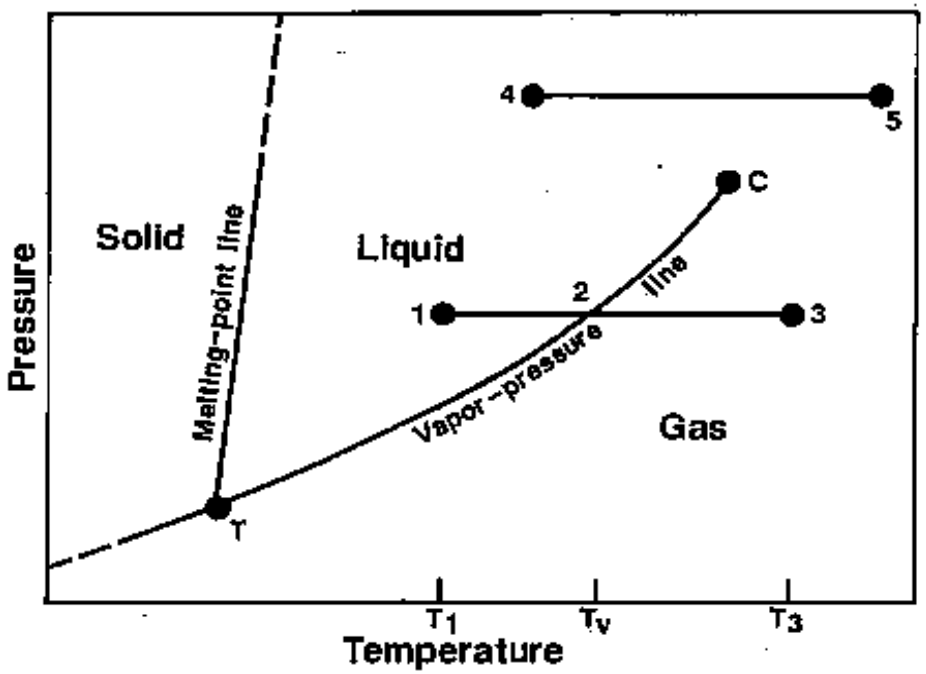
Vaporization of a pure substance at constant temperature.

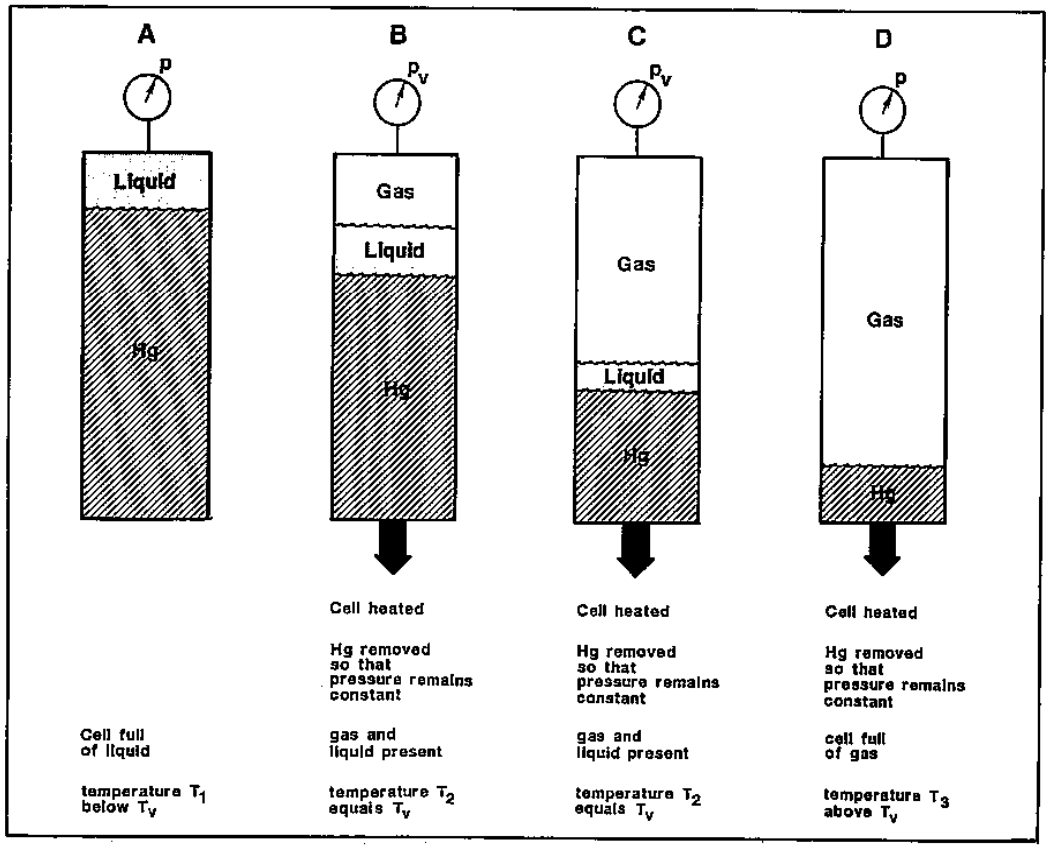




Vapor Pressure of Pure Substances

Vaporization of a pure substance at constant pressure.





Vapor Pressure of a Pure Substance

Clausius - Clapeyron Equation

$$\frac{dp_v}{dT} = \frac{L_v}{T(V_{Mg} - V_{ML})}$$

L_v : heat of vaporization of one mole of liquid

$V_{Mg} - V_{ML}$: the change in volume of one mole as it goes from liquid to gas

$$\frac{dp_v}{dT} = \frac{L_v}{TV_{Mg}}$$

Ideal gas

$$P_v V_{Mg} = RT$$

$$\frac{dp_v}{dT} = \frac{P_v L_v}{RT^2}$$ (Clausius – Clapeyron Equation)

Vapor Pressure of a Pure Substance

Clausius - Clapeyron Equation (CCE)

$\frac{dp_v}{dT} = \frac{P_v L_v}{RT^2}$ (Clausius – Clapeyron Equation)

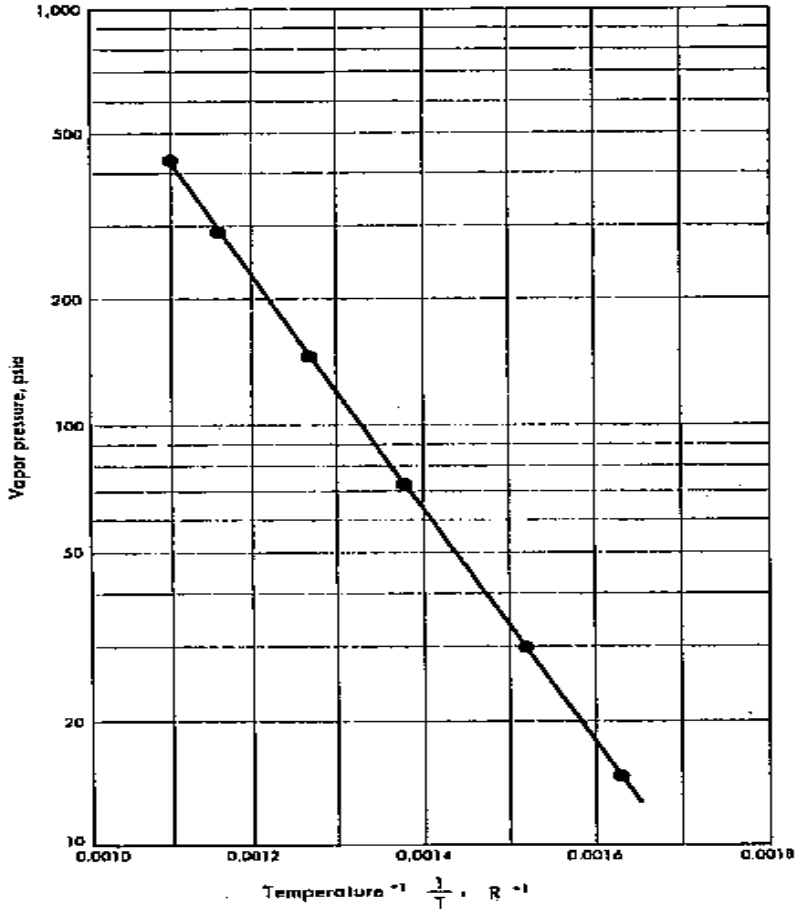
assume that L_v is a constant

$$\int \frac{dP_v}{P_v} = \frac{L_v}{R} \int \frac{dT}{T^2}$$

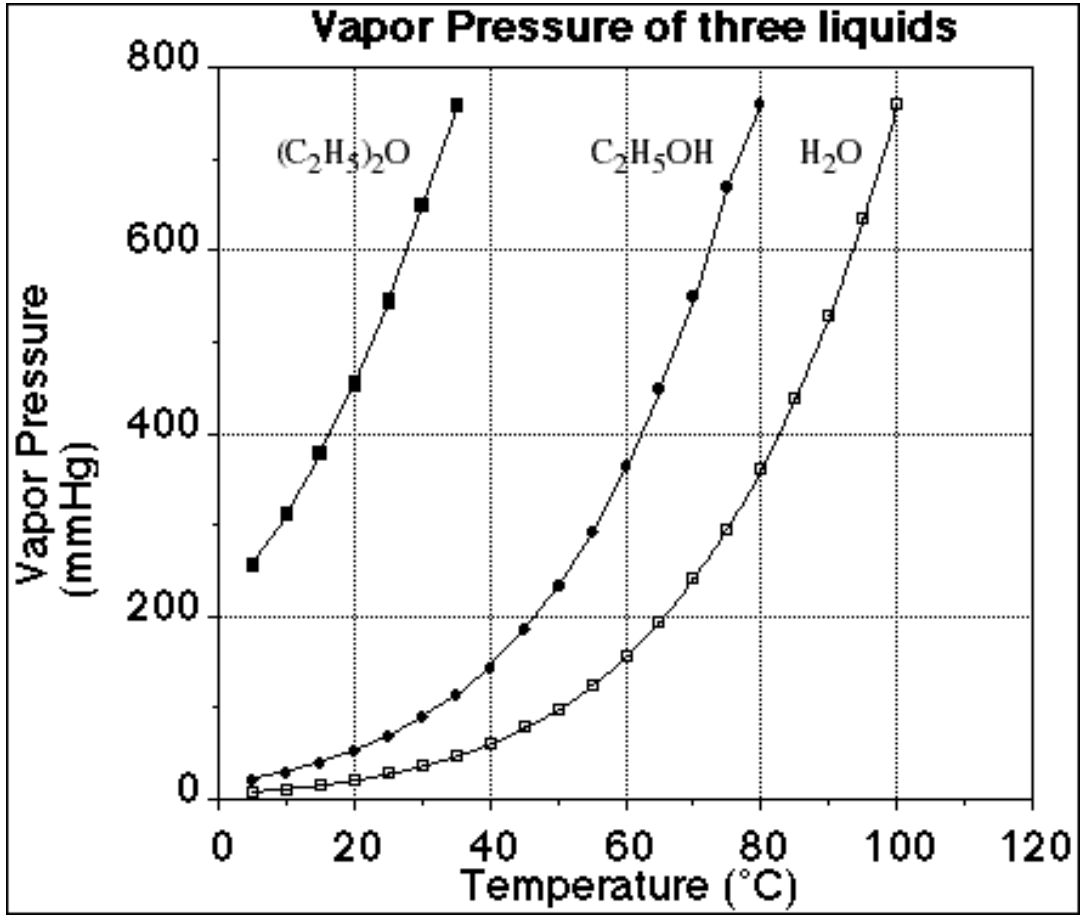
$$lnP_v = -\frac{L_v}{R}\left(\frac{1}{T}\right) + C$$

$$ln\frac{P_{v2}}{P_{v1}} = \frac{L_v}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$P_{v2} = P_{v1}.exp\left[\frac{L_v}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]$$



Vapor Pressure of a Pure Substance



Phase Diagram

Videos

- Phase Diagrams and the States of Matter
  - http://www.youtube.com/watch?v=gbUTffUsXOM
- Triple Point
  - http://www.youtube.com/watch?v=BLRqpJN9zeA
- What is Supercritical fluid
  - http://www.youtube.com/watch?v=QHcqyFm0i9M#aid=P8sRLIeLU1Q

Discussion

- What is the relation between vapor pressure and boiling point?
- What is the effect of molecular weight on the vapor pressure and boiling point?