


Phase Behavior of Liquids

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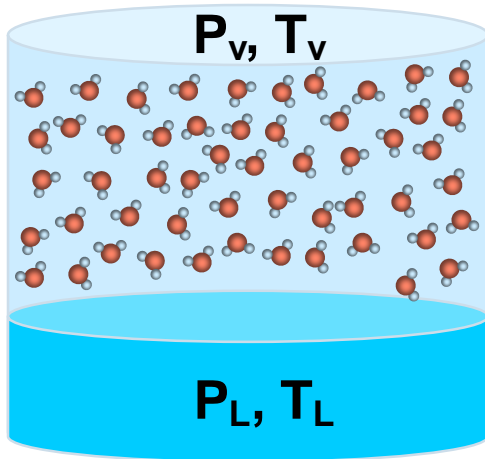
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Vapor Pressure of Pure Substance

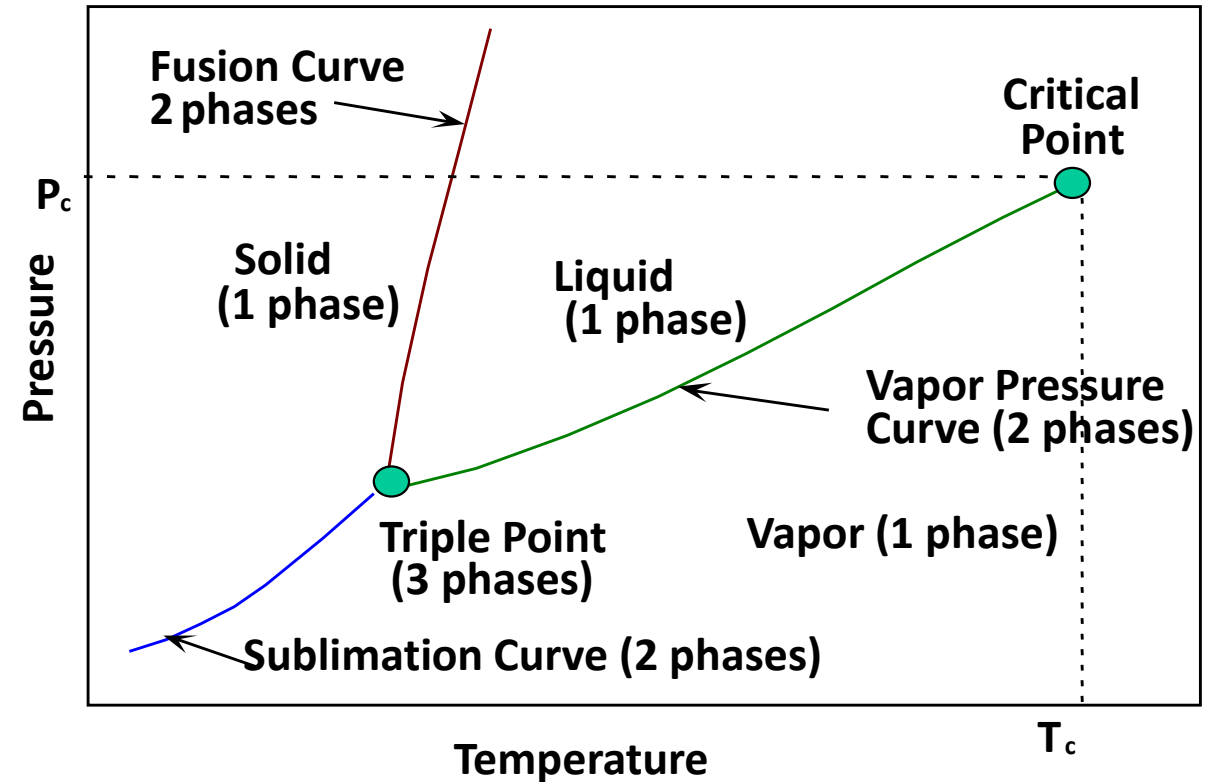
- Definition**

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



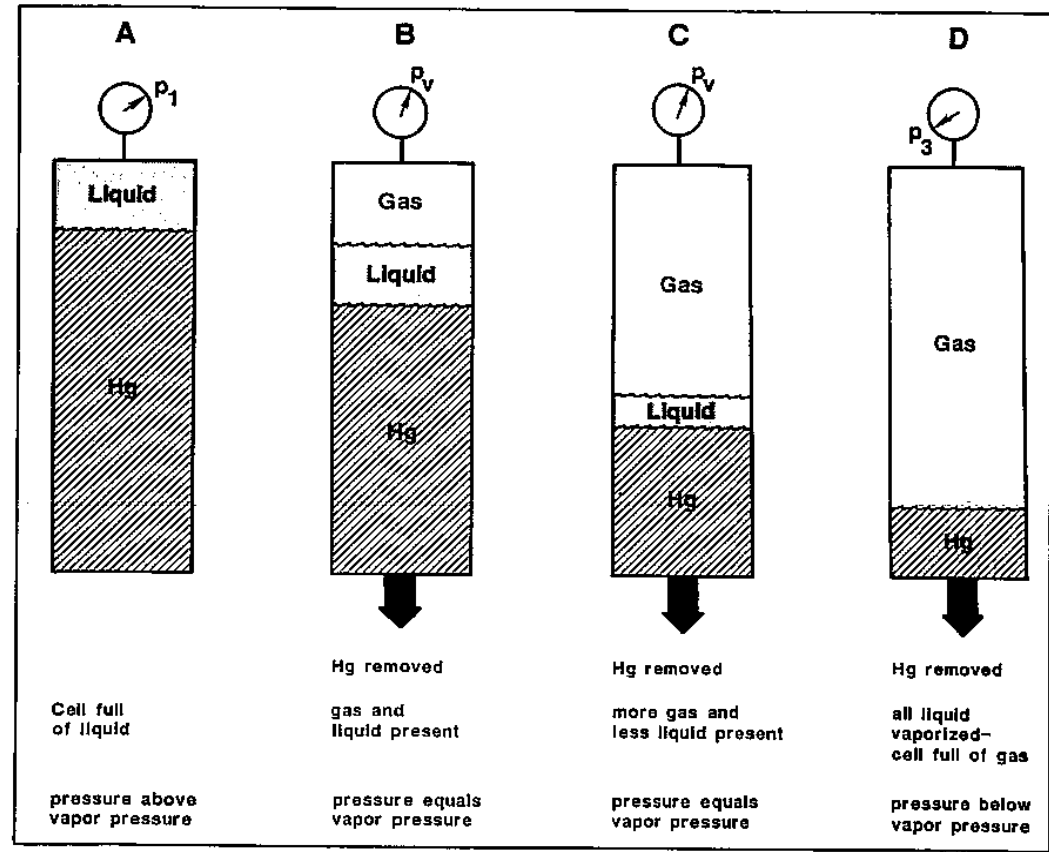
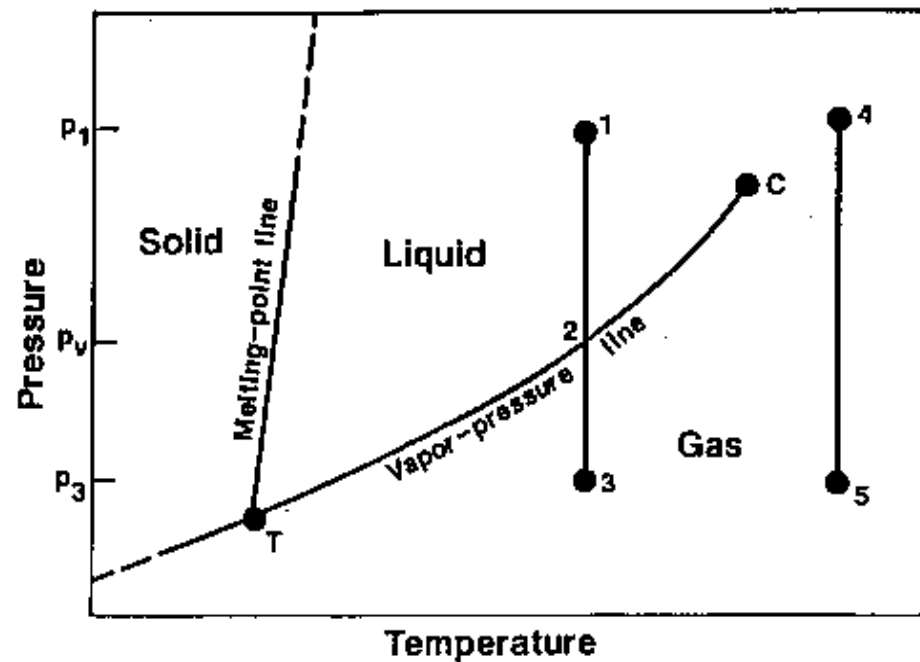
$$P_v = P_L$$

$$T_v = T_L$$



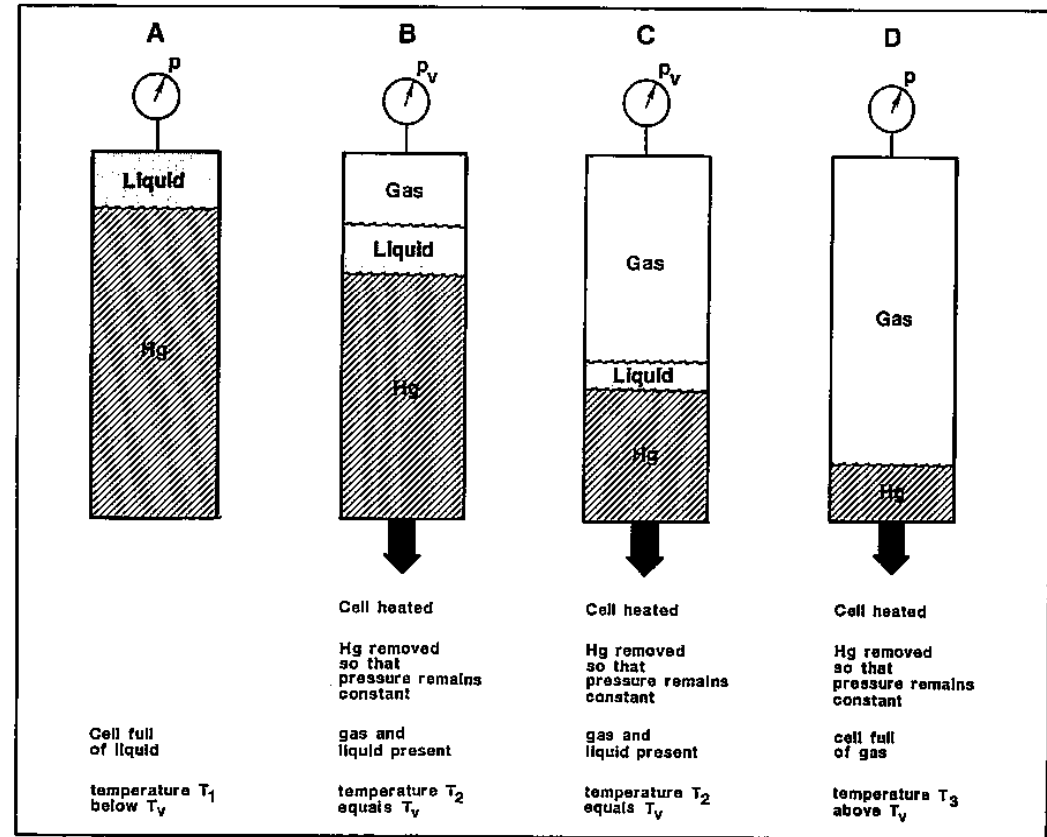
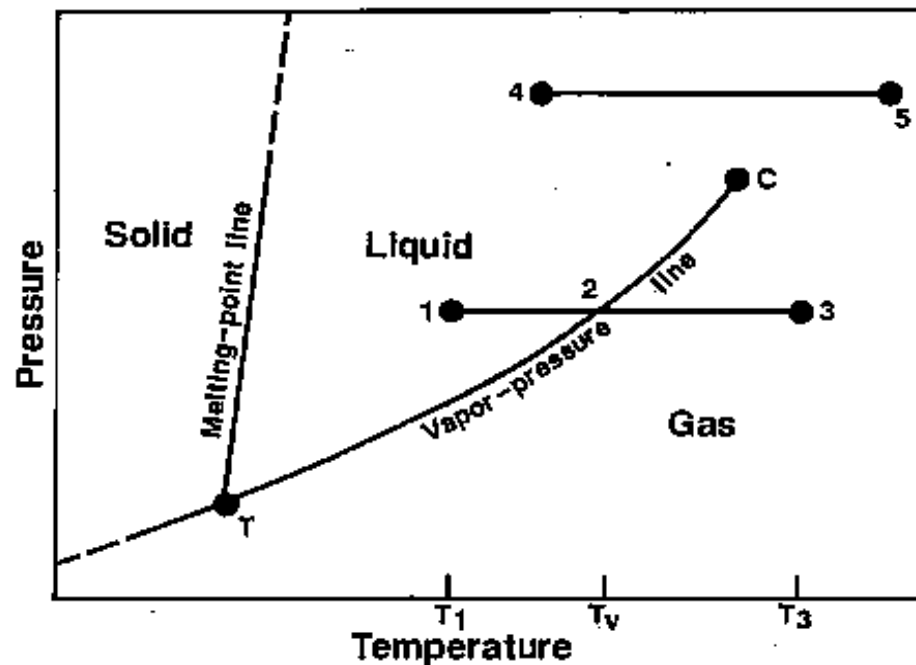
Vapor Pressure of Pure Substances

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

$$P_v V_{Mg} = RT$$

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

Vapor Pressure of a Pure Substance

Clausius - Clapeyron Equation (CCE)

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

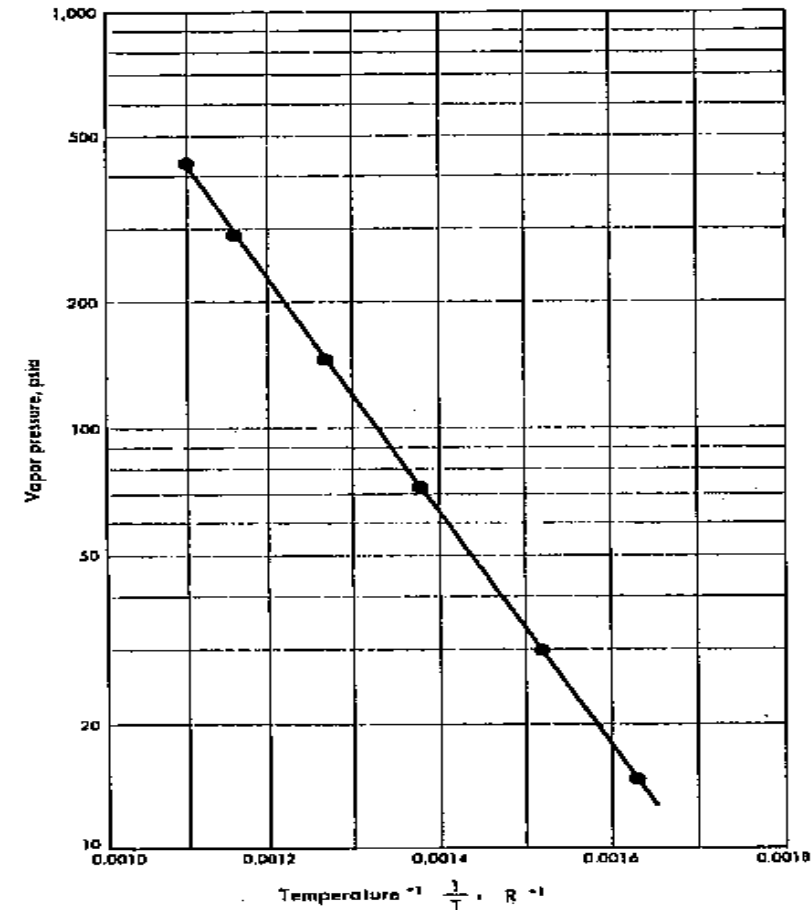
assume that L_v is a constant

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

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

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

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



Vapor Pressure of a Pure Substance

Example:

A substance has a heat of vaporization of 16.69 kJ/mole. At 254.3 K it has a vapor pressure of 92.44 mm Hg. Calculate its vapor pressure at 275.7 °K.

Solution:

$P_{v1} = 92.44 \text{ mm Hg}$: $L_v = 16.69 \text{ kJ/mole}$: $T_1 = 254.3 \text{ °K}$: $T_2 = 275.7 \text{ °K}$: $P_{v2} = ?$

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

$R = 0.00831443 \text{ kJole/mole.K}$ http://en.wikipedia.org/wiki/Gas_constant

$$P_{v2} = 92.44 \cdot \exp \left[\frac{16.69}{0.00831443} \left(\frac{1}{254.3} - \frac{1}{275.7} \right) \right]$$

$$P_{v2} = 170.6 \text{ mm Hg.}$$

Vapor Pressure of a Pure Substance

