جامعة الملك سعود
King Saud University

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Properties of Reservoir Fluids (PGE 362)

Phase Behavior of Liquids

BY
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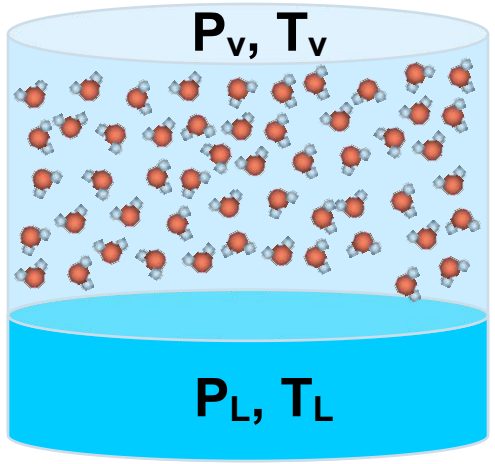
Vapor Pressure of Pure Substance

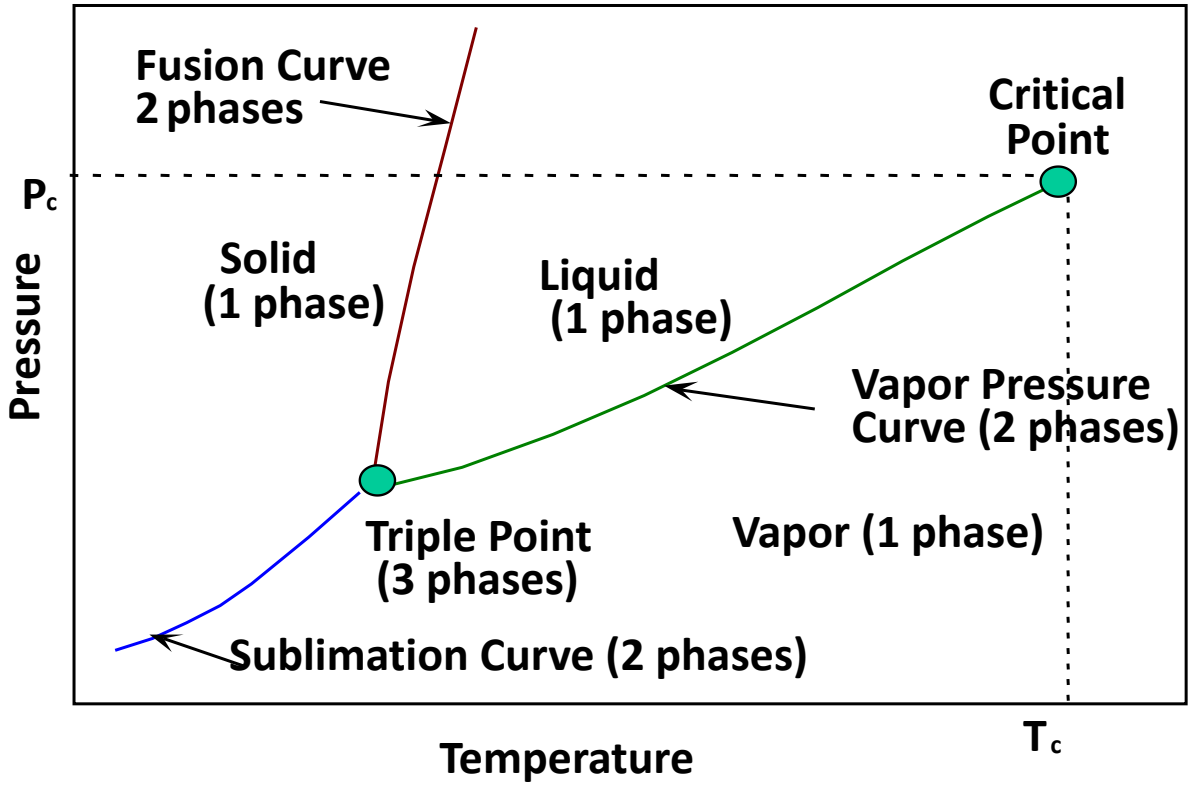
- **Definition**

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



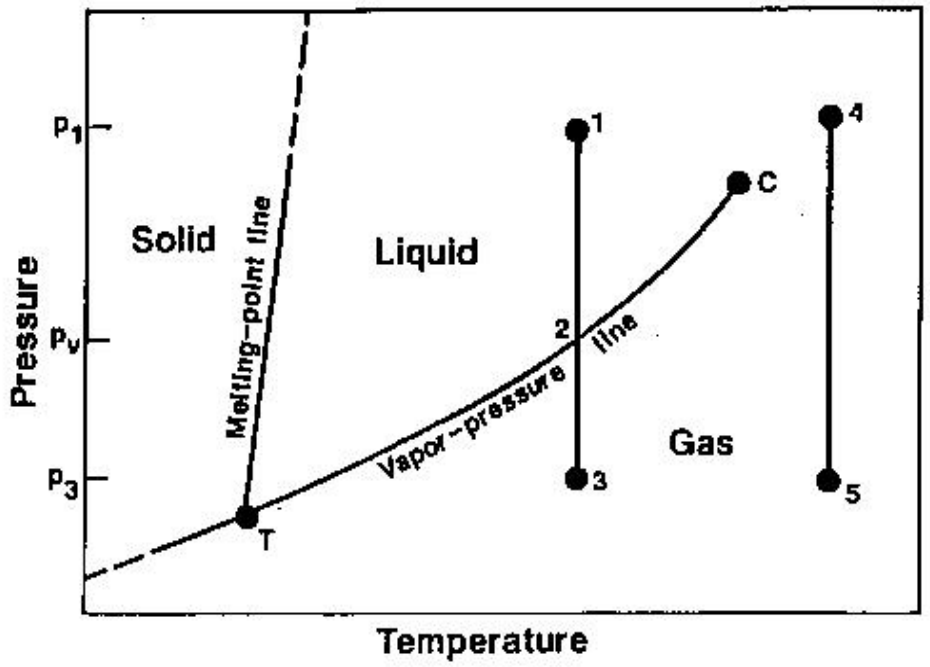
$$P_V = P_L$$

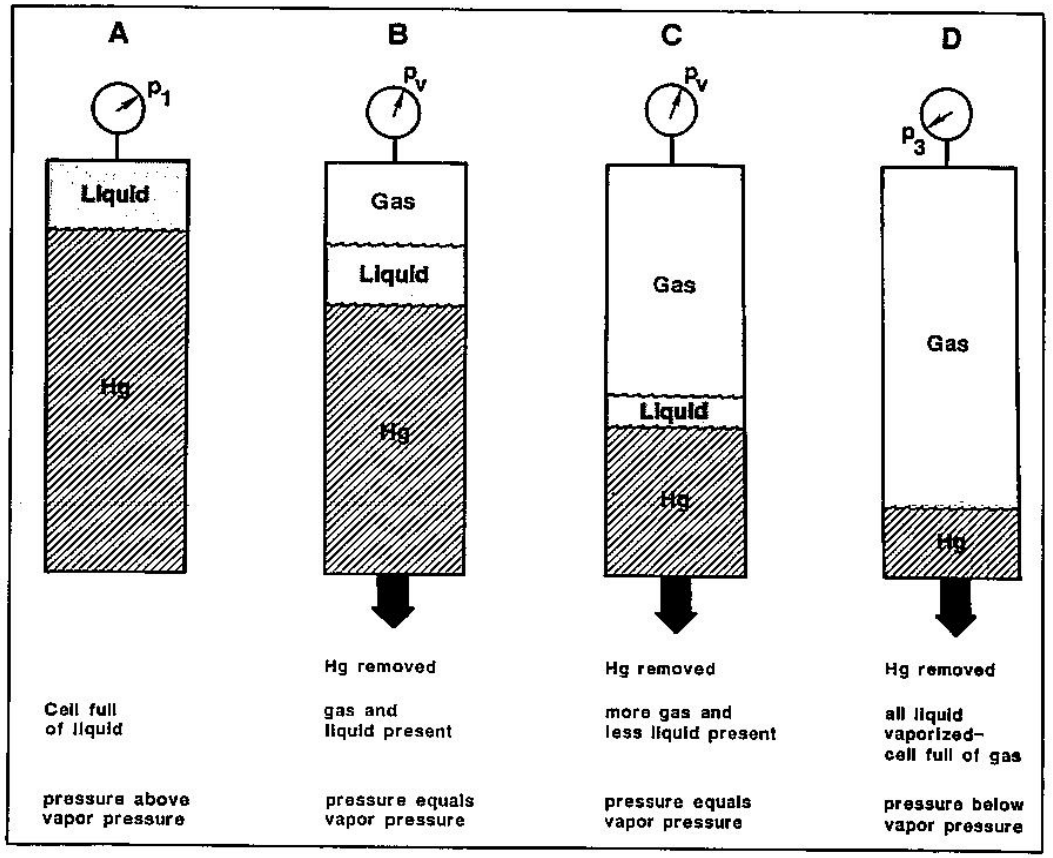
$$T_V = T_L$$



Vapor Pressure of Pure Substances

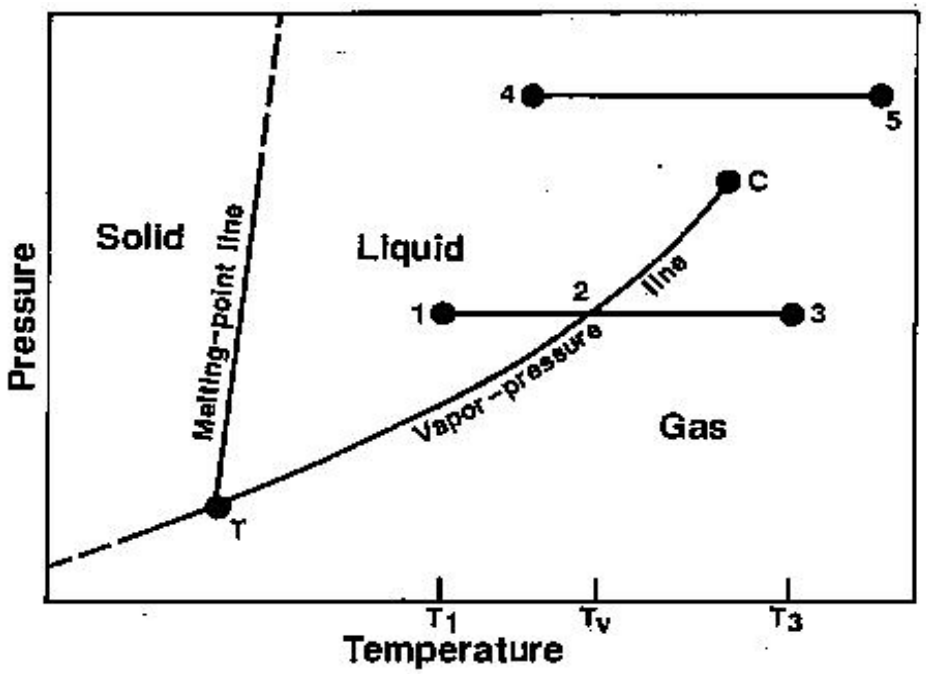
Vaporization of a pure substance at constant temperature.

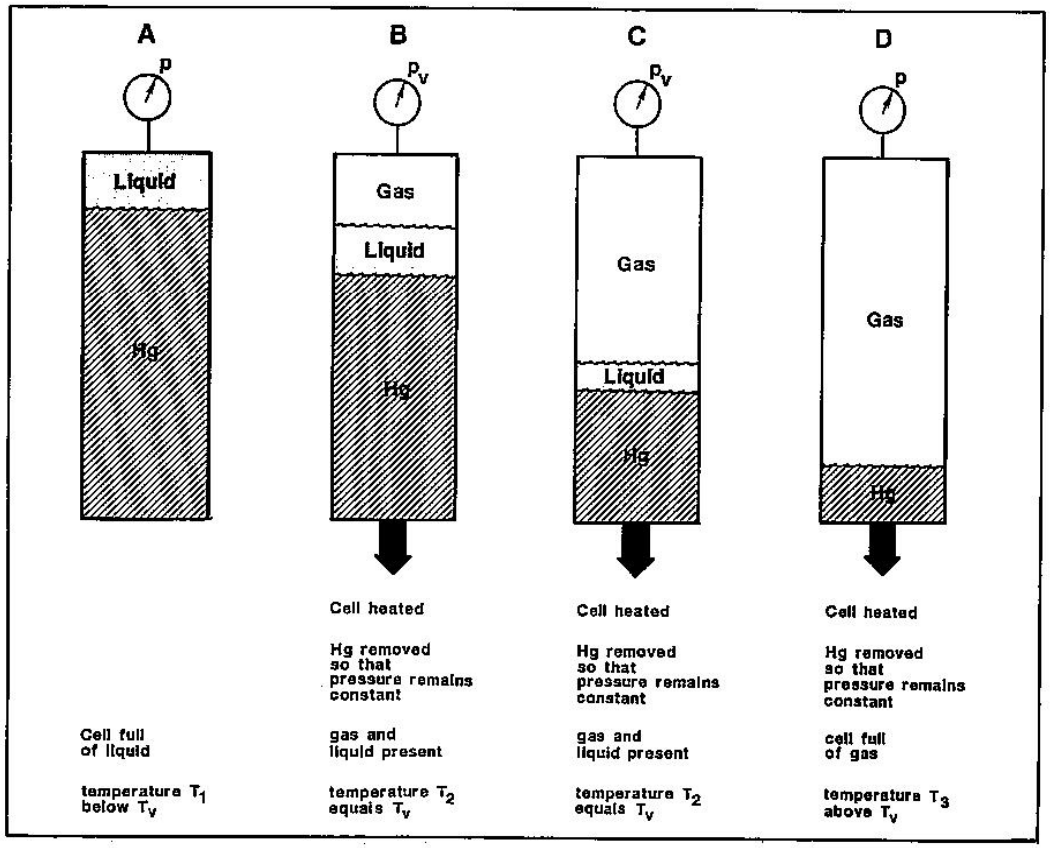




Vapor Pressure of Pure Substances

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

$$P_v V_{Mg} = RT$$

$$\frac{dp_v}{dT} = \frac{P_v L_v}{RT^2}$$ (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)

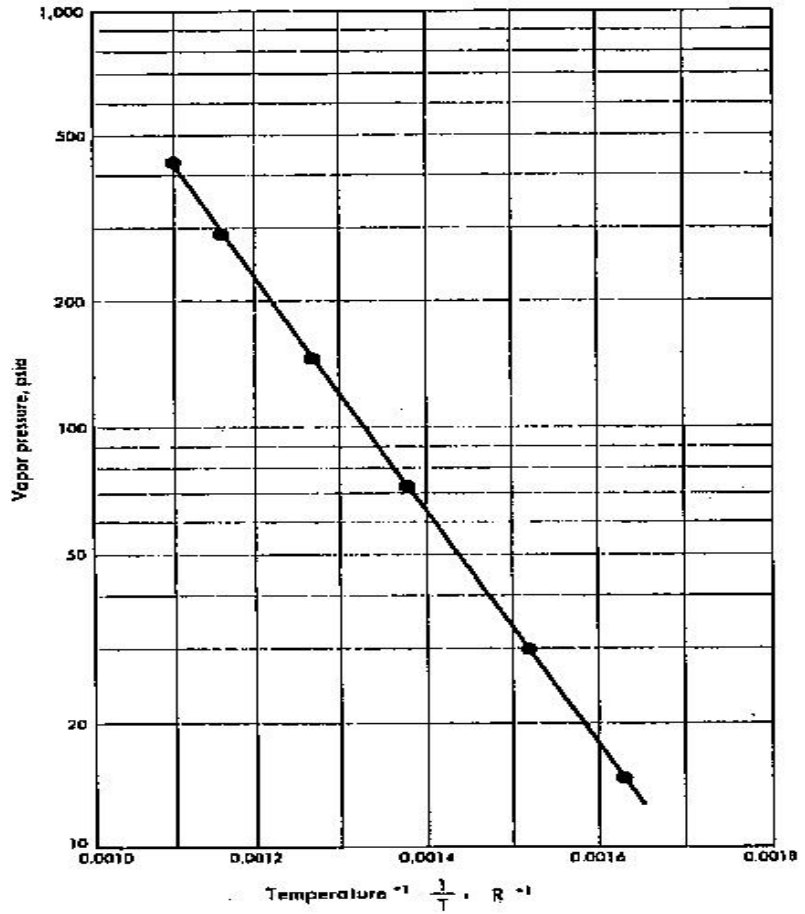
assume that L_v is a constant

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

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

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

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



Vapor Pressure of a Pure Substance

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

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

R = 0.00831443 kJole/mole.K http://en.wikipedia.org/wiki/Gas_constant

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

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

Vapor Pressure of a Pure Substance