

# Production Engineering Laboratory

## Determination of Liquids Vapor Pressure

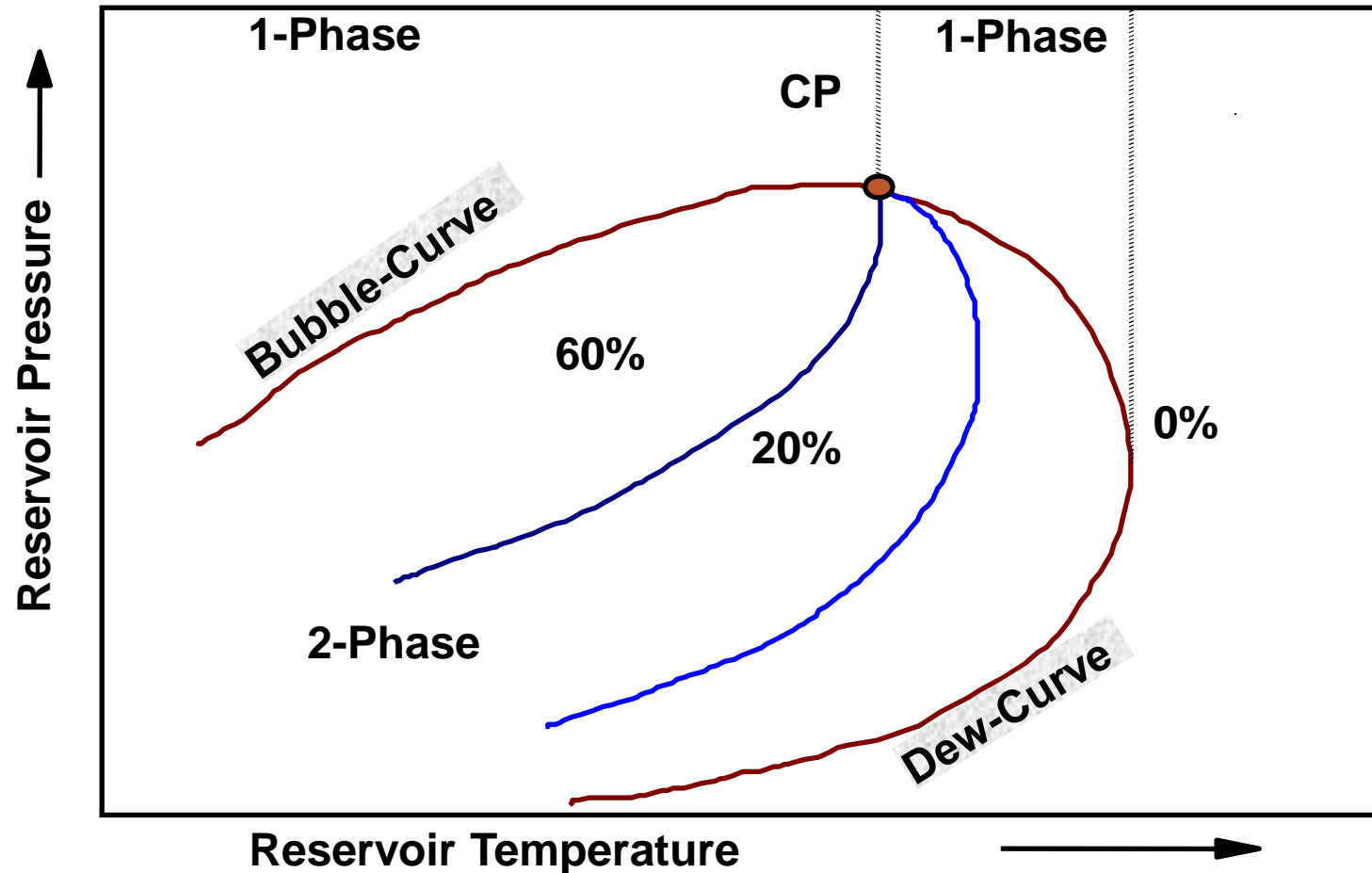
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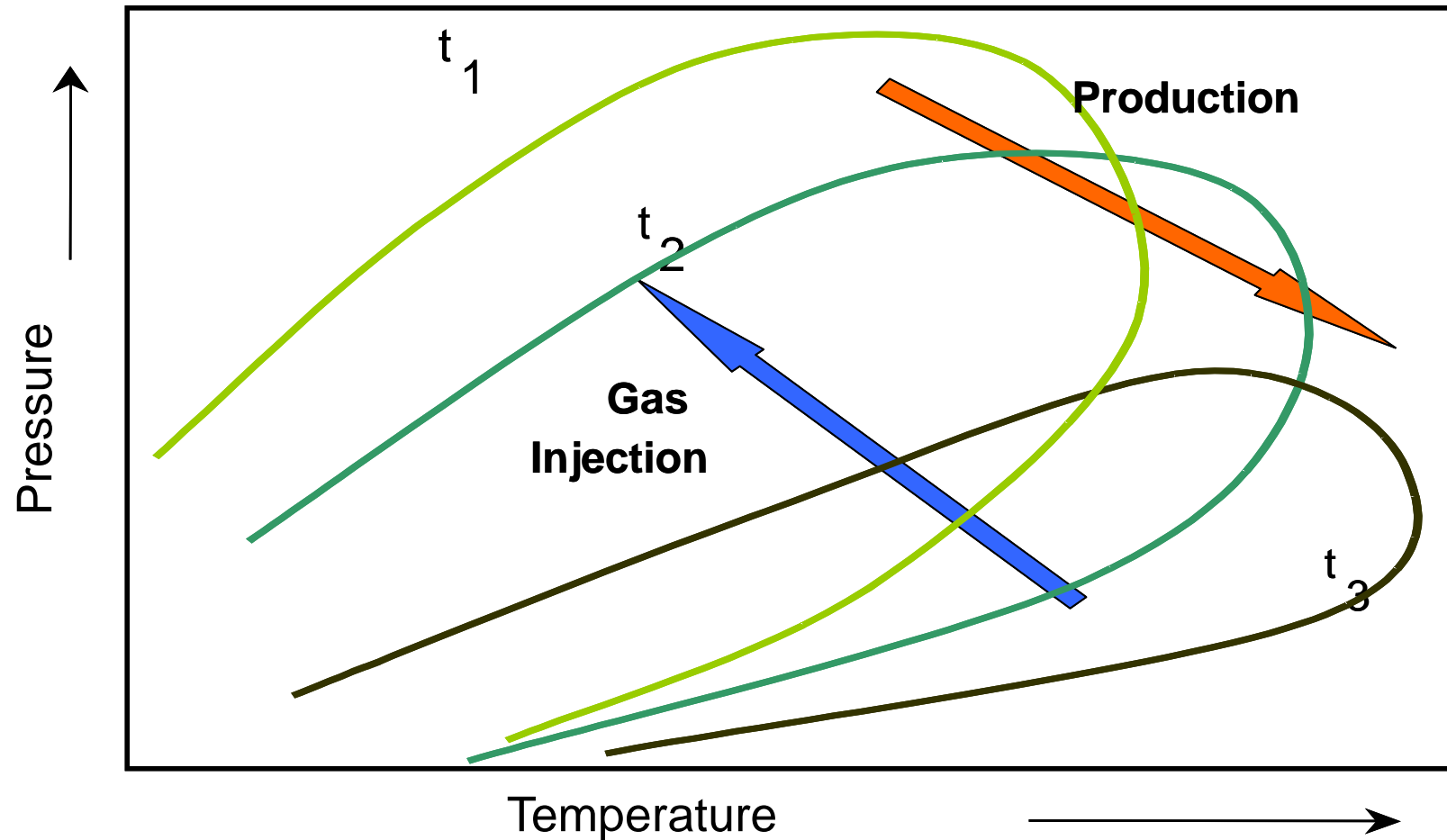
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04-04-2016

# Pressure-Temperature Diagram for Multicomponent Systems



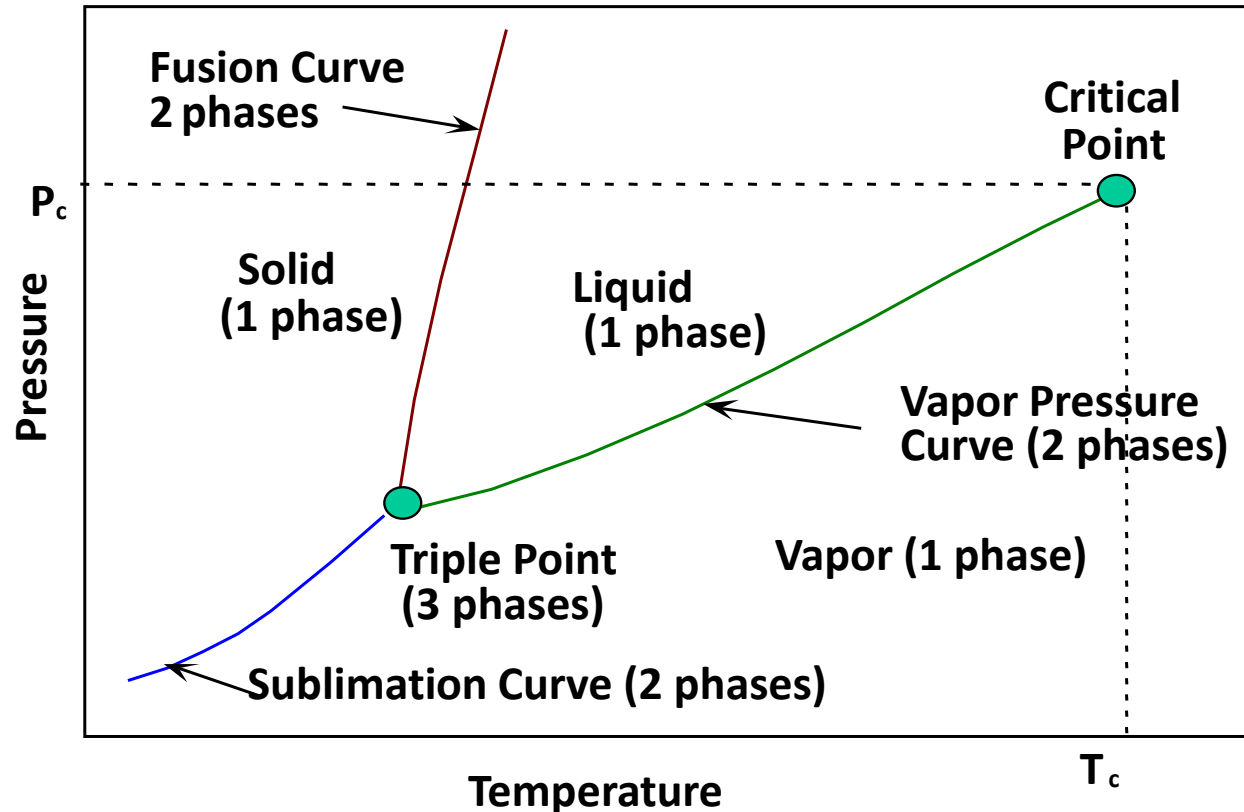
# Importance of Pressure-Temperature Diagram



# Phase Diagram

- **Types of phase diagrams for a single component (pure substance)**

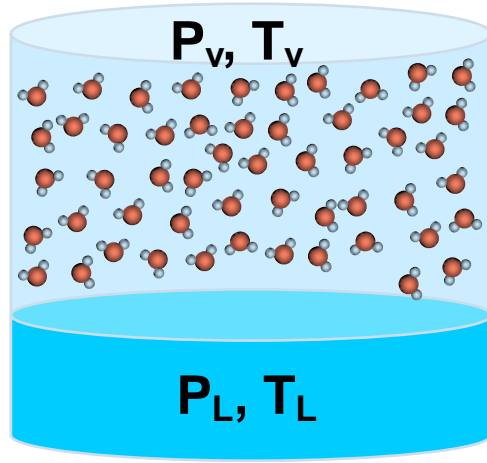
- Pressure-Temperature (PT)
- Pressure-Volume (PV) or ( $P\rho$ )
- Temperature-Volume (TV) or ( $T\rho$ )



# Vapor Pressure of Pure Substance

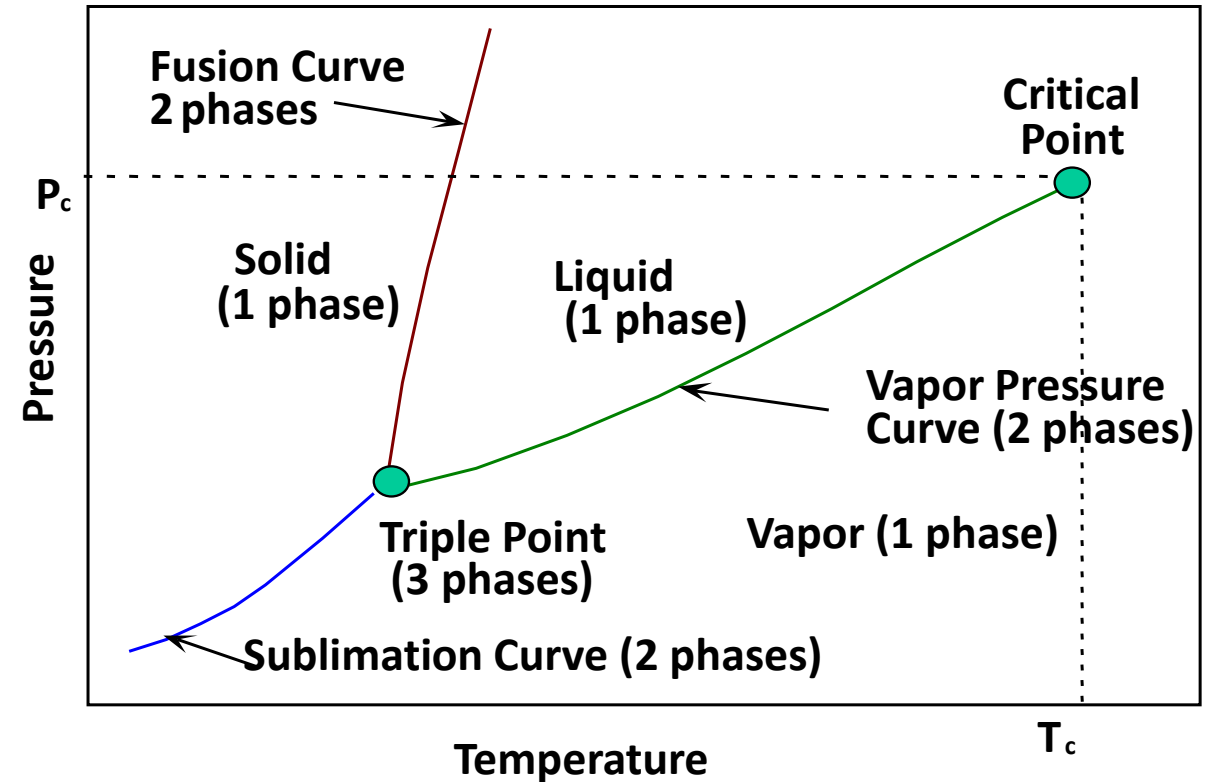
- Definition**

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



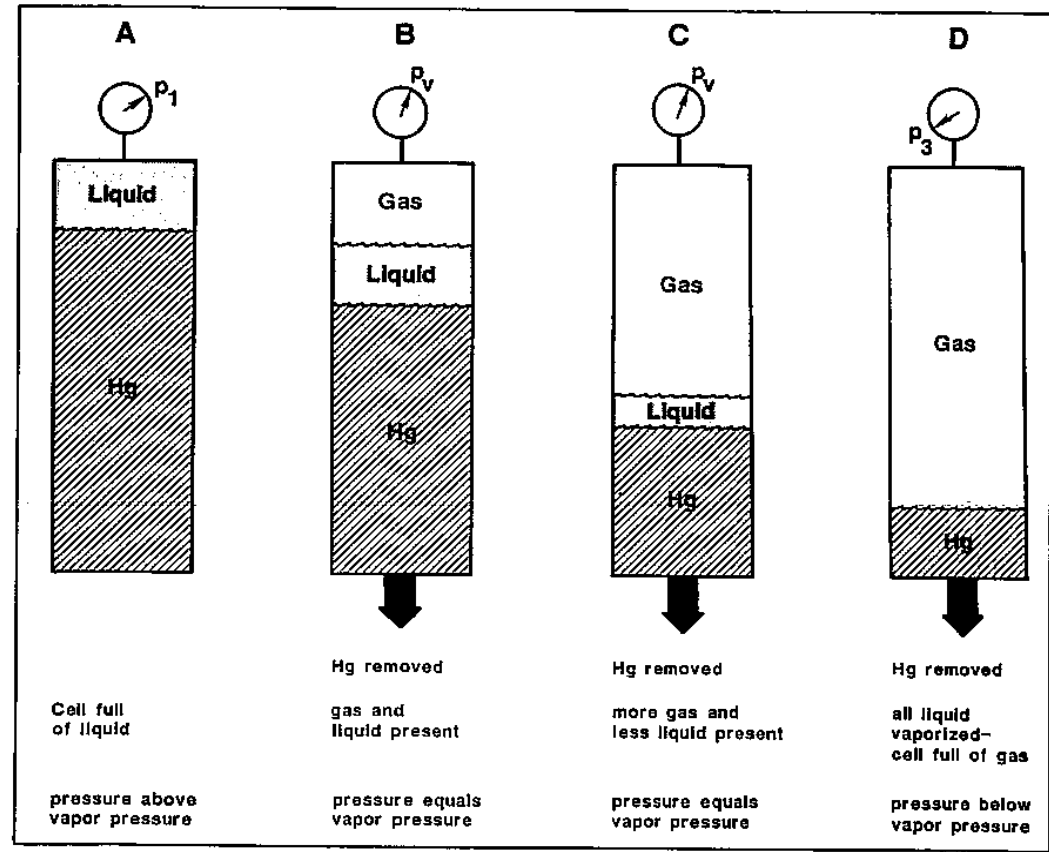
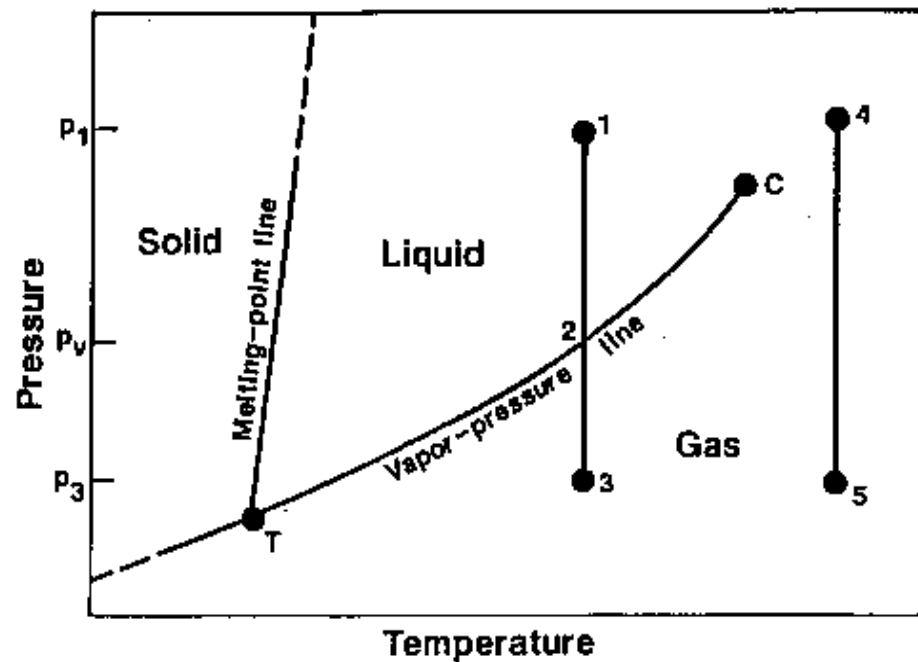
$$P_v = P_L$$

$$T_v = T_L$$



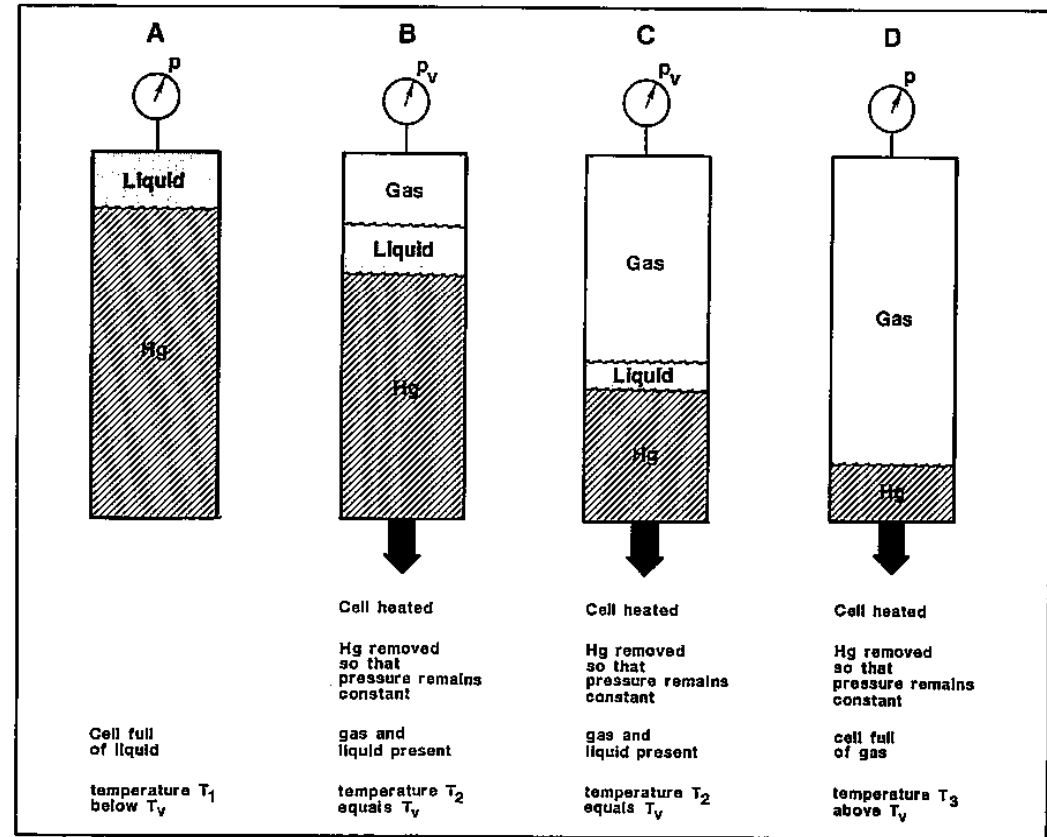
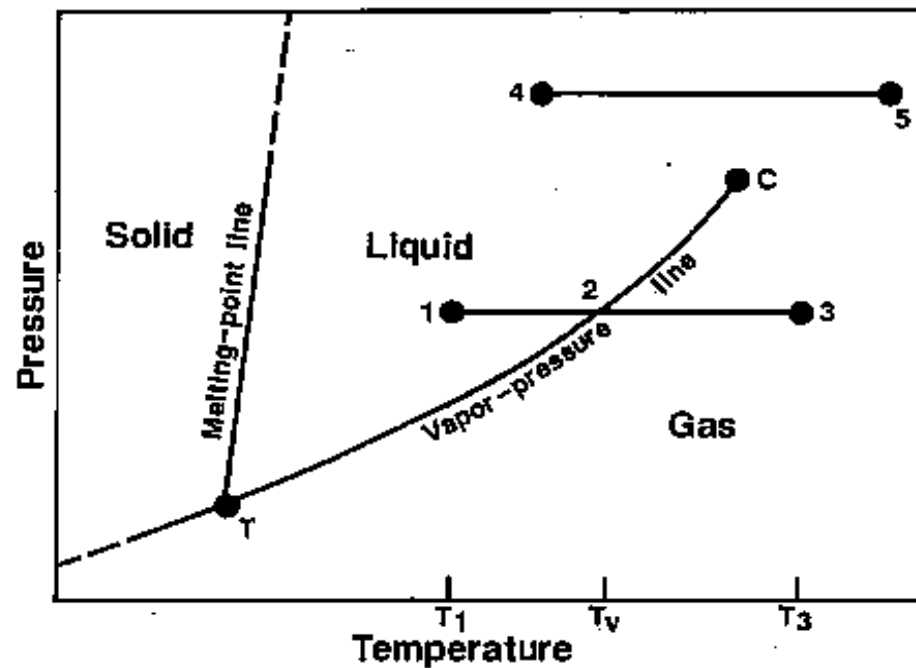
# Vapor Pressure of Pure Substances

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

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## 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)

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

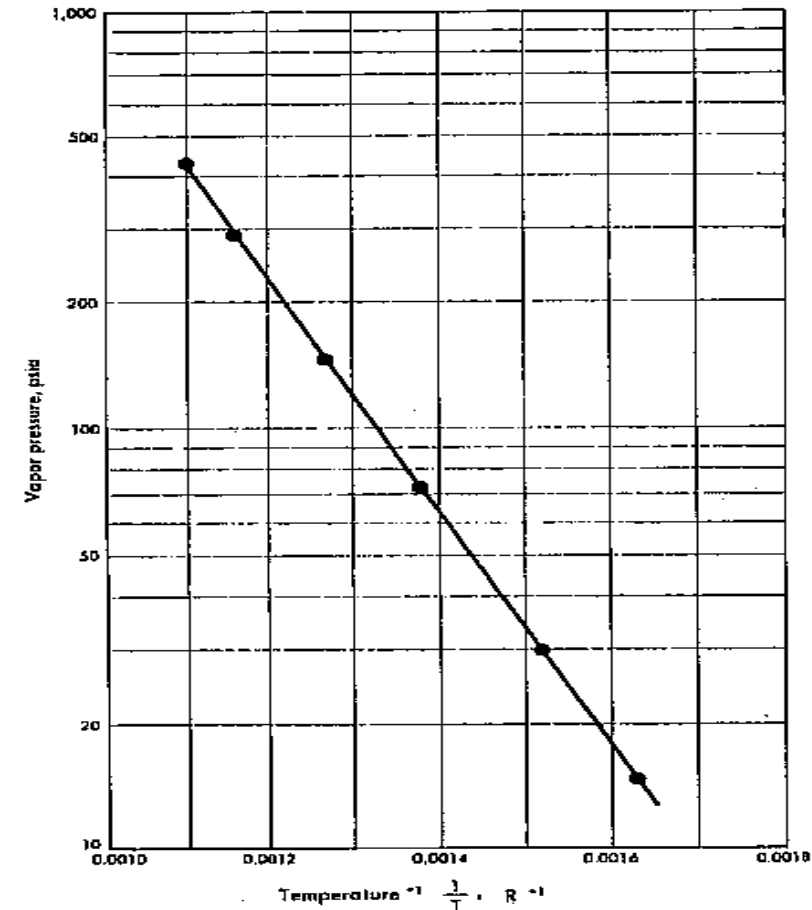
assume that  $L_v$  is a constant

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

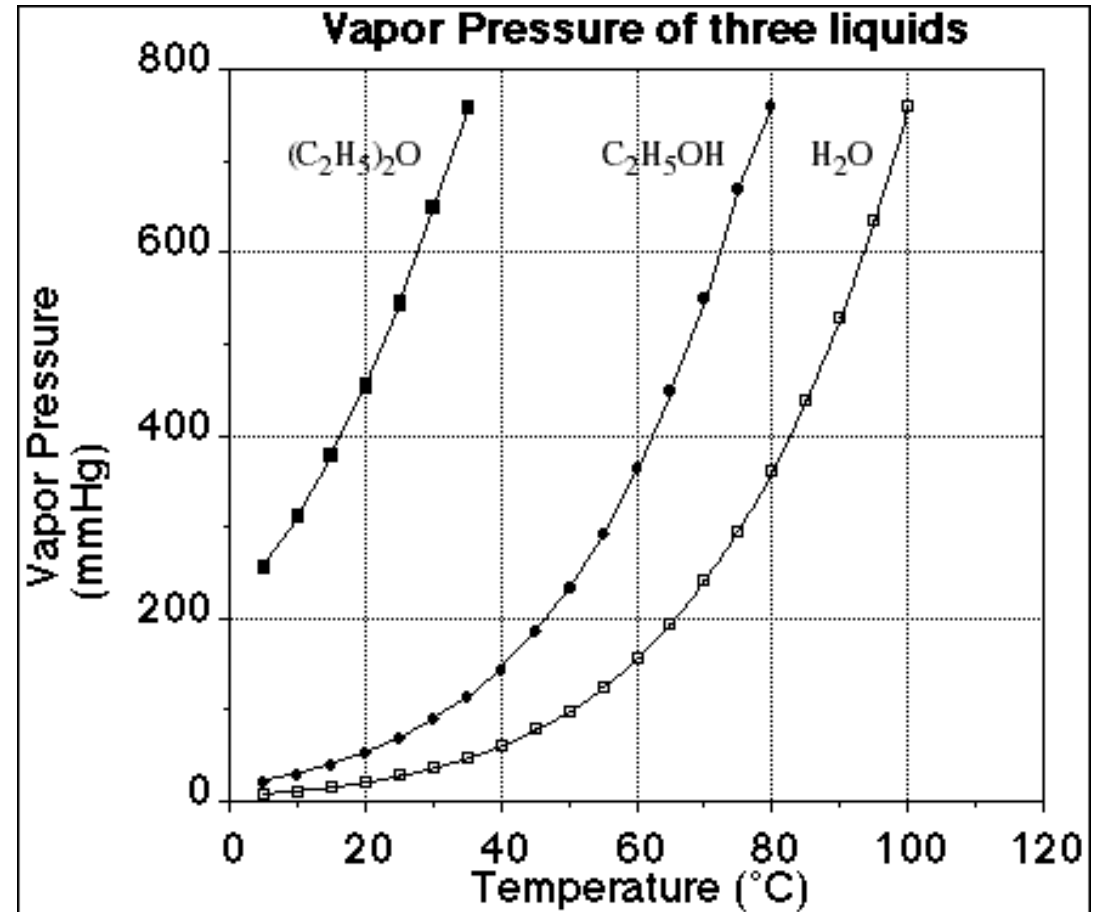
$$\ln P_v = -\frac{L_v}{R} \left( \frac{1}{T} \right) + C$$

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

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



# Vapor Pressure of a Pure Substance



# Phase Diagram

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## 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

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