

Phase Behavior of Liquids

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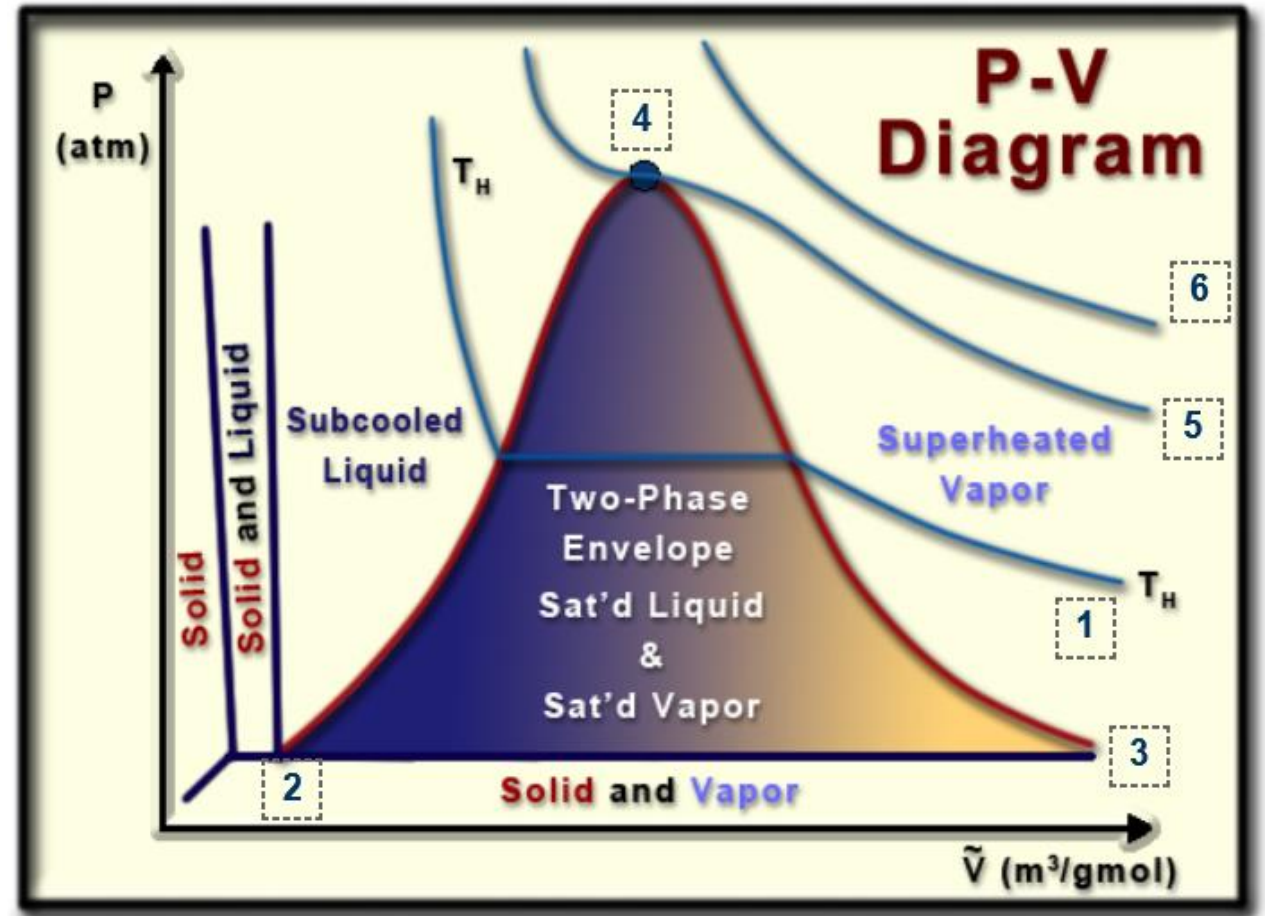
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Pressure-Volume diagram

- **Notes**

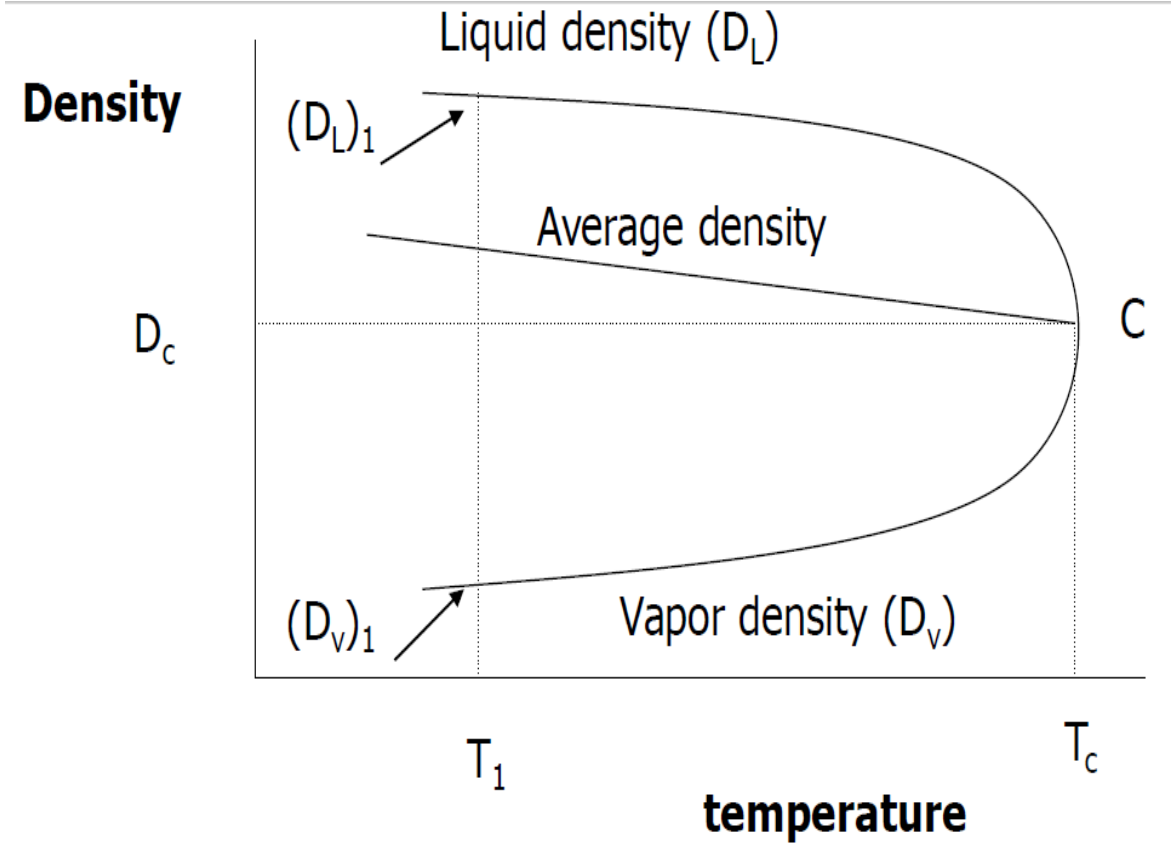
1. Isotherm curve
 - Constant temp. $< T_c$
2. Saturated liquid curve
3. Saturated vapor curve
4. Critical point
 - Saturated liquid and vapor are identical $T = T_c$
5. Critical isotherm curve
 - $T = T_c$
6. Supercritical isotherm curve
 - $T > T_c$



Density-Temperature diagram

Three cases

1. $\rho_{sys} > \rho_L$
2. $\rho_{sys} < \rho_v$
3. $\rho_L > \rho_{sys} > \rho_v$

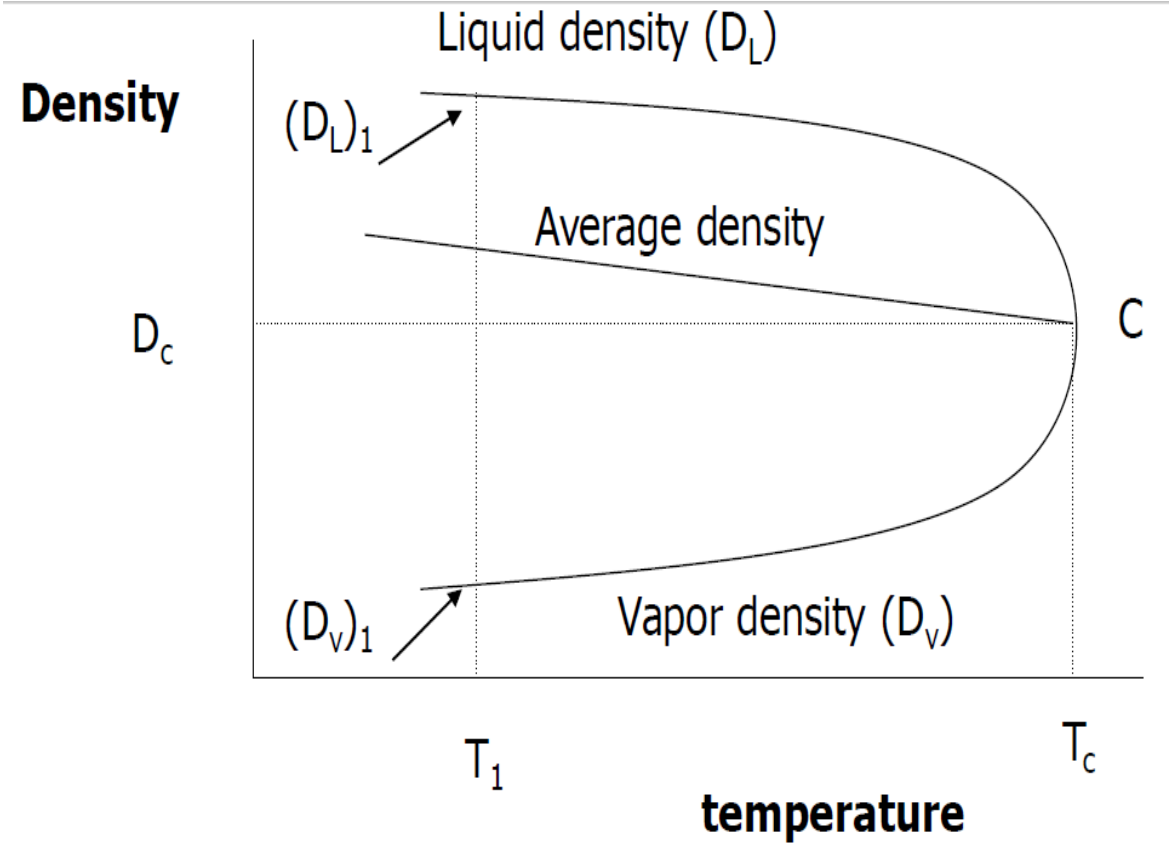


Density-Temperature diagram

Average density

$$\rho_{avg} = \frac{\rho_L + \rho_v}{2} = aT + b$$

$$V_c = \frac{MW}{\rho_c}$$



Density-Temperature diagram

Weight of liquid and vapor

$$V_L + V_v = V_T$$

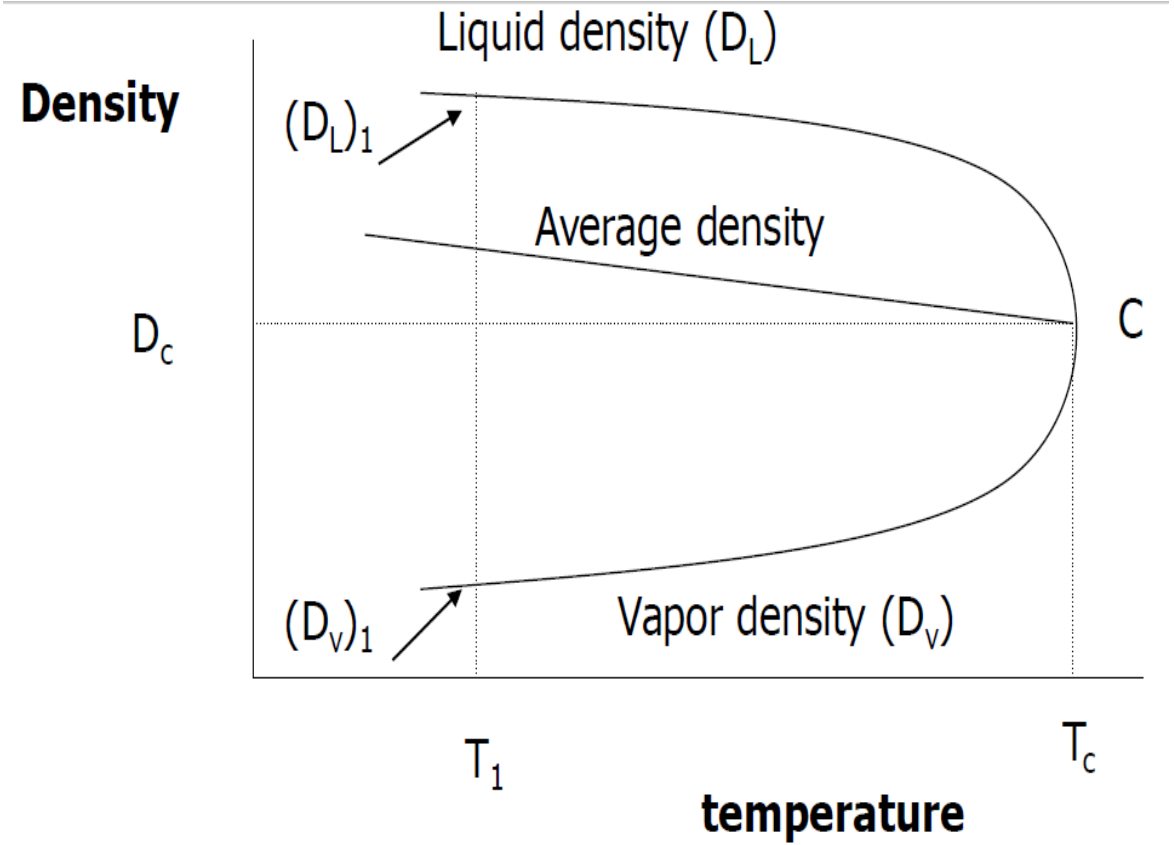
$$W_L + W_v = W_T$$

$$\rho_L = \frac{W_L}{V_L}, \quad V_L = \frac{W_L}{\rho_L}$$

$$\rho_v = \frac{W_v}{V_v}, \quad V_v = \frac{W_v}{\rho_v}$$

$$\frac{W_L}{\rho_L} + \frac{W_v}{\rho_v} = V_T$$

$$\frac{W_T - W_v}{\rho_L} + \frac{W_v}{\rho_v} = V_T$$



Density-Temperature diagram

Example

15 lb of HC is placed in 1 ft³ vessel at 60 °F. The density of the coexisting liquid and vapor is 30 lb/ft³ and 0.06 lb/ft³ respectively.

Determine the weight and volume of the liquid and vapor phase.

Solution

$$\frac{15 - W_v}{30} + \frac{W_v}{0.06} = 1$$

$$W_v = 0.03 \text{ lb}, \quad W_L = 15 - 0.03 = 14.97 \text{ lb}$$

$$V_v = \frac{W_v}{\rho_v} = \frac{0.03}{0.06} = 0.5 \text{ ft}^3$$

$$V_L = 1 - V_v = 1 - 0.5 = 0.5 \text{ ft}^3$$

