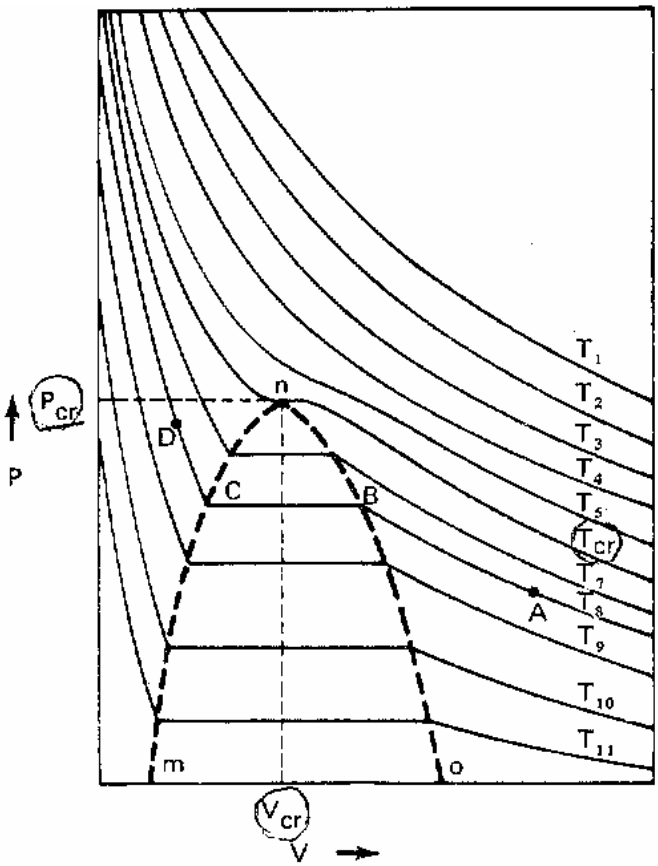
Equation of State

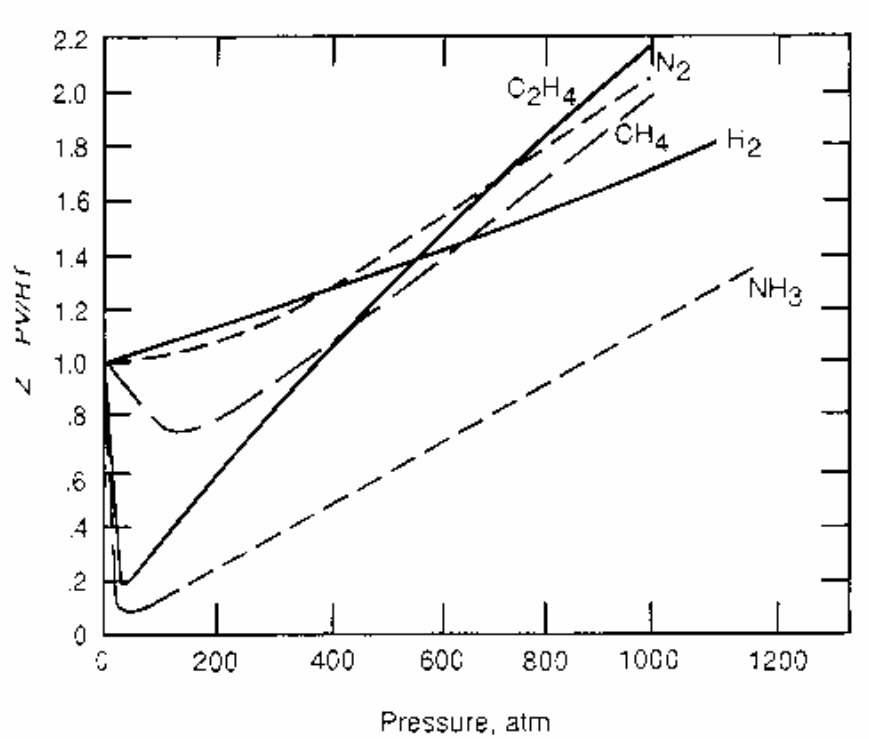
▷ $\frac{PV}{RT} \rightarrow 1$ as $p \rightarrow 0$

▷ Critical Point

$$\left(\frac{\partial P}{\partial V}\right)_{T_{cr}} = 0 \quad \text{and} \quad \left(\frac{\partial^2 P}{\partial V^2}\right)_{T_{cr}} = 0$$



▷ Real Gases



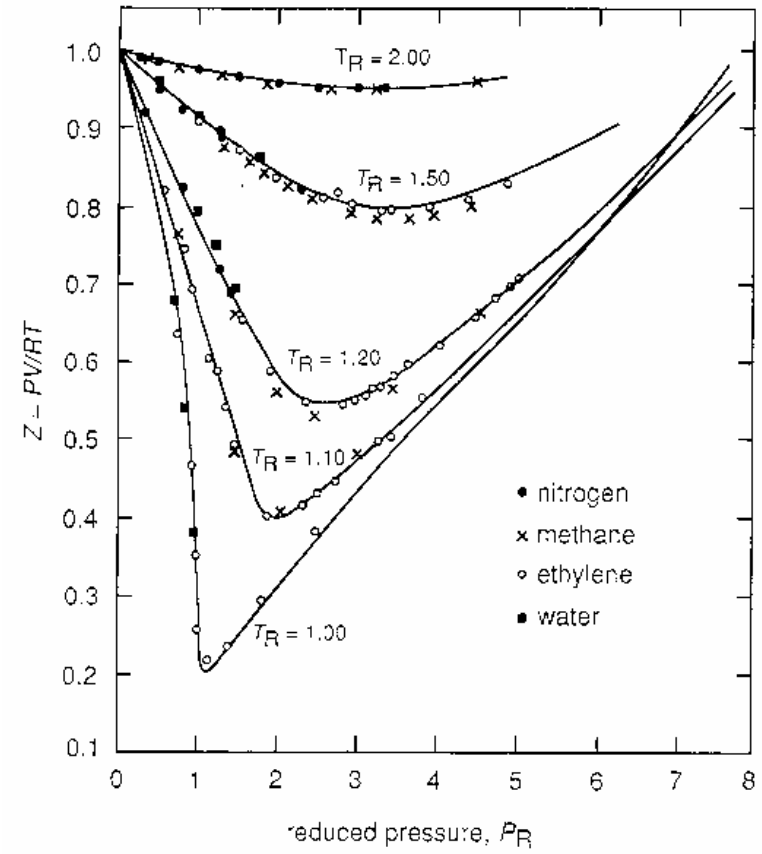
$$Z = \frac{PV}{RT} = 1 + mP$$

$$P(V - mRT) = RT$$

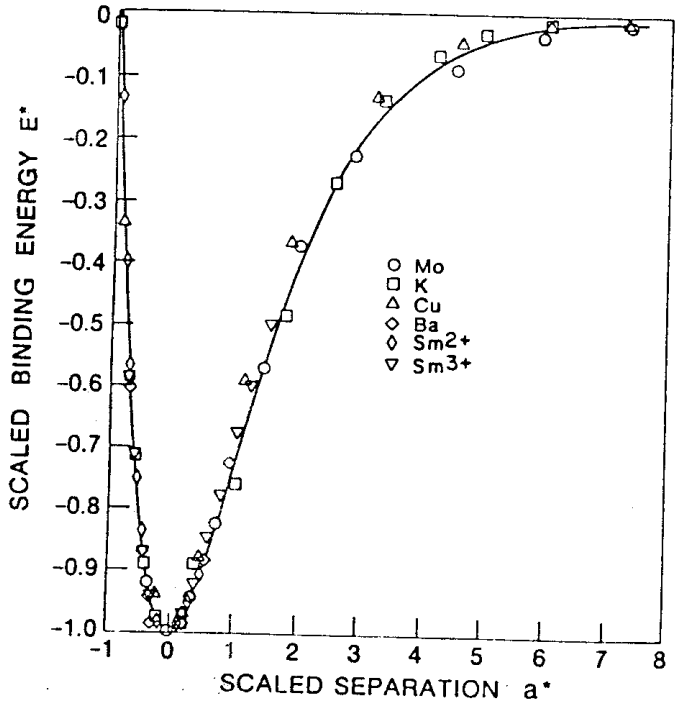
$$\leftrightarrow$$

$$P(V - b') = RT$$

▷ Law of Corresponding States



▷ Universal Equation of States for Pure Substances



$$E^u(r) = -E_c(1+a^*)e^{-a^*}$$

$$a^* = \alpha(r/r_e - 1)$$

$$\alpha = \left(\frac{9B\Omega}{E_c}\right)^{1/2}$$

▷ The Van Der Waals Gas

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

$$PV^3-(Pb+RT)\ V^2+aV-ab=0$$

$$P_{Cr}=\frac{RT_{Cr}}{(V_{Cr}-b)}-\frac{a}{V_{Cr}^2}$$

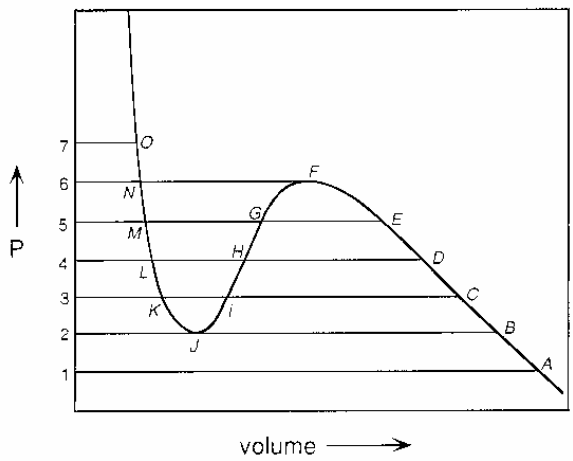
$$\left(\frac{\partial P}{\partial V}\right)_{T_{Cr}}=\frac{-RT_{Cr}}{(V_{Cr}-b)^2}+\frac{2a}{V_{Cr}^3}=0$$

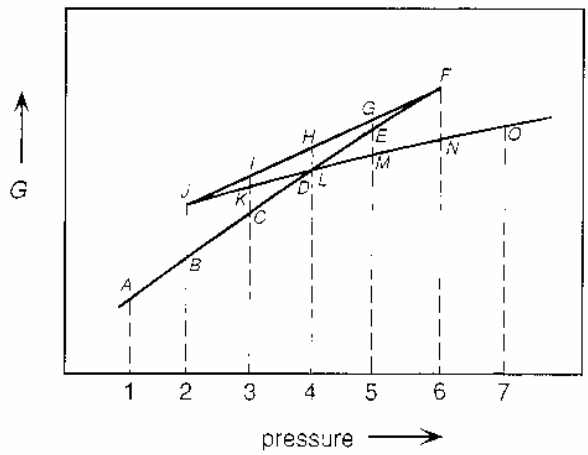
$$\left(\frac{\partial^2 P}{\partial V^2}\right)_{T_{Cr}}=\frac{2RT_{Cr}}{(V_{Cr}-b)^3}-\frac{6a}{V_{Cr}^4}=0$$

$$T_{Cr}=\frac{8a}{27bR}\quad,\qquad V_{Cr}=3b\quad,\qquad P_{Cr}=\frac{a}{27b^2}$$

※ Prove that the Van Der Waals gases follow the law of corresponding states

※ ΔH_{evap} for a van der Waals gas





※ Virial Equation

$$\frac{PV}{RT}=1+BP+CP^2+\cdots$$