Equation of state for non ideal gases

Virial Equation of state

$$\frac{P\hat{V}}{RT} = 1 + \frac{B}{\hat{V}} + \frac{C}{\hat{V}^2} + \frac{D}{\hat{V}^3} + \cdots$$

B, C, D are f(t)

2nd, 3rd, 4th Virial Coefficient

$$B = \frac{RT_c}{P_c}(B_0 + \omega B_1)$$

ω: Pitzer acentric factor

Table (5.3-1)

$$B_0 = 0.083 - \frac{0.422}{T_r^{1.6}}$$

$$B_1 = 0.139 - \frac{0.172}{T_r^{4.2}}$$

$$T_r = \frac{T}{T_c}$$

T_c: Critical Temp.

Table B'L

Cubic Equation of state

Van der Waals E.O.S

$$P = \frac{RT}{\hat{V}-b} - \frac{a}{\hat{V}^2}$$

$$a = \frac{27}{64}\frac{R^2T_c^2}{P_c}$$

$$b = \frac{1}{8}\frac{RT_c}{P_c}$$

Abussaud

Soave-Redlich-Kwong E.O.S (SRK)

$$P = \frac{RT}{\hat{V}-b} - \frac{\alpha a}{\hat{V}(\hat{V}+b)}$$

$$a = 0.42747\frac{R^2T_c^2}{P_c}$$

$$b = 0.08664\frac{RT_c}{P_c}$$

$$\alpha = \left[1 + m\left(1 - \sqrt{T_r}\right)\right]^2$$

$$m = 0.48508 + 1.55171\omega - 0.1561\omega^2$$

$$T_r = \frac{T}{T_c}$$

Compressibility Factor E.O.S

$$P\hat{V} = ZRT$$

1- Look up T_c & P_c of the species

Note: For H_2 & He

$$T_c^a = T_c + 8K$$

$$P_c^a = P_c + 8atm$$

2- Calculate T_r & P_r

3- Look up the value of Z using the appropriate Z chart 5.4-1 – 5.4-4

* If P or T is not given $\hat{V}$ should be given

Then

$$V_r^{ideal} = \frac{\hat{V}}{\hat{V}_c^{ideal}}$$

$$V_r^{ideal} = \frac{P_c\hat{V}}{RT_c}$$

Find the intersection of V_r^{ideal} with T_r and locate Z