

- Generic cubic equation of state:

$$Z = 1 + \beta - q\beta \frac{Z - \beta}{(Z + \epsilon\beta)(Z + \sigma\beta)} \quad (\text{vapour and vapour-like roots})$$

$$Z = 1 + \beta + (Z + \epsilon\beta)(Z + \sigma\beta) \left(\frac{1 + \beta - Z}{q\beta} \right) \quad (\text{liquid and liquid-like roots})$$

$$\text{with } \beta = \Omega \frac{P_r}{T_r} \quad \text{and} \quad q = \frac{\Psi \alpha(T_r)}{\Omega T_r}$$

$$\alpha_{\text{SRK}} = \left[1 + (0.480 + 1.574\omega - 0.176\omega^2) (1 - \sqrt{T_r}) \right]^2$$

$$\alpha_{\text{PR}} = \left[1 + (0.37464 + 1.54226\omega - 0.26992\omega^2) (1 - \sqrt{T_r}) \right]^2$$

EOS	α	σ	ϵ	Ω	Ψ
vdW	1	0	0	1/8	27/64
RK	$T_r^{-1/2}$	1	0	0.08664	0.42748
SRK	α_{SRK}	1	0	0.08664	0.42748
PR	α_{PR}	$1 + \sqrt{2}$	$1 - \sqrt{2}$	0.07780	0.45724

- Newton-Raphson (root-finder) method: $X_i = X_{i-1} - \frac{\mathcal{F}(X_{i-1})}{d\mathcal{F}/dX(X_{i-1})}$

- Fundamental thermodynamic equations:

$$dU = dQ + dW; \quad dH = dU + d(PV); \quad dA = dU - d(TS); \quad dG = dH - d(TS)$$

$$dU = TdS - PdV; \quad dH = TdS + VdP; \quad dA = -SdT - PdV; \quad dG = -SdT + VdP$$

$$dH = C_p dT + \left[V - T \left(\frac{\partial V}{\partial T} \right)_P \right] dP; \quad dS = C_p \frac{dT}{T} - \left(\frac{\partial V}{\partial T} \right)_P dP$$

$$dU = C_v dT + \left[T \left(\frac{\partial P}{\partial T} \right)_V - P \right] dV; \quad dS = C_v \frac{dT}{T} - \left(\frac{\partial P}{\partial T} \right)_V dV$$

- Polytropic Relations:

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2} \right)^{\gamma-1}; \quad TV^{\gamma-1} = \text{const}; \quad TP^{\frac{1-\gamma}{\gamma}} = \text{const}; \quad PV^\gamma = \text{const}$$

- Raoult's Law:

$$y_i P = x_i P_i^{\text{sat}} \quad \text{and} \quad y_i P = x_i \gamma_i P_i^{\text{sat}} \quad \text{with } i = 1, 2, \dots, N$$

- Henry's Law:

$$x_i \mathcal{H}_i = y_i P \quad \text{with } i = 1, 2, \dots, N$$

- Antoine Equation:

$$\log_{10} P^* = A - \frac{B}{T + C} \quad \text{with } P^* \text{ in mm-Hg and } T \text{ in } ^\circ\text{C}$$

- Solutions:

$$M^E = M - \sum_{i=1}^N x_i M_i; \quad \overline{M}_1 = M + x_2 \frac{dM}{dx_1}; \quad \overline{M}_2 = M - x_1 \frac{dM}{dx_1}$$