Formula Sheet

Vapor-Liquid Equilibrium:

$$P = P_A^0 x + P_B^0 (1-x)$$

$$y^* = \frac{P_A^0 x}{P}$$

$$\alpha = \frac{P_A^0}{P_B^0} = \frac{y^*(1-x)}{x(1-y^*)}$$

Flash Unit: Split Fraction:

$$\xi_k = \frac{\alpha_{k/n}\xi_n}{1 + (\alpha_{k/n} - 1)\xi_n}$$

Simplified bubble-point equation: $\frac{P_k^0}{P} = \frac{\alpha_{k/n}}{\bar{\alpha}}$

Simplified dew-point equation: $\sum_{i=1}^{n} \frac{y_i}{\alpha_{i/n}} = \frac{P_n^0}{P}$

Vapor Fraction and Split Fraction:

$$\xi_n = \frac{1}{\frac{1}{K_n \phi} - \frac{1}{K_n} + 1}$$

Distillation:

Fenske Equation

$$N = \frac{ln\left[\frac{(\xi_{lk}(1-\xi_{hk}))}{(\xi_{hk}(1-\xi_{lk}))}\right]}{ln(\alpha_{lk/hk})}$$

Split fractions:

$$\xi_k = \frac{\alpha_k^N \xi_{hk}}{1 + (\alpha_k^N - 1)\xi_{hk}}$$

$N_i = \frac{12.3}{(\alpha_{lk/hk} - 1)^{2/3}(1-\beta_i)^{1/6}} \qquad i = lk, hk \qquad R_i = \frac{1.38}{(\alpha_{lk/hk} - 1)^{0.9}(1-\beta_i)^{0.1}} \qquad i = lk, hk$

$N_T = 0.8max(N_i) + 0.2min(N_i) \qquad R = 0.8max(R_i) + 0.2min(R_i)$

Absorption:

$$A_E = \frac{L_0}{V_{N+1} K_n}$$

$$N = \frac{ln\left\{\frac{l_0^n + (r - A_E)v_{N+1}^n}{l_0^n - A_E(1-r)v_{N+1}^n}\right\}}{ln\{A_E\}}$$

$$\begin{aligned} \beta_N^k &= \frac{\left[1 - (A^k)^{N+1}\right]}{1 - A^k} \\ \beta_{N-1}^k &= \frac{\left[1 - (A^k)^N\right]}{1 - A^k} \end{aligned}$$

$$\begin{aligned} v_1^k &= \frac{v_{N+1}^k}{\beta_N^k} + \frac{\beta_{N-1}^k}{\beta_N^k} l_0^k \\ l_N^k &= \left(1 - \frac{\beta_{N-1}^k}{\beta_N^k}\right) l_0^k + \left(1 - \frac{1}{\beta_N^k}\right) v_{N+1}^k \end{aligned}$$

Energy Balance:

Enthalpy of Vapor Stream:

$$\Delta H_v = \Delta H_f + \Delta H_T$$

$$\Delta H_f = \sum y_k H_{f,k}(T_0)$$

$$\Delta H_T = \sum y_k \int_{T_0}^{T} c^0_{p,k} dT$$

Enthalpy of Liquid Stream:

$$\Delta H_{L,k}(T) = \Delta H^0_{f,k} + \int_{T_0}^{T} c^0_{p,k}(T) dT - \Delta H^k_{vap}$$

where

$$\Delta H^k_{vap}(T) = \Delta H^k_{vap}(T_b) \left[\frac{(T^k_c - T)}{(T^k_c - T_b)} \right]^{0.38}$$