Membranes

$\theta = \frac{V_p}{L_f}$

$\alpha^* = \frac{P'_A}{P'_B}$

$\frac{y_p}{1-y_p} = \frac{\alpha^*\left[x_0 - \left(\frac{P_l}{P_h}\right)y_p\right]}{(1-x_0)-\left(\frac{P_l}{P_h}\right)(1-y_p)}$

Case 1:

$r = \frac{P_l}{P_h}$

$a = 1 - \alpha^*$

$b = -1 + \alpha^* + \frac{1}{r} + \frac{x_0}{r}(\alpha^* - 1)$

$c = \frac{-\alpha^* x_0}{r}$

$y_p = \frac{-b+\sqrt{b^2-4ac}}{2a}$

Case 2:

$y_p = \frac{-b_1+\sqrt{b_1^2-4a_1c_1}}{2a_1}$

$a_1 = \theta + \frac{P_l}{P_h} - \frac{P_l}{P_h}\theta - \alpha^*\theta - \alpha^*\frac{P_l}{P_h} + \alpha^*\frac{P_l}{P_h}\theta$

$b_1 = 1-\theta-x_f-\frac{P_l}{P_h}+\frac{P_l}{P_h}\theta+\alpha^*\theta+\alpha^*\frac{P_l}{P_h}-\alpha^*\frac{P_l}{P_h}\theta+\alpha^* x_f$

$c_1 = -\alpha^* x_f$

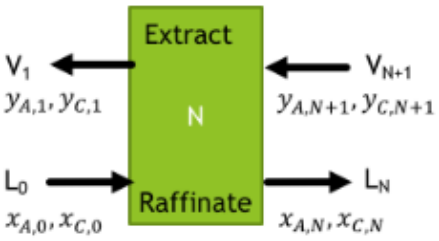
$x_0 = \frac{x_f-\theta y_p}{1-\theta}$

$y_p = \frac{x_f - x_0(1-\theta)}{\theta}$

$A_m = \frac{\theta L_f y_p}{\frac{P'_A}{t}(P_h x_0 - P_l y_h)}$

$x_{0M} = \frac{x_f\left[1+(\alpha^*-1)\frac{P_l}{P_h}\left(1-x_f\right)\right]}{\alpha^*\left(1-x_f\right)+x_f}$

Liquid-Liquid Extraction



V: organic layer; **L**: aqueous layer;

Stripping: removing from aqueous layer

$N = \frac{\ln\left[\frac{x_0-y_{N+1}/m}{x_N-y_{N+1}/m}(1-A)+A\right]}{\ln(1/A)}$

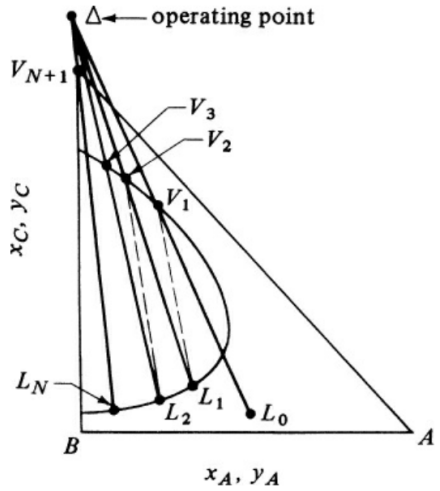
Absorption: removing from organic layer

$N = \frac{\ln\left[\frac{y_{N+1}-mx_0}{y_1-mx_0}\left(1-\frac{1}{A}\right)+\frac{1}{A}\right]}{\ln(A)}$

$A = \frac{L}{mV}$

$A = \sqrt{A_N A_1}$

$\Delta x_\Delta = \frac{L_0 x_0 - V_1 y_1}{L_0 - V_1} = \frac{L_N x_N - V_{N+1} y_{N+1}}{L_N - V_{N+1}}$



Adsorption

Mass Balance: $q_0 M + C_0 S = q_f M + C_f S$

H from geometry: $H_T = \frac{M}{\rho A_c \phi}$; ϕ: void fraction

$t_t = \int_0^\infty \left(1 - \frac{c}{c_0}\right) dt$

$t_u = \int_0^{t_b} \left(1 - \frac{c}{c_0}\right) dt$

$\eta = \frac{t_u}{t_t}$

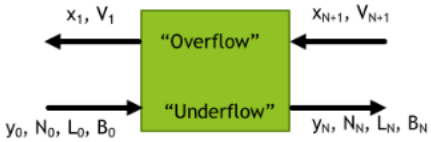
$H_B = \frac{t_u}{t_t} H_T$

$H_{\text{UNB}} = \left(1 - \frac{t_u}{t_b}\right) H_T$

$\frac{Q_1}{D_1^2} = \frac{Q_2}{D_2^2}$

$Q = v\frac{\pi}{4}D^2$

Leaching



V: overflow layer; **L**: liquid = A + C; **x**: overflow liquid; **y**: liquid in slurry;

$N = \frac{B}{L}$

$x_\Delta = \frac{L_0 y_0 - V_1 x_1}{L_0 - V_1} = \frac{L_N y_N - V_{N+1} x_{N+1}}{L_N - V_{N+1}}$

$N_\Delta = \frac{B}{L_0 - V_1} = \frac{N_0 L_0}{L_0 - V_1}$