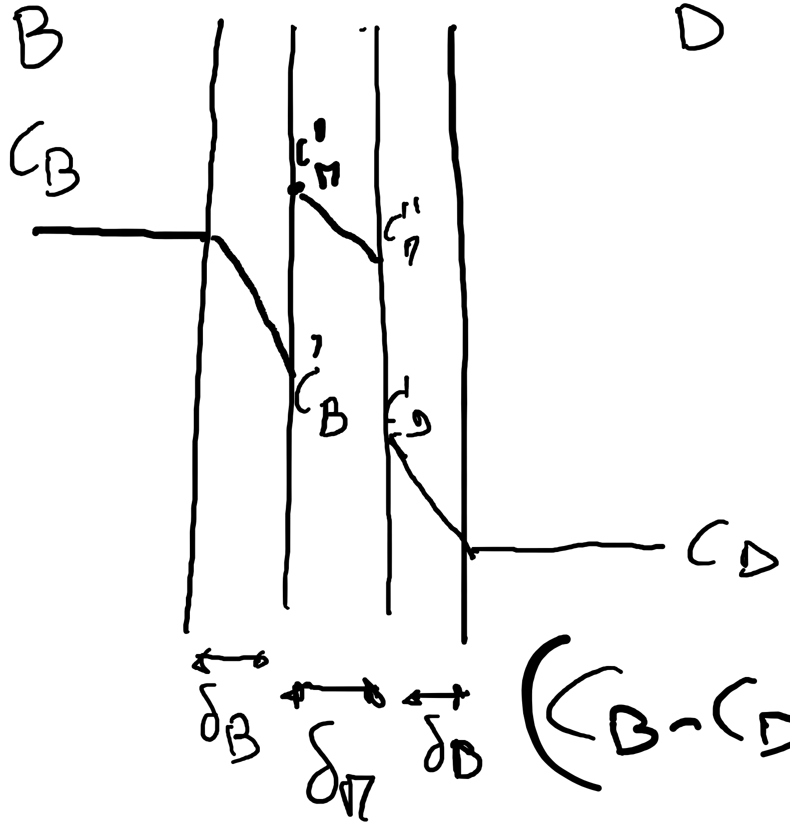


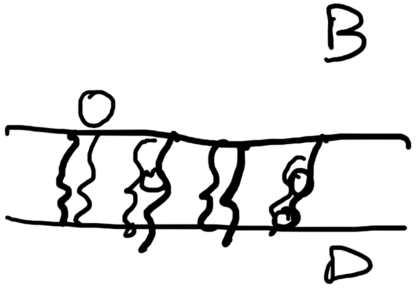
$$N = D_B \frac{(C_B - C'_B)}{\delta_B} = D_M \frac{(C'_M - C''_M)}{\delta_M} = D_D \frac{(C'_D - C_D)}{\delta_D}$$

$$C_B - C_D = C_B - C'_B + C'_B + C'_D - C'_D - C_D$$

$$(C_B - C_D) = (C_B - C'_B) + (C'_D - C_D) + (C'_B - C'_D)$$

α = coeff. di partizione = affinità di membrana $= \dfrac{C'_M}{C'_B} = \dfrac{C''_M}{C'_D}$

$$(C_B - C_D) = (C_B - C'_B) + (C'_D - C_D) + \left(\frac{C'_M}{\alpha} - \frac{C''_M}{\alpha}\right)$$



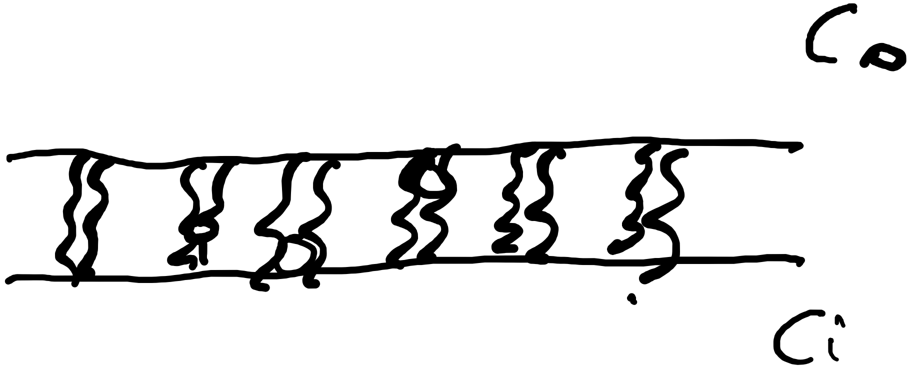
$$(C_B - C_D) = N\frac{\delta_B}{D_B} + N\frac{\delta_D}{D_D} + \frac{1}{\alpha} N \frac{\delta_M}{D_M}$$

$$(C_B - C_D) = N\left(\frac{\delta_B}{D_B} + \frac{\delta_D}{D_D} + \frac{1}{\alpha}\frac{\delta_\Pi}{D_\Pi}\right)$$

$$N = \frac{(C_B - C_D)}{\frac{\delta_B}{D_B} + \frac{\delta_D}{D_D} + \frac{1}{\alpha}\frac{\delta_\Pi}{D_\Pi}} = K(C_B - C_D)$$

$K =$ coeff. compl. di trasporto

$$R = \frac{1}{K} = \overset{\simeq 0}{\frac{\delta_B}{D_B}} + \overset{\simeq 0}{\frac{\delta_D}{D_D}} + \frac{1}{\alpha}\frac{\delta_\Pi}{D_\Pi} = \text{resistenza di membrana}$$

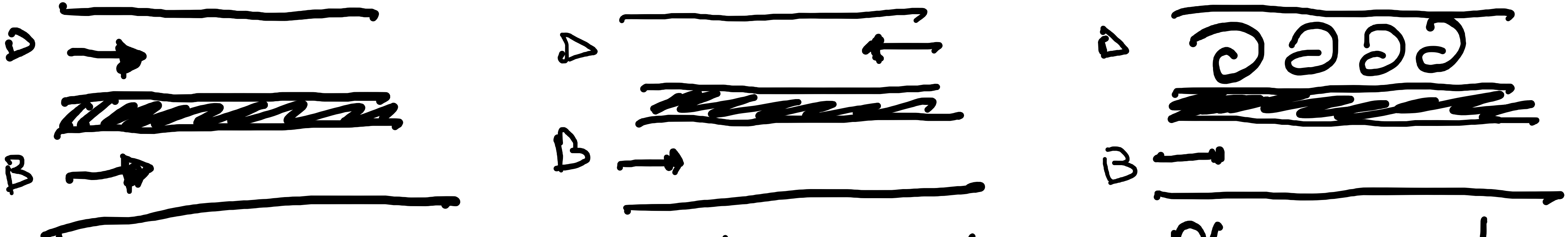


$$\Delta C = C_o - C_i = C_{ass} + C_{pass}$$

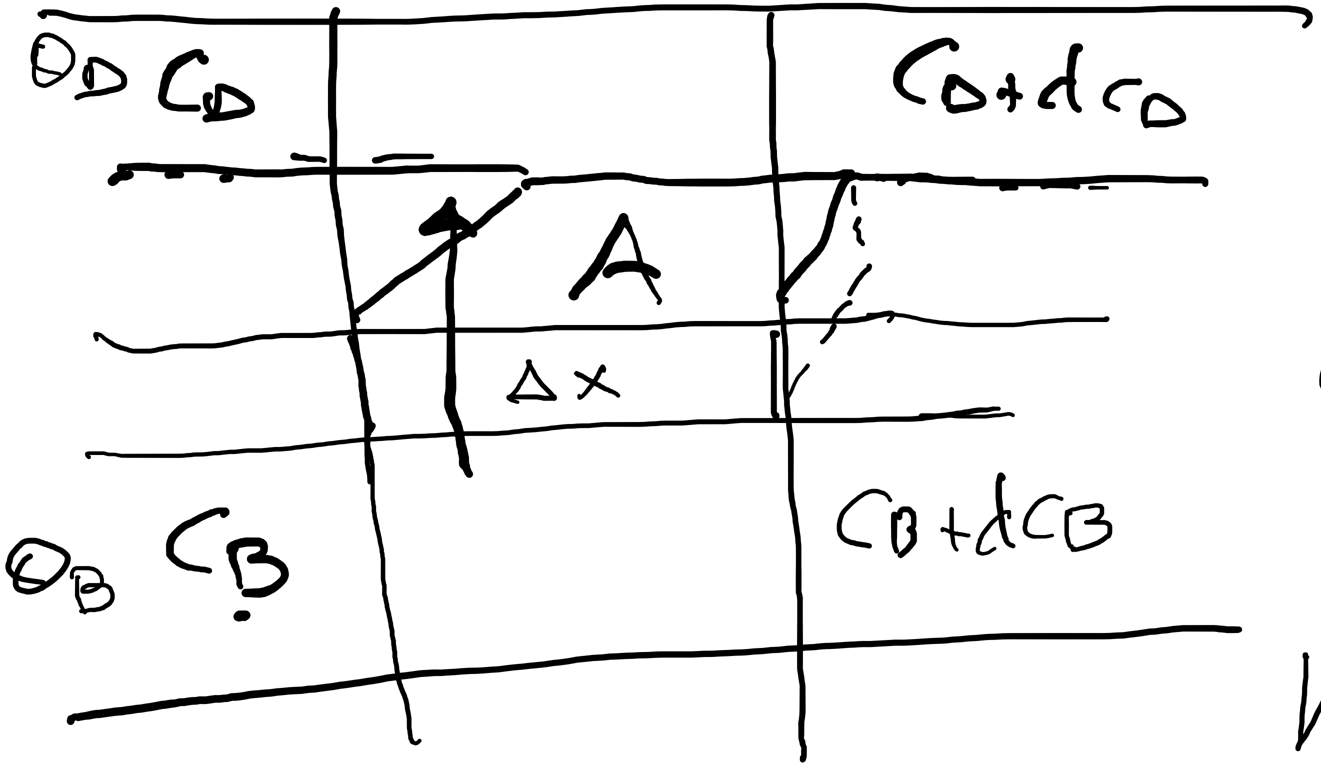
$$C_{ass} = \Delta C - C_{pass} \qquad \alpha = \frac{C_{ass}}{C_o}$$

$$J = D_m \frac{\partial c}{\partial x} = D_m \frac{C_0 - C_{eq}}{\delta m} = D_m \frac{C_0 - \alpha C_0}{\delta m} = \frac{D_m C_0}{\delta m}(1-\alpha)$$

$$(1-\alpha) = \frac{J\,\delta m}{D_m C_0} \longrightarrow 1 - \frac{J\,\delta m}{D_m C_0} = \alpha.$$



corcorrente — controcorrente — flusso misto



$$N = K(C_B - C_D)$$

$$dW = K(C_B - C_D)\,dA = -Q_B\,dC_B$$

$$= Q_D\,dC_D$$

1 2 3

$$K(C_B - C_D)\,dA = -Q_B\,dC_B$$

$$K(C_B - C_D)\,dA = Q_D\,dC_D.$$

$$\frac{dC_B}{C_B - C_D} = -\frac{K}{Q_B}\,dA$$

$$\frac{dC_D}{(C_B - C_D)} = \frac{K}{Q_D}\,dA$$

$$\frac{dC_B}{(C_B - C_D)} - \frac{dC_D}{(C_B - C_D)} = -\frac{K}{Q_B}\,dA - \frac{K}{Q_D}\,dA$$

$$\int_{i}^{\phi} \frac{d(C_B - C_D)}{C_B - C_D} = \int_{A} -K\,dA \left[\frac{1}{Q_B} + \frac{1}{Q_D}\right]$$

$$\ln \frac{(C_{Bo} - C_{Do})}{(C_{Bi} - C_{Di})} = -KA\left[\frac{1}{Q_B} + \frac{1}{Q_D}\right]$$

$$\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})} = KA\left[\frac{1}{Q_B} + \frac{1}{Q_D}\right]$$

$$dW = -Q_B \, dC_B \qquad W = -Q_B (C_{Bo} - C_{Bi})$$

$$dW = Q_D \, dC_D \qquad W = Q_D (C_{Do} - C_{Di})$$

$$\frac{1}{Q_B} = \frac{C_{Bi} - C_{Bo}}{W}$$

$$\frac{1}{Q_D} = \frac{C_{Do} - C_{Di}}{W}$$

$$\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})} = KA \left[\frac{C_{Bi} - C_{Bo}}{W} + \frac{C_{Do} - C_{Di}}{W} \right] = \frac{KA}{W} \left[(C_{Bi} - C_{Di}) - (C_{Bo} - C_{Do}) \right]$$

$$\underline{W} = KA \frac{\left[(C_{Bi} - C_{Bi}) - (C_{Bo} - C_{Do})\right]}{\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})}}$$

eq. del logaritmo medio

A_{urea}

A_{urica}

A_{Na^+}

A_{Cl^-}

$$A_{eff} = \text{mean}(A_i)$$

max(A_i)

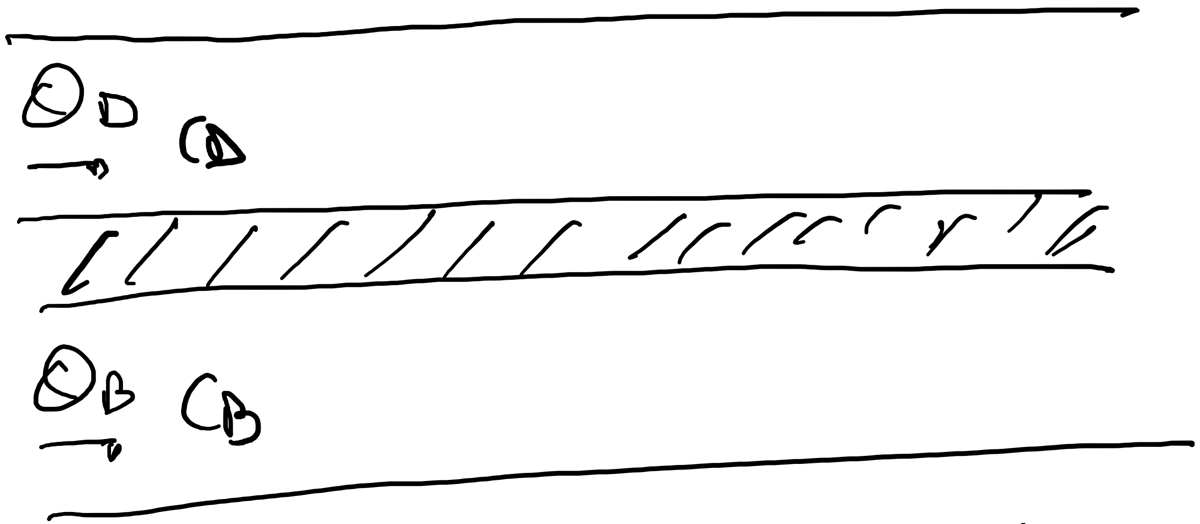
min(A_i) X

$$K = \frac{1}{R} \qquad R = \frac{\delta \pi}{2 D \pi} \qquad A$$

$$D^{*} = \text{dialysance} = Q_B \frac{(C_{Bi} - C_{Bo})}{(C_{Bi} - C_{Di})} = \frac{W}{(C_{Bi} - C_{Di})}$$

$$C^{*} = \text{Clearance} = Q_B \frac{(C_{Bi} - C_{Bo})}{(C_{Bi} - C_{Di})} \Bigg|_{C_{Di}=0} = \frac{W}{C_{Bi}}$$

$$E = \text{EXTRACTIO RATIO} = \frac{D^{*}}{Q_B} \Bigg|_{C_{Bi}=0} = Q_B \frac{(C_{Bi} - C_{Bo})}{C_{Bi}} \cdot \frac{1}{Q_B} = \left(1 - \frac{C_{Bo}}{C_{Bi}}\right)$$



$$dW = K(C_B - C_D)\,dA = -Q_B\,dC_B$$
$$= Q_D\,dC_D$$

$$dW = -Q_B\,dC_B \Rightarrow \frac{W}{Q_B} = -C_{Bo} + C_{Bi} \qquad C_{Bo} = C_{Bi} - \frac{W}{Q_B}$$

$$dW = Q_D\,dC_D \Rightarrow \frac{W}{Q_D} = C_{Do} - C_{Di} \qquad C_{Do} = C_{Di} + \frac{W}{Q_D}$$

$$W = \frac{KA\left[(C_{Bi} - C_{Di}) - (C_{Bo} - C_{Do})\right]}{\ln\dfrac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})}}$$

$$W = \frac{KA\left[C_{Bi} - C_{Di} - C_{Bi} + \frac{W}{Q_B} + C_{Di} + \frac{W}{Q_D}\right]}{\ln \frac{(C_{Bi} - C_{Di})}{\left[C_{Bi} - \frac{W}{Q_B} - C_{Di} - \frac{W}{Q_D}\right]}}$$

$$W = \frac{KA\,W\left[\frac{1}{Q_B} + \frac{1}{Q_D}\right]}{\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bi} - C_{Di})\left[1 - \frac{W}{(C_{Bi} - C_{Di})} \cdot \left(\frac{1}{Q_B} + \frac{1}{Q_D}\right)\right]}}$$

Z = coeff. di partizione dei flussi $= \frac{Q_B}{Q_D}$

$N_T = \frac{KA}{Q_B}$

$$\ln \frac{1}{1 - \frac{W}{(C_{Bi} - C_{Di})} \cdot \frac{1}{Q_B}\left(1 + \frac{Q_B}{Q_D}\right)} = \frac{KA}{Q_B}\left[1 + \frac{Q_B}{Q_D}\right]$$

$$\ln \frac{1}{1-\frac{W}{(C_{Bi}-C_{Di})}\cdot\frac{1}{Q_B}\left(1+\frac{Q_B}{Q_D}\right)} = \frac{KA}{Q_B}\left[1+\frac{Q_B}{Q_D}\right]$$

$$\ln \frac{1}{1-\frac{D^*}{Q_B}(1+Z)} = N_T(1+Z)$$

$$\ln \frac{1}{1-E(1+Z)} = N_T(1+Z)$$

$$\ln\left[1-E(1+Z)\right] = -N_T(1+Z)$$

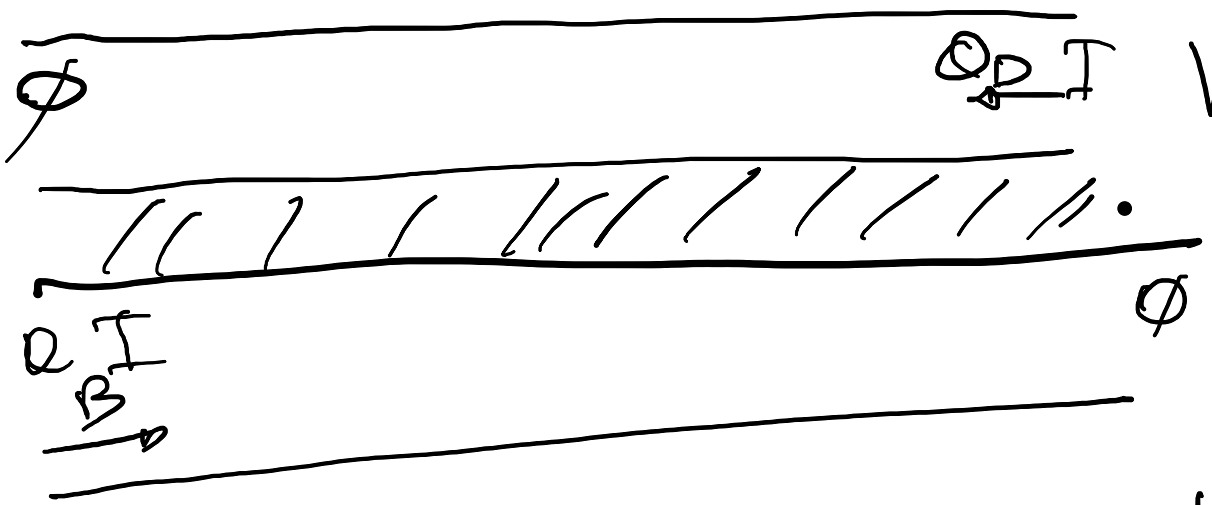
$$1-E(1+Z) = e^{-N_T(1+Z)} \qquad 1-e^{-N_T(1+Z)} = E(1+Z)$$

$$E_{C.C.} = \frac{1 - e^{-N_T(1+z)}}{(1+z)}$$

$$N_T = \frac{KA}{Q_B} \quad z = \frac{Q_B}{Q_D}$$

$$Q_B << Q_D \quad z \simeq 0$$

$$E_{C.C.} = 1 - e^{-N_T}$$



$$W_{C.C.} = K A \frac{(C_{Bi} - C_{Di}) - (C_{Bo} - C_{Do})}{\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})}}$$

$$W_{COC} = K A \frac{(C_{Bi} - C_{Do}) - (C_{Bo} - C_{Di})}{\ln \frac{(C_{Bi} - C_{Do})}{(C_{Bo} - C_{Di})}}$$

$$C_{Di}^{vec} = C_{Do}$$

$$C_{Do}^{vec} = C_{Di}$$

$$dW = K(C_B - C_D)\,dA = -Q_B\,dC_B = Q_D\,dC_D$$

$$dW = -Q_B\,dC_B \Rightarrow W = -Q_B(C_{Bo} - C_{Bi}) \qquad \frac{W}{Q_B} = -C_{Bo} + C_{Bi}$$

$$dW = Q_D\,dC_D \Rightarrow W = Q_D(C_{Do} - C_{Di}) \qquad \frac{W}{Q_D} = C_{Do} - C_{Di}$$

$$C_{Bo} = C_{Bi} - \frac{W}{Q_B}$$

$$C_{Do} = C_{Di} + \frac{W}{Q_D}$$

$$W = \frac{KA\left[(C_{Bi} - C_{Do}) - (C_{Bo} - C_{Di})\right]}{\ln\left(\frac{C_{Bi} - C_{Do}}{C_{Bo} - C_{Di}}\right)}$$

$$W = \frac{KA\left[C_{Bi} - C_{Di} - \frac{W}{Q_D} - C_{Bi} + \frac{W}{Q_B} + C_{Di}\right]}{\ln \frac{C_{Bi} - C_{Di} - \frac{W}{Q_D}}{C_{Bi} - \frac{W}{Q_B} - C_{Di}}}$$

$$W = \frac{KA\,W\left[\frac{1}{Q_B} - \frac{1}{Q_D}\right]}{\ln \frac{(C_{Bi} - C_{Di})\left[1 - \frac{W}{(C_B - C_{Di})} \cdot \frac{1}{Q_D}\right]}{(C_{Bi} - C_{Di})\left[1 - \frac{W}{(C_B - C_{Di})} \cdot \frac{1}{Q_B}\right]}}$$

$$\ln \frac{1 - \frac{W}{CB - CDi} \cdot \frac{1}{QD}}{1 - \frac{W}{CB - CDi} \cdot \frac{1}{QB}} = KA \left[\frac{1}{QB} - \frac{1}{QD} \right]$$

$$\ln \frac{1 - \frac{D^*}{QD}}{1 - \frac{D^*}{QB}} = \frac{KA}{QB} \left[1 - \frac{QB}{QD} \right]$$

$$\ln \frac{1 - \frac{D^*}{QB} \frac{QB}{QD}}{1 - \frac{D^*}{QB}} = N_T \left[1 - z \right] \Rightarrow \ln \frac{1 - Ez}{1 - E} = N_T (1 - z)$$

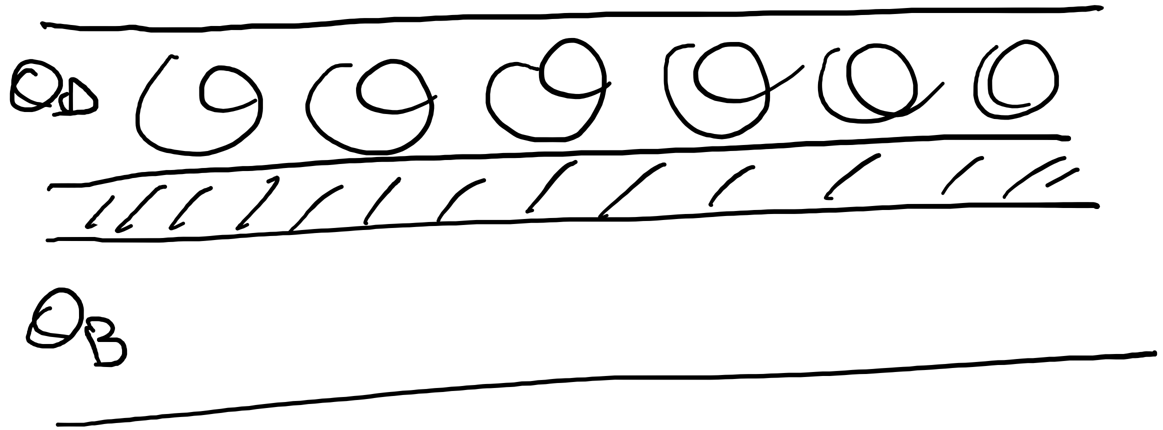
$$\frac{1-\mathcal{E}z}{1-\mathcal{E}} = e^{N_T(1-z)} \qquad 1-\mathcal{E}z = e^{N_T(1-z)}(1-\mathcal{E})$$

$$1-\mathcal{E}z = e^{N_T(1-z)} - \mathcal{E}e^{N_T(1-z)}$$

$$\mathcal{E}\left[e^{N_T(1-z)} - z\right] = e^{N_T(1-z)} - 1$$

$$\mathcal{E} = \frac{e^{N_T(1-z)} - 1}{e^{N_T(1-z)} - z} = \frac{1-e^{-N_T(1-z)}}{1-z\,e^{-N_T(1-z)}}$$

$z \simeq 0 \quad Q_B \ll Q_B \qquad \mathcal{E} = 1-e^{-N_T}$



$$C_{Di} = C_{Do}$$

$$W_{C.C} = KA \frac{(C_{Bi} - C_{Di}) - (C_{Bo} - C_{Do})}{\ln \frac{(C_{Bi} - C_{Di})}{(C_{Bo} - C_{Do})}}$$

$$W_{F.n} = KA \frac{[(C_{Bi} - C_{Do}) - (C_{Bo} - C_{Do})]}{\ln \frac{(C_{Bi} - C_{Do})}{(C_{Bo} - C_{Do})}}$$

$$dW = -Q_B \, dC_B \qquad W = -Q_B (C_{Bo} - C_{Bi}) \qquad C_{Bo} = C_{Bi} - \frac{W}{Q_B}$$

$$dW = Q_B \, dC_D \qquad W = Q_D (C_{Do} - C_{Di}) \qquad C_{Do} = C_{Di} + \frac{W}{Q_D}$$

$$W = KA\,\frac{\left[C_{Bi} - C_{Do} - C_{Bo} + C_{Do}\right]}{\ln \dfrac{C_{Bi} - C_{Do}}{C_{Bo} - C_{Do}}} = \frac{KA\left(C_{Bi} - C_{Bi} + \dfrac{W}{Q_B}\right)}{\ln \dfrac{C_{Bi} - C_{Di} + \dfrac{W}{Q_D}}{C_{Bi} - \dfrac{W}{Q_B} - C_{Di} - \dfrac{W}{Q_D}}}$$

$$W = \frac{KA}{Q_B} \cdot \frac{W}{\ln \dfrac{C_{Bi} - C_{Di} - \dfrac{W}{Q_D}}{C_{Bi} - C_{Di} - \dfrac{W}{Q_B}\left[1 + \dfrac{Q_B}{Q_D}\right]}}$$

$$\ln \frac{(C_{Bi} - C_{Di})\left[1 - \dfrac{W}{(C_{Bi} - C_{Di})} \cdot \dfrac{1}{Q_D}\right]}{(C_{Bi} - C_{Di})\left[1 - \dfrac{W}{(C_{Bi} - C_{Di})} \cdot \dfrac{1}{Q_B}\left(1 + \dfrac{Q_B}{Q_D}\right)\right]} = \frac{KA}{Q_B}$$

$$\ln \frac{\left[1-\frac{D^*}{Q_D}\right]}{\left[1-E(1+z)\right]} = N_T$$

$$\ln \frac{\left[1-\frac{D^*}{Q_B}\cdot\frac{Q_B}{Q_D}\right]}{\left[1-E(1+z)\right]} = N_T$$

$$\ln \frac{\left[1-Ez\right]}{\left[1-E(1+z)\right]} = N_T$$

$$\frac{1-Ez}{1-E(1+z)} = e^{N_T}$$

$$1-Ez = e^{N_T} - e^{N_T}E(1+z)$$

$$E\left[e^{N_T}(1+z)-z\right] = e^{N_T}-1$$

$$E = \frac{e^{N_T}-1}{e^{N_T}(1+z)-z} = \frac{1-e^{-N_T}}{(1+z)-ze^{-N_T}}$$

$z \simeq \phi \quad Q_B \ll Q_B$

$$E_{F.M.} = 1-e^{-N_T}$$