1 a) $x_F F = x_D \cdot D + x_B B$

$0{,}2 \cdot 1 = 0{,}95 D + 0{,}01 B$

$F = D + B$

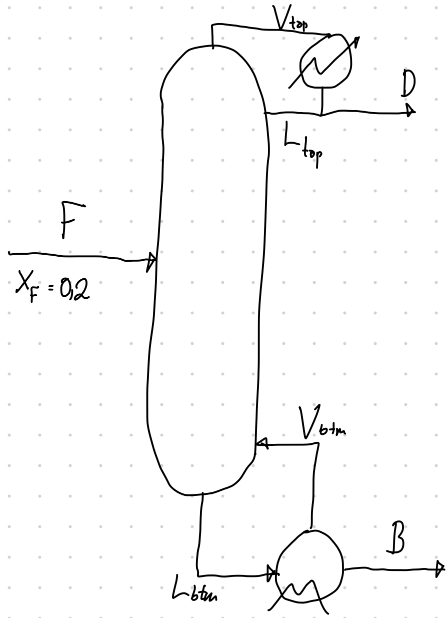
$D = F - B$

$0{,}2 = 0{,}95(1-B) + 0{,}01 B$

$0{,}94 B = 0{,}75$

$\underline{\underline{B = 0{,}7979 \text{ mol/s}}}$

$\Rightarrow \underline{\underline{D = 0{,}2021 \text{ mol/s}}}$



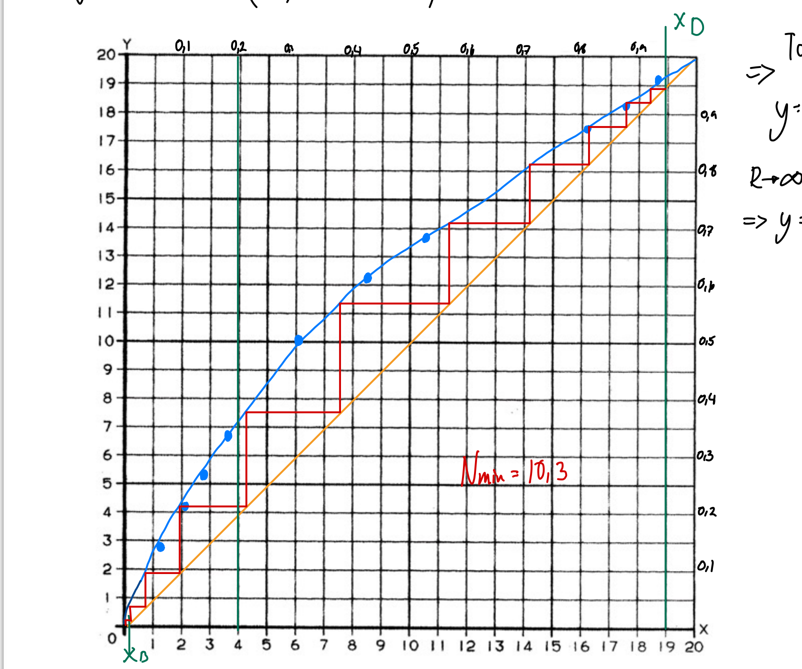
b)

Ideell $\Rightarrow R = \infty = \dfrac{L_{top}}{D}$

Balance $V_{top} = D + L_{top}$

$V_{top}\, y = D x_D + L_{top} x_n \Rightarrow y = \dfrac{D}{V} x_D + \dfrac{L}{V} x_n$

$\dfrac{L}{V} = \dfrac{L}{L+D} \cdot \dfrac{(1/D)}{(1/D)} = \dfrac{R}{R+1}$, $\dfrac{D}{V} = \dfrac{D}{L+D} \cdot \dfrac{1/D}{1/D} = \dfrac{1}{R+1}$



$\Rightarrow$ Top-op-line

$y = \dfrac{R}{R+1} x_n + \dfrac{1}{R+1} x_D$

$R \to \infty$

$\Rightarrow y = x_n$

c) Der q-line krysser eq-line x' og y'

$q = \frac{L}{F} = 1$

$X' = 0{,}2$

$y' = 0{,}37$

Feed line

$y = \frac{q}{q-1} x - \frac{x_F}{q-1}$

$y = \infty \Rightarrow$

$\frac{R_m}{R_m+1} = \frac{x_D - y'}{x_D - x'} = \frac{0{,}95 - 0{,}37}{0{,}95 - 0{,}2} = 0{,}7733$

$R_m(1 - 0{,}7733) = 0{,}7733$

$R_m = \frac{0{,}7733}{1 - 0{,}7733} = 3{,}41$

$\Rightarrow L_{min} = R_m \cdot D = 3{,}41 \cdot 0{,}2021 = \underline{\underline{0{,}6895 \text{ mol/s}}}$

d) Balanse over toppen gir at

$V_{min} = L_{min} + D_{min}$

$= 0{,}8916 \text{ mol/s}$

$Q_{min} = V_{min} \cdot \Delta H_{vap}$

$= 0{,}8916 \text{ mol/s} \cdot 45 \text{ kJ/mol}$

$= 40{,}122 \text{ kJ/s}$

$\underline{\underline{\approx 40{,}1 \text{ kW}}}$

e) Typisk, la $N = 2{,}5 N_{min} = 25{,}5 \Rightarrow L \leq 1{,}1 L_{min} = 0{,}758$ mol/s

f) α er relativ flyktighet:
S er separasjonsfaktor.

g) $$S = \frac{(x_1/x_2)_D}{(x_1/x_2)_B} = \frac{0{,}95/0{,}05}{0{,}01/0{,}99} = 1881$$

$$\alpha = \frac{y_1/x_1}{y_2/x_2} = \frac{y^*}{x^*} \cdot \frac{(1-x^*)}{(1-y^*)} =$$

$x^* = 0{,}068$, $y^* = 0{,}146 \Rightarrow \alpha = 2{,}34$
$x^* = 0{,}524$, $y^* = 0{,}6840 \Rightarrow \alpha = 1{,}97$
$x^* = 0{,}947$, $y^* = 0{,}967 \Rightarrow \alpha = 1{,}64$

Det er ikke rimelig å anta konstant volatilitet for stor variasjon.

Antar $\alpha = \bar{\alpha} \approx 2$

$$\Rightarrow N_{min} = \frac{\ln 1881}{\ln 2} = 10{,}9$$ $\Rightarrow$ Er relativt nærme

$$\frac{L_{min}}{F} = \frac{1}{2-1} = \frac{1}{1} \Rightarrow L_{min} = 1$$ moll S, ganske stor bom kommer av at α er variabel.

h) $$\ln S = \ln S_1 \cdot S_2 = \ln S_1 + \ln S_2 \overset{\text{analog til}}{=} N_{min_1} + N_{min_2}$$

$$S_2 = \frac{0{,}9999/0{,}0001}{0{,}95/0{,}05} = 526$$

$$N_{min_2} = \frac{\ln 526}{\ln 1{,}64} = \underline{\underline{12{,}7 \text{ steg}}}$$

Oppgave 2

a) • Dersom dataen er lineær når man plotter C mot q er den lineær (Henrys)

• Langmuir $\frac{1}{q}$ mot $\frac{1}{C}$

• $\ln q$ mot $\ln c$, freundlich

b) Passes med Langmuir

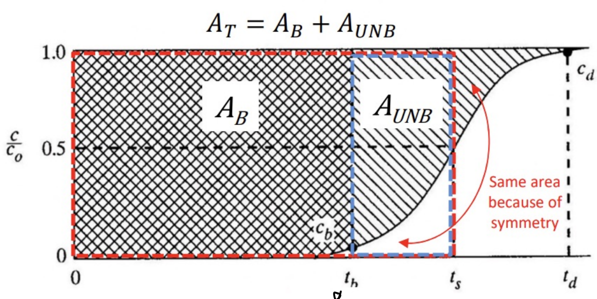
$$q_0 = 0{,}143$$

$$K = 0{,}0148$$

$$\Rightarrow q = \frac{0{,}143 \cdot C}{0{,}0148 + C}$$

c) $\tau_{MTZ} = \tau_d - \tau_b$

$$A_{tot} = A_B + A_{UNB}$$



$$\tau_T = \int_0^{t\to\infty} \left(1 - \frac{c}{c_i}\right) dt$$

breakpoint

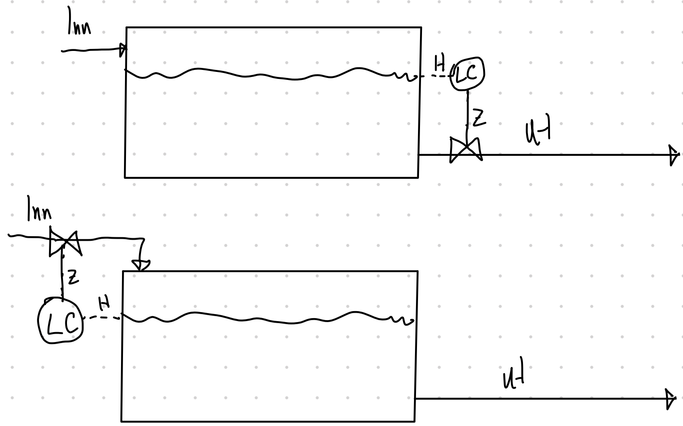
når

τ_{MTZ}

når overgangen mellom (tilnærmet) ren komponent og blandings skjer.

Oppgave 3

a)



b)

1. $P_A = x_A \cdot P_{A sat}(T)$, ideell (væske) blanding
2. Det er Henry's lov, gjelder for fortynnede blandinger
$K = \frac{H(T)}{P}$ => Doble trykk halverer H

c) 1. Molbalanse:

$$Inn - Ut + Gen = \frac{dn}{dt}$$

$$0 - V + 0$$

$$\Rightarrow \frac{dn}{dt} = -V$$ (Har at $n = L$)

$$\Rightarrow \frac{dL}{dt} = -V \Rightarrow dL = -Vdt$$

Komponent:

$$\frac{d(xL)}{dt} = -yV$$

2.

$$x\frac{dL}{dt} + L\frac{dx}{dt} = -Vy \Rightarrow x\,dL + L\,dx = -Vy\,dt$$

$$x\,dL + L\,dx = y\,dL$$

$$L\,dx = (y-x)\,dL$$

$$\frac{dx}{y-x} = \frac{dL}{L} \qquad / \text{integrerer}$$

$$\int_{x_0}^{x_1} \frac{dx}{y-x} = \int_{L_0}^{L_1} \frac{dL}{L}$$

3. $$\int_{10^{-2}}^{10^{-4}} \frac{dx}{100x-x} = \ln \frac{L_1}{L_0}$$

$$\ln L_1 = \ln L_0 + \left[\frac{1}{99} \ln (99x)\right]_{10^{-2}}^{10^{-4}} = \ln L_0 + \frac{1}{99} \ln \left(\frac{10^{-4}}{10^{-2}}\right)$$

$$L_1 = L_0\, e^{\ln (100^{-1/99})}$$

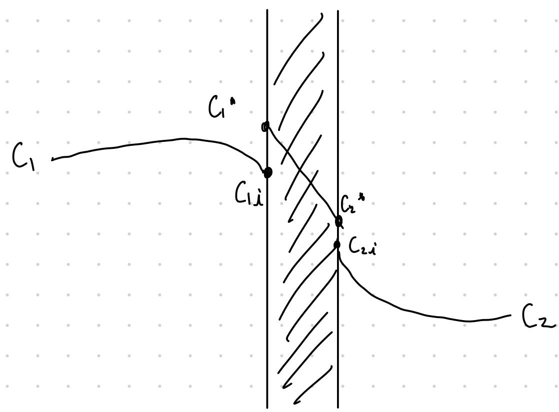
$$L_1 = L_0 \cdot 100^{-1/99}$$

$$L_1 = 1000 \cdot 100^{-1/99}$$

$$\underline{\underline{L_1 = 954{,}6 \text{ mol}}}$$

$$t = \frac{L_0 - L_1}{V} = \frac{45{,}45 \text{ mol}}{0{,}1 \text{ mol/s}} = \underline{\underline{455 \text{ s}}}$$

4



Antar steady state, da er N_A lik over alt.

$$N_F = k_{c1}(C_1 - C_{1i})$$

$$N_M = \frac{D_{AB}K'}{L}(C_1^* - C_2^*)$$

$$N_P = k_{c2}(C_{2i} - C_2)$$

$$K' = \frac{C_S}{C_L} \Rightarrow C_S' = K' \cdot C_L$$

$$(C^* = K' \cdot C_{1i})$$

$$N_A = k_{c1}(C_1 - C_1^*) \Rightarrow \frac{N_A}{k_{c1}} = C_1 - C_1^*$$

Er kluss her, men resultatet er rett

$$N_A = \frac{D_{AB}}{L}(C_1^* - C_2^*) \Rightarrow \frac{N_A}{D_{AB}/L} = C_1^* - C_2^*$$

$$N_A = k_{c2}(C_2^* - C_2) \Rightarrow \frac{N_A}{k_{c2}} = C_2^* - C_2$$

$\Rightarrow$ Summerer alle:

$$N_A\left(\frac{1}{k_{c1}} + \frac{1}{D_{AB}/L} + \frac{1}{k_{c2}}\right) = C_1 - C_2$$

$$\Rightarrow N_A = \frac{C_1 - C_2}{\left(\frac{1}{k_{c1}} + \frac{1}{K' D_{AB}/L} + \frac{1}{k_{c2}}\right)} = \frac{C_1 - C_2}{\left(\frac{1}{k_{c1}} + \frac{1}{P_M} + \frac{1}{k_{c2}}\right)}$$

c) $\frac{1}{k_c} = 2,7 \cdot 10^4 \quad s/m$

$\frac{1}{P_M} = 5 \cdot 10^5 \ s/m$

$\frac{1}{k_{c_2}} = 4,5 \cdot 10^4 \ s/m$

$K_c = 5,72 \cdot 10^5 \ s/m, \quad \% \ Vis = \frac{5}{5,72} \cdot 100\% = 87,4\%$

d) $N_A = \frac{(2,5 - 0,3) \cdot 10^{-2} \cdot kmol\ A / \cancel{m^3} m^2}{5,72 \cdot 10^5 \ s/\cancel{m}} = \underline{\underline{3,846 \cdot 10^{-8} \ kmol\ A / s \cdot m^2}}$

$A = \frac{n_A / t}{N_A} = \frac{0,02 \ \cancel{kmol\ A} / 3600 \cancel{s}}{3,846 \cdot 10^{-8} \ \cancel{kmol\ A} / \cancel{s} \cdot m^2} = \underline{\underline{144,44 \ m^2}}$

e) Får at $\frac{1}{k_{c_1}} \Rightarrow 0$,

$P_m^{-1} = \left(\frac{K' D_{AB}}{L}\right)^{-1} = \left(\frac{0,75 \cdot 4 \cdot 10^{-11} \ m^2/s}{1 \cdot 10^{-6} \ m}\right)^{-1} = 3,33 \cdot 10^5 \ s/m$

$\underline{K_c = 7,83 \cdot 10^5 \ s/m}$

$\Rightarrow N_A = \frac{C_1 - C_2}{K} = \frac{(2,5 - 0,3) \cdot 10^{-2} \ kmol\ A / \cancel{m^3} m^2}{7,83 \cdot 10^5 \ s/\cancel{m}}$

$\underline{\underline{N_A = 2,81 \cdot 10^{-7} \ \frac{kmol\ A}{m^2 \cdot s}}}$