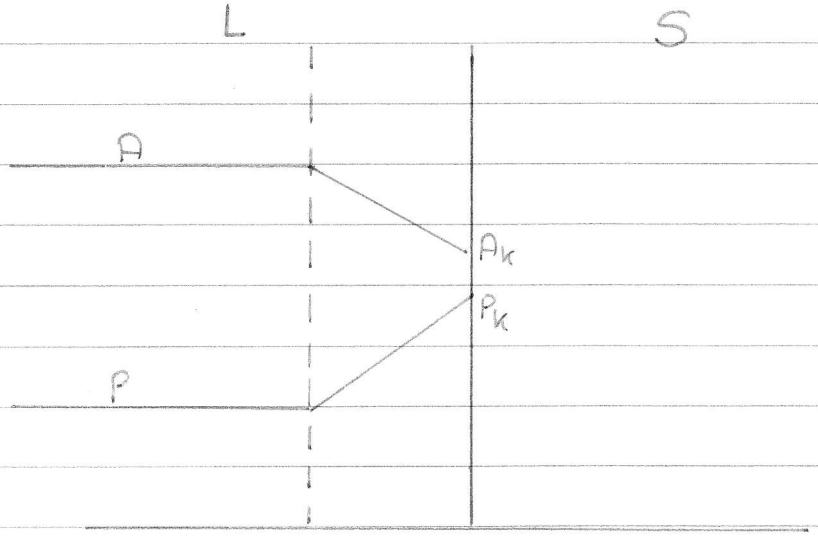
Tentamen / examen 19-04-2011

Opgave 1

a) Dimensie k_1 is $m.s^{-1}$

b) $$a_k = \frac{b\,\varepsilon_s}{d_k} = \frac{6 * 0.05}{10^{-4}} = 3000 \ \frac{m^2}{m^3_{reactor}}$$

c)



d) $$\phi_p \ (mol.s^{-1}) = \frac{C_{AL,in}}{\frac{1}{\phi_{L,in}} + \frac{1}{k_{LS}\,a_k\,V_r} + \frac{1}{k_1\,a_k\,V_r}}$$

via: $$\phi_p = \phi_{L,in}\,(C_{AL,in} - C_{AL,mit})$$

$$\phi_p = k_{LS}\,(C_{AL,mit} - C_{AL,kat})\,a_k\,V_r$$

$$\phi_p = k_1\,a_k\,C_{AL,kat}\,a_k\,.\,V_R$$

e) $\dfrac{1}{\phi_{L,in}} = 1000$

$\dfrac{1}{k_{LS}\, a_k\, V_r} = 166,67$ $\qquad k_{LS} = \dfrac{Sh.\, D_{A,L}}{d_{kat}} = 2 \times 10^{-5}$

$\dfrac{1}{k_1\, a_k\, V_r} = 3.33 \times 10^{-3}$

$\phi_L \left(C_{AL,in} - C_{AL,sit} \right) = 8.57 \cdot 10^{-4} \cdot C_{AL,in}$

$C_{AL,sit} = C_{AL,in} \left(\dfrac{\phi_L - 8.57 \cdot 10^{-4}}{\phi_L} \right) = 0.2g$

$\xi_A = 36\,\%$

Opgave 2:

a) $SO_2 + (Na^+) + OH^- \longrightarrow HSO_3^-$

$$J_{SO_2} = \frac{(C_{SO_2,G} - C_{SO_2,L})}{\frac{1}{k_G} + \frac{1}{m k_L E_{SO_2}}}$$

b) $Ha = \frac{\sqrt{5.10^7 . 2000 . 10^{-9}}}{10^{-4}} = 10^5 \gg 2 \Rightarrow C_{SO_2,L} = 0$

$E_{A,\infty} = 1 + \frac{D_{OH^-} C_{OH^-}}{D_{SO_2} C_{SO_2,Li}}$ stel k_G te verwaarlozen dan $C_{SO_2,G,max} \leq 0.004$

$\geq 1 + \frac{2.10^{-9} . 2000}{10^{-9} . 50 . 0.004} \gg 20.001 \ll Ha$

dus $E = E_\infty$

nu k_G checken.

$k_G = 10^{-2}$ $\qquad m k_L E_\infty = 50.10^{-4} . 20.001 = 100,01$

dus $k_G \ll m k_L E_\infty$

dus k_G is limitered ! $\qquad J_{SO_2} = k_G . C_{SO_2,G}$

c) $$\phi_G \frac{dC_{SO_2,G}}{dx} = -k_G.a.C_{SO_2,G}.S$$

$$\frac{C_{SO_2,G\,out}}{C_{SO_2,G\,in}} = \exp\left(-\frac{k_G.a\,S.h}{\phi_G}\right)$$

$$h = 3.65 \text{ m.}$$

Opgave 3

30 pnt

a) $\Phi_A = J \cdot A = k_L \, m \, E_A \left(C_g - \frac{C_L}{m}\right) \cdot A \quad mols^{-1}$

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$A = 4\pi r^2 = \pi d_{bel}^2$

$k_L = \frac{10 \, D_A}{d_{bel}}$

$E_A = f^{ie}(Ha) \quad Ha = \frac{\sqrt{k_1 D_A}}{k_L} = \frac{\sqrt{1000 \cdot 10^{-9}}}{10 \cdot 10^{-9}} \cdot d_{bel}$

$= 10^5 \cdot d_{bel}$

$10 \leq Ha \leq 10^3 \rightarrow E = Ha > 2$

$\rightarrow C_L = 0$

$\Phi_A = k_L \cdot m \cdot Ha \, C_g \cdot \pi d_{bel}^2$

$= \frac{10 \, D_A}{d_{bel}} \cdot m \cdot \frac{\sqrt{k_1 D_A} \, d_{bel}}{10 \, D_A} \cdot \pi \cdot d_{bel}^2 \cdot C_G$

$= \pi \cdot d_{bel}^2 \sqrt{k_1 D_A} \cdot m \cdot C_G \quad mol/s$

b) $d_{bel} = 10^{-2} \qquad n_{bel} = C_G \cdot V_{bel} = 40 \cdot \frac{4}{3}\pi r^3 = 40 \cdot \frac{4}{3}\frac{\pi}{8} d_{bel}^3$

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$\rightarrow 25\% = 5.24 \cdot 10^{-7} \, mol \qquad = 40 \cdot \frac{4}{3}\frac{\pi}{8} d_{bel}^3 = 2.09 \cdot 10^{-6} \, mol$

$\Phi_A = 1.26 \cdot 10^{-5} \, mol/s \rightarrow 0.042 \, sec \qquad 0.42 \, min.$

Bonus

5 1 B $Ha < 0{,}2$ and $(Al-1)Ha^2 \ll 1$

completely reaction controlled.

5 II B $Ha < 0.2$ and $(Al-1)Ha^2 \ll 1$

completely reaction controlled $\rightarrow$ 0° ord.