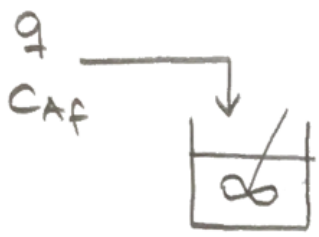
14/5-18 Föreläsning 7

Tenta 29/5-2017

1) Vid fyllning av satsreaktor: semi-sats
(sats m. inflöde)

Semi-batch



MB: $qC_{Af} - 0 - kC_A W = \frac{dN_A}{dt}$ (1)

(in, ut)

V eller W (beror på enhet på k)

$$\frac{dN_A}{dt} = \frac{d(C_A V)}{dt} = C_A \overbrace{\frac{dV}{dt}}^{q} + V\frac{dC_A}{dt} \quad (2)$$

(produktregeln)

vid fyllning ändrar sig både C_A och V m. tiden

$$V = V_0 + qt \quad (3)$$

$$\frac{dN_A}{dt} = C_A q + (V_0 + qt)\frac{dC_A}{dt} \overset{(1)}{=} qC_{Af} - kC_A W$$

$$(V_0 + qt)\frac{dC_A}{dt} = qC_{Af} - (kW + q)C_A$$

$$\int_{C_{Af}}^{C_{Afull}} \frac{dC_A}{(qC_{Af} - (kW+q)C_A} = \int_0^{t_{full}} \frac{dt}{(V_0+qt)}$$

$$\left[\ln(V_0 + qt)\cdot\frac{1}{q}\right]_0^{t_{full}} = \left[\ln(qC_{Af} - (kW+q)C_A)\frac{-1}{(kW+q)}\right]_{C_{Af}}^{C_{Afull}}$$

$$\Rightarrow -\frac{(kW+q)}{q}\ln\frac{(V_0+q\,t_{full})}{(V_0)} = \ln\frac{(qC_{Af}-(kW+q)C_{Afull})}{(qC_{Af}-(kW+q)C_{Af})}$$

$$t_{full} = \frac{V_{r_0}-V_0}{q} = 385\,s$$

lös ut $C_{Afull} = 382{,}4\ mol/m^3$

När reaktor är full $\Rightarrow$ Batchreaktor!

$$-kC_A W = \frac{dN_A}{dt}$$

V konst $\quad \frac{dN_A}{dt} = V\frac{dC_A}{dt}$

$$-kC_A W = V\frac{dC_A}{dt}$$

$$\int_{t_{full}}^{t_{tot}} -\frac{kW}{V}\,dt = \int_{C_{Afull}}^{C_{Atot}} \frac{dC_A}{C_A}$$

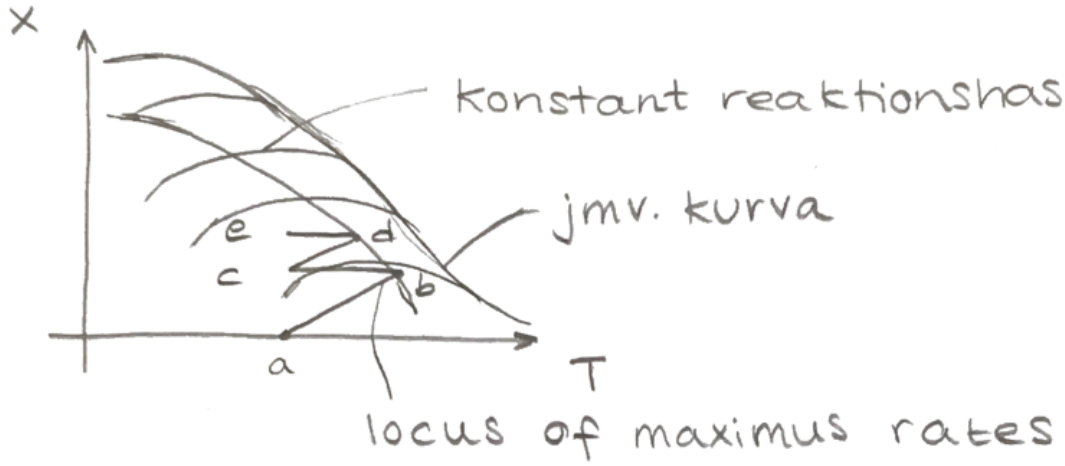
$$-\frac{kW}{V}(t_{tot}-t_{full}) = \ln\frac{C_{Atot}}{C_{Afull}}$$

$X = 0{,}75 \Rightarrow C_{Atot} = C_{Af}(1-X) = 112{,}5\ mol/m^3$

$$t_{tot} = -\frac{V}{kW}\ln\frac{C_{Atot}}{C_{Afull}} + t_{full} = 3648\ s$$

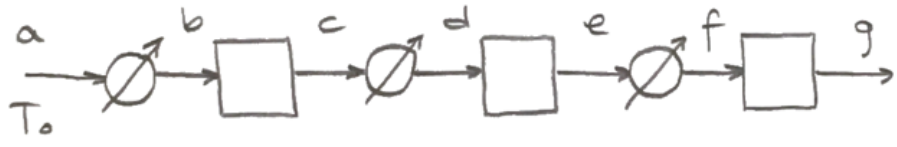
2)

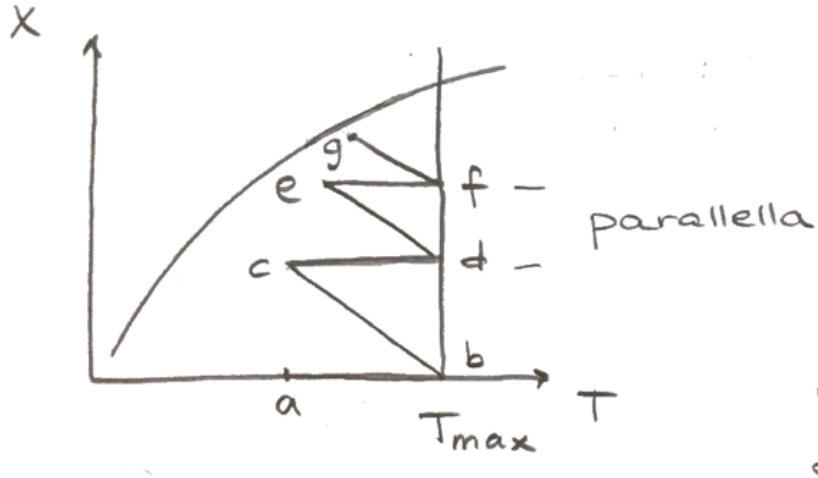
a)



(viktigt att streck mellan b o c är raka då omsättningsgraden är samma)

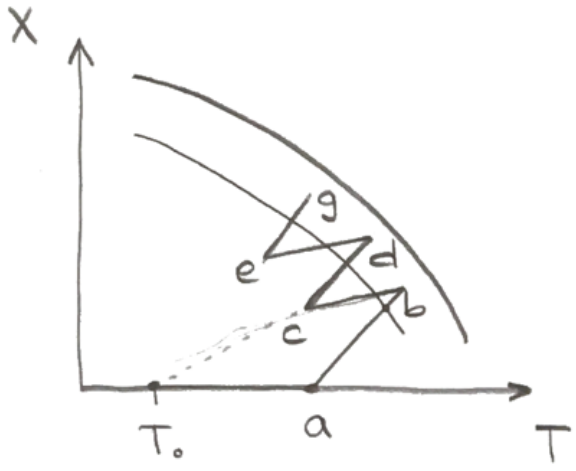
b)





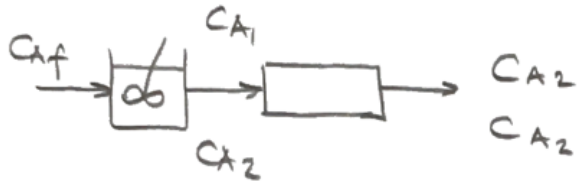
c, e, g - måste inte nödvändigtvis ha samma temp.

c) Cold-shot – man kyler/värmer m. inflödet + blandar strömmarna.



Alla "reaktorlinjer" ska vara parallella.

3)



$$3A \xrightarrow{r_1} 2B \xrightarrow{r_2} C$$

Söker: C_{B_2}

$$r_1 = k_1 C_A = A_1 e^{-E_{A_1}/RT} \cdot C_A$$

$$r_2 = k_2 C_B^2 = A_2 e^{-E_{A_2}/RT} \cdot C_B^2$$

MB tank: $q C_{Af} - q C_{A_1} - 3k_1 C_{A_1} V = 0 \quad (1)$

$q \cdot 0 - q C_{B_1} + 2k_1 C_{A_1} V - 2k_2 C_{B_1}^2 V = 0 \quad (2)$

VB tank: $\sum F_{j_0} C_{pj} (T_0 - T_{ref}) - \sum F_j C_{pj} (T_1 - T_{ref}) + r_2 V(-\Delta H) = 0$

$T_{ref} = T_1$

(antar $\dot{Q} = 0$)
C_p - konst.

$$\Rightarrow \sum F_{j_0} C_{pj} (T_0 - T_1) + 2k_2 C_{B_1}^2 V(-\Delta H) = 0 \quad (3)$$

(1) + (2) + (3) $\Rightarrow$ C_{A_1}, C_{B_1}, T_1

MB tub: $F_A - (F_A + dF_A) - 3k_1 C_A dV = 0$

$\Rightarrow -dF_A = 3k_1 C_A dV$

$-q dC_A = 3k_1 C_A dV \quad (4)$

map A

map B:

$F_B - (F_B + dF_B) + 2k_1 C_A dV - 2k_2 C_B^2 dV = 0$

$q dC_B = (2k_1 C_A - 2k_2 C_B^2) dV \quad (5)$

VB: Antar $\dot{Q} = 0$

$\sum C_{pi} F_i dT = r(-\Delta H) dV$

$k_2 C_B^2 (-\Delta H) dV = \sum C_{pi} q\, c_i dT \quad (6)$

$(4) + (5) + (6) \Rightarrow C_{B_2}$

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4) $A \longrightarrow B$, $r = kC_A$

MB: $qC_{Af} - qC_{Ab} - kC_{As}\eta V = 0$

film, inre transport

$$Sh = \frac{k_c d_p}{D_A}$$

$$\Rightarrow k_c = \frac{Sh\, D_A}{d_p} = 0{,}01 \text{ m/s}$$

$k_c (C_{Ab} - C_{As}) = kC_{As}\eta$

$$C_{As} = \frac{k_c}{k\eta + k_c} C_{Ab}$$

$$qC_{Af} - qC_{Ab} - k\left(\frac{k_c}{k\eta + k_c}\right) C_{Ab}\eta V = 0 \quad \Rightarrow \quad V = 0{,}31\ m^3$$

Inre motstånd försummat $\Rightarrow$ $\eta = 1$

$\eta = 0$ (∞ inre motst.)

$$\Rightarrow \quad qC_{Af} - qC_{Ab} - kV\left(\frac{k_c}{k + k_c}\right) C_{Ab} = 0$$

$$\Rightarrow \quad V = 0{,}3\ m^3$$

Slutsats: Interna motståndet ej viktigt!

5) a) söker:

$$qC_A - q(C_A + dC_A) - kC_A dV = 0$$

$$-qdC_A = kC_A dV \qquad \Rightarrow \quad k = -\frac{q}{V} \ln \frac{C_A}{C_{Af}} = 0{,}0017\ s^{-1}$$

$$-q \ln \frac{C_A}{C_f} = kV$$

Segregationsmodellen

$$\bar{X} = \int_0^\infty (1 - e^{-kt}) \cdot E(t)\, dt = 0{,}77$$

b) Skevhet s^3

c) Spridning σ^2