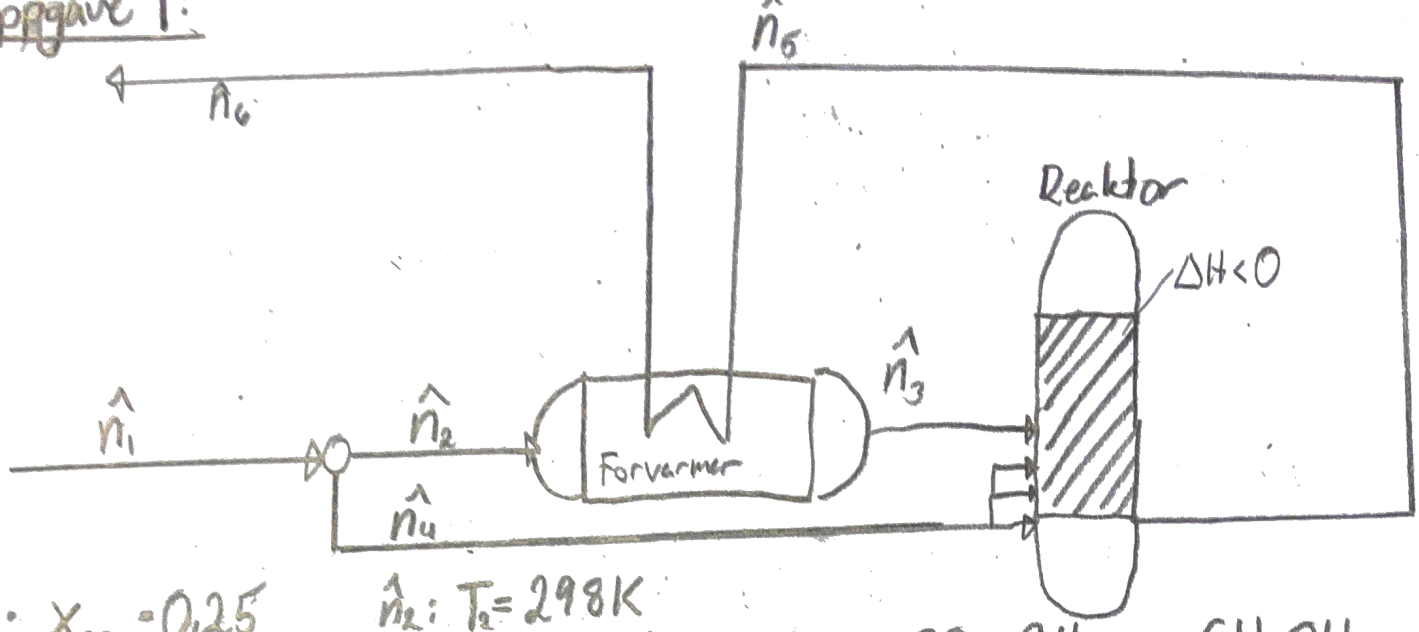
Prosessteknikk - Øving 7

Oppgave 1:



$\hat{n}_1$: $x_{CO} = 0{,}25$, $x_{H_2} = 0{,}55$, $x_{CH_4} = 0{,}15$, $x_{N_2} = 0{,}05$, $T_1 = 298\,K$

$\hat{n}_2$: $T_2 = 298\,K$
$\hat{n}_3$: $T_3 = 500\,K$
$\hat{n}_4$: $T_4 = 298\,K$
$\hat{n}_5$: $T_5 = 550\,K$

Rx: $CO + 2H_2 \rightarrow CH_3OH$
Antar ideell gasslov
$\chi_{CO} = 0{,}20$

Velger basis 1 mol/s

a) Molbalanser reaktor, vi kjenner ikke $\hat{n}_2, \hat{n}_3, \hat{n}_4$ => bruk $\hat{n}_1$

Fra rx omfang: $\chi_{CO} = 0{,}20 \Rightarrow n_{CO}^5 = n_{CO}^1 (1 - 0{,}20)$

$= 1\,mol/s \cdot 0{,}25 \cdot 0{,}80$

$n_{CO}^5 = 0{,}20\,mol/s$

$n_{H_2}^5 = n_{H_2}^1 - 2\xi = 0{,}45\,mol/s$

$n_{CH_4}^5 = n_{CH_4}^1 + 0\xi = 0{,}15\,mol/s$

$n_{N_2}^5 = n_{N_2}^1 + 0\xi = 0{,}05\,mol/s$

$n_{CH_3OH}^5 = \xi = 0{,}05\,mol/s$

$\Rightarrow \xi = (0{,}25 - 0{,}20)\,mol/s$

$\xi = 0{,}05\,mol/s$

$\hat{n}_{5\,tot} = 0{,}90\,mol/s$

Sammensetning $\hat{n}_5$: $\hat{n}_{H_2}^5 = 0{,}45\,mol/s$, $\hat{n}_{CH_4}^5 = 0{,}15\,mol/s$

$\hat{n}_{N_2}^5 = 0{,}05\,mol/s$, $\hat{n}_{CH_3OH}^5 = 0{,}05\,mol/s$

$\hat{n}_{CO}^5 = 0{,}20\,mol/s$

b)

Komponent	C_p (298K) [J/(mol·K)]	C_p (650K) [J/(mol·K)]
CO	29,18	30,12
H_2	28,88	29,34
CH_4	35,55	49,66
N_2	29,18	29,85
CH_3OH	43,83	63,24

I python

$$\bar{C_p}^i = \frac{1}{T_i - T_0} \sum x_{ij} \cdot \int_{T_0}^{T_i} C_{p,i}(T)\, dT$$

$$\bar{C_p}^{\hat{n}_3} = 31,01 \text{ J/(mol·K)}, \quad \bar{C_p}^{\hat{n}_5} = 32,85 \text{ J/(mol·K)}$$

c) Energibalanser reaktor

$\Delta U = U_{inn} - U_{ut} + Q + W$ Antar adiabatisk reaktor, $Q=0$ og $W=0$, videre $\Delta U = 0$

$\Rightarrow \Delta H = 0 = H_{inn} - H_{ut}$

$H_{inn} = H_{ut}$

$H_3 + H_4 = H_5$

$\alpha n'_{tot} \bar{C_p}^3 (T_3 - T_1) = \xi \Delta H_{rx} + \bar{C_p}^5 (T_5 - T_1) n^5_{tot}$

Vet at $H_5 = \xi \Delta H_{rx} + \bar{C_p}^5 (T_5 - T_1) \cdot n^5_{tot}$

$H_3 = \alpha n'_{tot} \bar{C_p}^3 (T_3 - T_1)$

$H_4 = 0$

Kommentar; har her forenklet bort ΔH_f° for strømmene til fordel for ΔH_{rx}. $\Delta H_{rx} = -90$ kJ/mol

$\alpha \cdot 1 \cdot 31,01 (500 - 298) = 0,05 (-90 \cdot 10^3) + 0,9 \cdot 32,85 (650 - 298)$

$$\alpha = \frac{2950}{6262} = 0,471$$

$\alpha = 0,471$

d) Energien skal være bevart: $\Delta E = 0$

Blir ikke helt riktig ettersom $\bar{C_p}^5$ er regnet ut ifra høyeste T

Vet at $\hat{n}_6$ har samme sammensetning som $\hat{n}_5$, forenkler, lar $C_{p n_6} = \bar{C_p}^5$

Det er to enérgibidrag; ΔH_{rx} og oppvarming av strøm

$$\xi \cdot \Delta H_{rx} + n_6 C_{p n_6} (T_6 - T_1) = 0 \Rightarrow T_6 = \frac{-\xi \cdot \Delta H_{rx}}{n_6 C_{p n_6}} + T_1$$

$\Rightarrow T_6 = 450$K