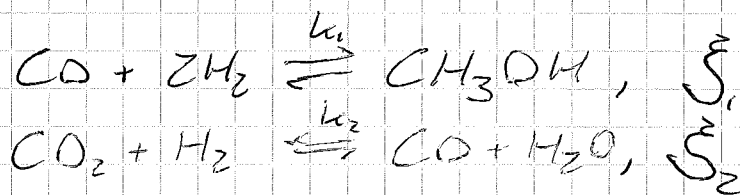


Process 10

OPPG. 1a)



$$\text{I } \dot{n}_{\text{CO}}^{\text{UT}} = \dot{n}_{\text{CO}}^{\text{INN}} - \dot{S}_1 + \dot{S}_2$$

$$\text{II } \dot{n}_{\text{H}_2}^{\text{UT}} = \dot{n}_{\text{H}_2}^{\text{INN}} - 2\dot{S}_1 - \dot{S}_2$$

$$\text{III } \dot{n}_{\text{CH}_3\text{OH}}^{\text{UT}} = \dot{n}_{\text{CH}_3\text{OH}}^{\text{INN}} + \dot{S}_1$$

$$\text{IV } \dot{n}_{\text{CO}_2}^{\text{UT}} = \dot{n}_{\text{CO}_2}^{\text{INN}} - \dot{S}_2$$

$$\text{V } \dot{n}_{\text{H}_2\text{O}}^{\text{UT}} = \dot{n}_{\text{H}_2\text{O}}^{\text{INN}} + \dot{S}_2$$

1b)

$$\dot{n}_0 = 7000 \text{ mol/s}$$

$$x_{\text{CO}}^0 = 0,08$$

$$\text{VI } \dot{n}_{\text{H}_2\text{O}}^{\text{UT}} = 40 \text{ mol/s}$$

$$x_{\text{CO}_2}^0 = 0,02$$

$$\textcircled{1} \quad \dot{S}_2 = 40 \text{ mol/s}$$

$$x_{\text{H}_2}^0 = 0,25$$

$$x_{\text{CH}_4}^0 = 0,15$$

$$\text{VII } \dot{n}_{\text{CO}_2}^{\text{INN}} = x_{\text{CO}_2}^0 \cdot \dot{n}_0 = 140 \text{ mol/s}$$

$$\textcircled{2} \quad \dot{n}_{\text{CO}_2}^{\text{UT}} = (140 - 40) \text{ mol/s} = 100 \text{ mol/s}$$

70% av CO_2 og CO omsettes til CH_3OH

$$0,7(\dot{n}_{\text{CO}_2}^0 + \dot{n}_{\text{CO}}^0) = \dot{n}_{\text{CH}_3\text{OH}}^{\text{UT}}, \quad \dot{n}_{\text{CO}_2}^0 = 140 \text{ mol/s}, \quad \dot{n}_{\text{CO}}^0 = 560 \text{ mol/s}$$

$$\textcircled{3} \quad \dot{n}_{\text{CH}_3\text{OH}}^{\text{UT}} = 490 \text{ mol/s}$$

$$\text{VIII } \dot{S}_1 = \dot{n}_{\text{CH}_3\text{OH}}^{\text{UT}} = 490 \text{ mol/s} \quad \textcircled{4}$$

Oppgave 1b) (fortsettelse)

$$\text{II } \dot{n}_{\text{H}_2}^{\text{UT}} = \dot{n}_{\text{H}_2}^{\text{INN}} - 2\dot{\xi}_1 - \dot{\xi}_2, \quad \dot{n}_{\text{H}_2}^{\text{INN}} = 5250 \text{ mol/s}$$

$$\textcircled{5} \quad \dot{n}_{\text{H}_2}^{\text{UT}} = 5250 - 2 \cdot 490 - 40 = 4230 \text{ mol/s}$$

$$\text{I } \dot{n}_{\text{CO}}^{\text{UT}} = \dot{n}_{\text{CO}}^{\text{INN}} - \dot{\xi}_1 + \dot{\xi}_2, \quad \dot{n}_{\text{CO}}^{\text{INN}} = 560 \text{ mol/s}$$

$$\dot{n}_{\text{CO}}^{\text{UT}} = (560 - 490 + 40) \text{ mol/s}$$

$$\textcircled{6} \quad \dot{n}_{\text{CO}}^{\text{UT}} = 110 \text{ mol/s}$$

$$\textcircled{7} \quad \dot{n}_{\text{H}_2\text{O}}^{\text{UT}} = 40 \text{ mol/s}$$

$$\textcircled{2}, \textcircled{3}, \textcircled{5}, \textcircled{6}, \textcircled{7} : \dot{n}^{\text{UT}} = (190 + 490 + 4230 + 110 + 40) \text{ mol/s}$$

$$\dot{n}^{\text{UT}} = 4970 \text{ mol/s} + 1050 \text{ mol/s}$$

$$x_{\text{CO}_2}^{\text{UT}} = 0,016$$

$$x_{\text{CO}}^{\text{UT}} = 0,028$$

$$x_{\text{CH}_3\text{OH}}^{\text{UT}} = 0,8$$

$$x_{\text{H}_2}^{\text{UT}} = 0,7$$

$$x_{\text{H}_2\text{O}}^{\text{UT}} = 0,007$$

$$x_{\text{CH}_4}^{\text{UT}} = 0,17$$

1c)

$$C_p^{\text{CO}} = 29 \frac{\text{J}}{\text{mol K}} \quad C_p^{\text{CH}_4} = 36 \frac{\text{J}}{\text{mol K}}$$

$$C_p^{\text{CO}_2} = 37 \text{ --} \quad C_p^{\text{H}_2\text{O}} = 34 \text{ --}$$

$$C_p^{\text{H}_2} = 29 \text{ --} \quad C_p^{\text{CH}_3\text{OH}} = 44 \text{ --}$$

$$\text{Varmekapasitet utstrøm} = \sum \dot{n}_i C_{p,i} = 190 \frac{\text{kJ}}{\text{K}}$$

$$\text{Varmekapasitet innstrøm} = \sum \dot{n}_i C_{p,i} = 211,5 \frac{\text{kJ}}{\text{K}}$$

$$\dot{H}^{\text{INNSTRØM}} = \sum \Delta_f H_i \cdot \dot{n}_i + C_p^{\text{INN}} (160^\circ\text{C} - 25^\circ\text{C})$$

$$= ~~237,5 \text{ kJ}~~ + 28,5 \text{ kJ} - 194,5 \text{ kJ} = -166 \text{ kJ}$$

$$\dot{H}^{\text{UTSTRØM}} = \sum \Delta_f H_i \cdot \dot{n}_i + C_p^{\text{UT}} (270^\circ\text{C} - 25^\circ\text{C})$$

$$= -237,5 \text{ kJ} + 46,5 \text{ kJ} = -191 \text{ kJ}$$

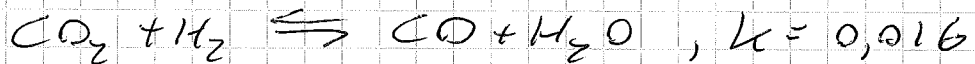
1c) (Fortsetzung)

$$H^W = H^{inn} + Q$$

$$-191 \text{ kJ} = -166 \text{ kJ} + Q$$

$$\underline{Q = -25 \text{ kJ}}$$

1d)



$$\frac{[\text{CO}][\text{H}_2\text{O}]}{[\text{CO}_2][\text{H}_2]} = 0,016$$

alle Koeffizienten = 1

$$\text{I} \quad \frac{n_{\text{CO}}^W \cdot n_{\text{H}_2\text{O}}^W}{n_{\text{CO}_2}^W \cdot n_{\text{H}_2}^W} = 0,016$$

$$\text{II} \quad n_{\text{CH}_3\text{OH}}^W = n_{\text{CH}_3\text{OH}}^{inn} + \xi_1 \rightarrow \underline{\xi_1 = 490 \text{ mol/s}}$$

$$\text{II} \quad n_{\text{CO}}^W = n_{\text{CO}}^{inn} + \xi_2 - \xi_1$$

$$\text{III} \quad n_{\text{H}_2\text{O}}^W = \xi_2$$

$$\text{IV} \quad n_{\text{CO}_2}^W = n_{\text{CO}_2}^{inn} - \xi_2$$

$$\text{V} \quad n_{\text{H}_2}^W = n_{\text{H}_2}^{inn} + 2\xi_1 - \xi_2$$

Unglenne:

$$n_{\text{CO}}^W, n_{\text{H}_2\text{O}}^W, n_{\text{CO}_2}^W$$

$$n_{\text{H}_2}^W, \xi_2$$

5 Gleichungen, 5 Unglenne, L6ser i python:

$$x_{\text{CO}} = 0,02, x_{\text{CO}_2} = 0,016, x_{\text{H}_2\text{O}} = 0,01, x_{\text{H}_2} = 0,76$$

$$x_{\text{CH}_4} = 0,18$$

Oppg 1e)

$$K = \exp\left(\frac{-\Delta G(T)}{RT}\right)$$

$$\Delta G(\text{reak}) = \Delta_r H - T \Delta_r S$$

$$\Delta_r H = \Delta_f H(T)_{\text{prod}} - \Delta_f H(T)_{\text{reaktanter}}$$

$$\Delta_r H = -201 \frac{\text{kJ}}{\text{mol}} + 44(270^\circ\text{C} - 25^\circ\text{C}) - (-111 + 3 \cdot 29(270^\circ\text{C} - 25^\circ\text{C}))$$

$$\Delta_r H = -109,5 \frac{\text{kJ}}{\text{mol}}$$

$$\Delta_r S = S_{\text{prod}} - S_{\text{reakt}}$$

$$= 240 \frac{\text{J}}{\text{K mol}} - (198 \frac{\text{J}}{\text{K mol}} + 2 \cdot 131 \frac{\text{J}}{\text{K mol}})$$

$$= 240 \frac{\text{J}}{\text{K mol}} + 44 \ln\left(\frac{545}{248}\right) - \left(198 \frac{\text{J}}{\text{K mol}} + 29 \frac{\text{J}}{\text{K mol}} \ln\left(\frac{545}{248}\right) + 2(131 + 29 \ln\left(\frac{545}{248}\right))\right)$$

$$\Delta_r S = -245 \frac{\text{J}}{\text{mol K}} + 112 \frac{\text{J}}{\text{mol K}}$$

$$\Delta S = \int_{T_0}^{T_1} \frac{C_p dT}{T} = C_p \ln\left(\frac{T_1}{T_0}\right)$$

$$\Delta_r G = \Delta_r H - T \Delta_r S \sim -37 \frac{\text{kJ}}{\text{mol}}$$

$$\Delta_{\text{vap}} H_{\text{CH}_3\text{OH}} = 38 \frac{\text{kJ}}{\text{mol}} \rightarrow \Delta_{\text{vap}} S = 112 \frac{\text{J}}{\text{mol K}}$$

$$K = 3518$$

produkt sammensetning i oppg d gir:

$$Q = \frac{[\text{CH}_3\text{OH}]}{[\text{CO}][\text{H}_2]^2} = 7,6$$

likevekten er forskyvet
mot venstre ($Q < K$)

~~likevekten er forskyvet mot høyre~~

Kommentar: Her virker det som noe ikke
stemmer, har jeg misforstått noe?

Tror jeg fant feilen (beregner stygg foring)