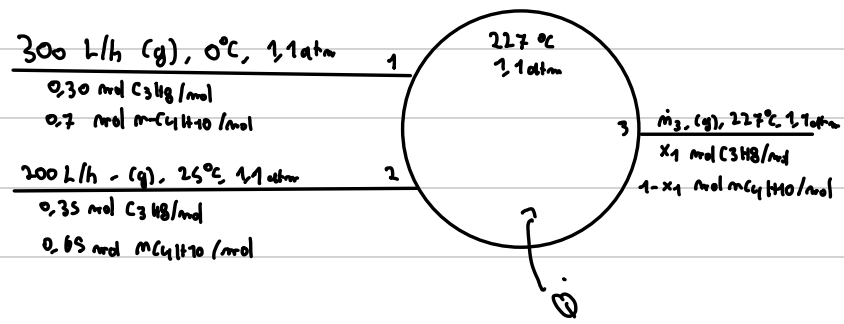
Problème 11.1

C_3H_8 : P

$m\text{-}C_4H_8$: B



① Bilan d'énergie : $\dot{Q} - \dot{W}_s = \Delta\dot{E}_P + \Delta\dot{E}_k + \Delta\dot{H}$

On $W_s = 0$ car on a pas de pièces mobiles

$\Delta E_P \approx 0$ car la hauteur est constante

$\Delta E_k \approx 0$ car la vitesse est constante

Donc $\dot{Q} = \Delta\dot{H}$

② Posons nos références:

- B (g), 0°C, 1 atm
- P (g), 0°C, 1 atm

③ Calculs des débits et compositions

① : $300\ L/h = \dfrac{300\ kg/h \times \frac{1000\ g}{1\ kg}}{(44 \cdot 0{,}3 + 58 \cdot 0{,}7)\ g/mol} = 5576{,}24\ mol/h = 1{,}55\ mol/s$

② $200\ L/h = \dfrac{200\ kg/h \times 1000\ g/1\ kg}{0{,}35 \cdot 44 + 0{,}65 \cdot 58} = 3766{,}48\ mol/h = 1{,}046\ mol/s$

③ $\dot{m}_3 = 1{,}55 + 1{,}046 = 2{,}596\ mol/s$

Bilan sur Pentane : $0{,}3 \cdot 1{,}55 + 0{,}35 \cdot 1{,}046 = x_1 \cdot 2{,}596$

$x_1 = 0{,}32\ mol\ P/mol$

$1 - x_1 = 0{,}68\ mol\ B/mol$

④ On crée le tableau des enthalpies

Substance	$\dot{m}_{in}$	$\hat{H}_{in}$	$\dot{m}_{out}$	$\hat{H}_{out}$
C_3H_8 (g)	0,8311	$\hat{H}_1$	0,831	$\hat{H}_3$
m-C_4H_{10} (g)	1,7649	$\hat{H}_2$	1,763	$\hat{H}_4$

$\hat{H}_1 = \int_0^{25} C_{p(P)_g} = 1772\ J/mol$ $\quad \hat{H}_3 = \int_0^{227} C_{p(P)_g} = 20685\ J/mol$

$\hat{H}_2 = \int_0^{25} C_{p(B)_g} = 2394\ J/mol$ $\quad \hat{H}_4 = \int_0^{227} C_{p(B)_g} = 27442\ J/mol$

⑤ On a $\dot{Q} = \sum \dot{m}_o \hat{H}_o - \sum \dot{m}_i \hat{H}_i$

$= 0{,}831 \cdot 20685 + 1{,}763 \cdot 27442$

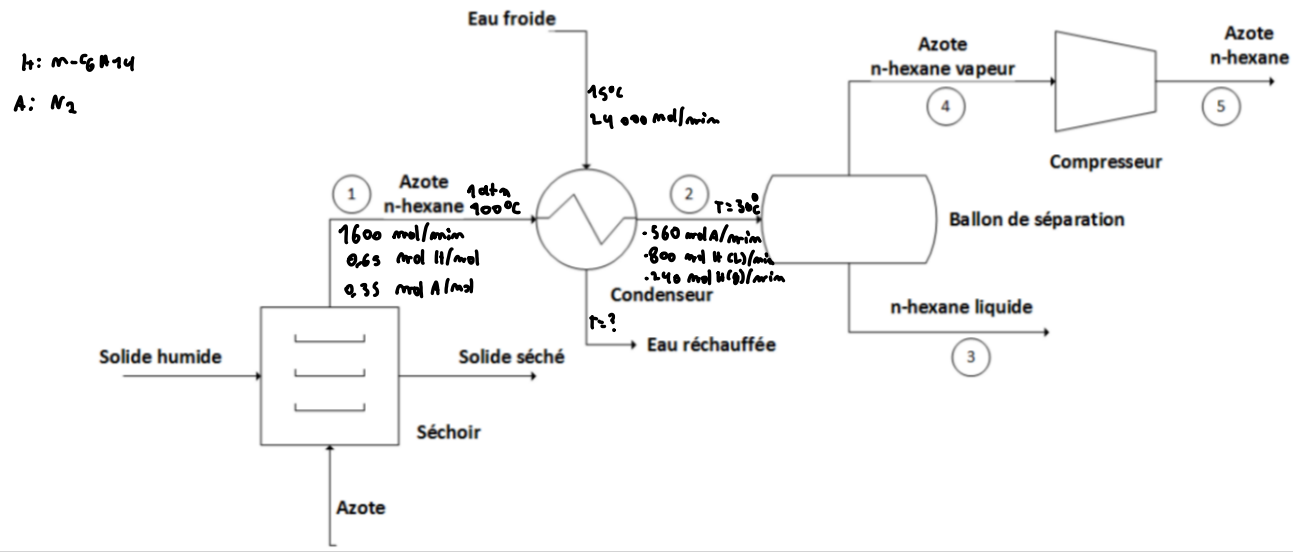
$- 0{,}8311 \cdot 1772 - 1{,}7649 \cdot 2394$

$= 59926{,}49\ J/s$

$= 59{,}9\ kJ/s$

$= 215\,735{,}3\ kJ/h$

Problème 17.4



A) ① Bilan d'énergie: $\dot{Q} - \dot{W}_s = \Delta\dot{E}_p + \Delta\dot{E}_k + \Delta\dot{H}$ or $W_s = 0$ car on a pas de parties mobiles

$\Delta E_p \approx 0$ car la hauteur est constante

$\Delta E_k \approx 0$ car la vitesse est constante

Donc $\dot{Q} = \Delta\dot{H}$

② Posons nos références : Azote (g), 25°C, 1 atm

H_2O (L), 15°C, 1 atm

Hexane (g), 100°C, 1 atm

③ Tableau Enthalpies

Substance	$\dot{m}_{in}$	$\hat{H}_{in}$	$\dot{m}_{out}$	$\hat{H}_{out}$
Hexane (L)	-	-	800	$\hat{H}_1$
Azote (g)	560	-	560	$\hat{H}_2$
Hexane (g)	1040	-	240	$\hat{H}_3$

③ Calcul des enthalpies:

$$\hat{H}_1 = \int_{100}^{69} C_p(g)\,dT - \Delta\hat{H}_v + \int_{69}^{30} C_p(L)$$

$$= \int_{100}^{69} 0{,}14 + 0{,}0004\,T - 28{,}85 + \int_{69}^{30} 0{,}22\,dT = -42{,}8170 \text{ kJ/mol}$$

$$\hat{H}_2 = \int_{25}^{100} C_p(g)\,dT + \int_{100}^{30} C_p(g)\,dT = 2{,}19 - (f(30) + 2{,}19)$$

$$f(30) = \frac{2{,}19 - 0}{100 - 0} \cdot 30 + \frac{100 \cdot 0 - 2{,}19 \cdot 0}{100 - 0} = 0{,}657$$

$$= 2{,}19 - (0{,}657 - 2{,}19)$$

$$= 0{,}657$$

$$\hat{H}_3 = \int_{100}^{69} C_p(g)\,dT + \int_{69}^{30} C_p(g)\,dT = -13{,}9678 \text{ kJ/mol}$$

⑤ On a alors: $\dot{Q} = \sum \dot{m}_o \hat{H}_o - \sum \dot{m}_i \hat{H}_i$

$= 0 - (800 \cdot (-42{,}8170) + 560 \cdot 0{,}657 + 240 \cdot (-13{,}9678))$

$= 37\,237{,}952$ kJ/min

On soutire de la chaleur donc

$\dot{Q} = -37\,237{,}952$ kJ/min

B) On a $Q_2 = -Q_1$ où Q_1 est la chaleur soutirée au condensateur

$\dot{Q}_2 = 37\,237,952$ kJ/min

On a notre référence : $H_2O(l)$, 15 °C, 1 atm

$\dot{Q}_2 = \dot{m} \cdot \hat{H}_0$ $\qquad \hat{H}_0 = \int_{15}^{T} Cp(l)\,dT = \int_{15}^{T} 0,075\,dT = 0,075T - 0,075 \cdot 15$

$= 0,075T - 1,125$

$37\,237,952 = 24\,000\,(0,075 - 1,125)$

$1,55 + 1,125 = 0,075T$

$T = 35,67$ °C