

Corrigé Examen Réacteurs Homogènes 2025/2026

Exercice N°1 (6pts) $A \rightarrow 2R$ (phase gazeuse) RAO

$T_0 = 1219\text{K}$; $P_0 = 1\text{atm}$; $F_{A0} = 1\text{kmol/h}$; $K = 200\text{h}^{-1}$

$X_{AS} = 80\%$, $r = -r_A = K C_A$

$$\tau = \frac{C_{A0} X_{AS}}{-r_{AS}} = \frac{C_{A0} X_{AS}}{K C_{AS}} \quad (0,5)$$

$$C_{AS} = \frac{n_{AS}}{V} = \frac{n_{A0}(1-X_{AS})}{V_0 \beta (1+\epsilon X_{AS})} = \frac{C_{A0}(1-X_{AS})}{1+\epsilon X_{AS}} = \frac{C_{A0}(1-X_{AS})}{1+X_{AS}} \quad (0,5)$$

$\beta = 1$ (T, P etc) (0,25)

$X = X_A$ (réaction $A \rightarrow$ Produits) (0,25)

$\epsilon = \frac{\Delta d}{1+I} = \Delta d = 1$ (0,5)

$$\tau = \frac{(1+X_{AS})X_{AS}}{K(1-X_{AS})} = \frac{(1+0,8)0,8}{200(1-0,8)} = 0,036\text{h} \quad (0,5)$$

$\tau = \frac{V_{RAO}}{\Phi} \Rightarrow V = \tau \cdot \Phi$

$$\left. \begin{array}{l} F_{A0} = C_{A0} \Phi \\ P_0 = C_{A0} R T_0 \end{array} \right\} \Rightarrow \Phi = \frac{F_{A0} R T_0}{P_0} = \frac{10^3 \cdot 0,082 \cdot 1219}{1} = 99958\text{ l/h} \quad (0,5)$$

$\Phi = 99958\text{ l/h} \approx 27,77\text{ l/s}$

$V_{RAO} = \tau \cdot \Phi = 3598,5\text{ l} \approx 3,6\text{ m}^3 \quad (0,5)$

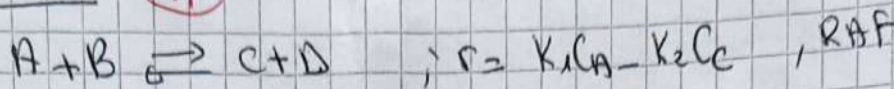
20) $F_{A0} = F_I = 1\text{kmol/h}$; $X_{AS} = 80\%$

$$\epsilon' = \frac{\Delta d}{1+I} = \frac{\Delta d}{1 + \frac{\epsilon I_0}{F_{A0}}} = \frac{1}{2} \quad (0,5)$$

$$\left. \begin{array}{l} \Phi' = \frac{F_{A0} R T_0}{\frac{P_0}{2}} = \frac{2 F_{A0} R T_0}{P_0} = 199916\text{ l/h} \\ \tau' = \frac{X_{AS}(1 + \frac{X_{AS}}{2})}{K(1-X_{AS})} = \frac{0,8(1 + \frac{0,8}{2})}{200(1-0,8)} = 0,028\text{h} \end{array} \right\} \begin{array}{l} V' = \tau' \Phi' \quad (0,5) \\ = 5597,6\text{ l} \\ V' \approx 5,6\text{ m}^3 \end{array} \quad (0,5)$$

Exercice N°2

715



10)
$$\left. \begin{aligned} k_1 + k_2 &= 0,018 \\ \frac{k_1}{k_2} &= 4 \end{aligned} \right\} \Rightarrow \begin{aligned} k_1 &= 0,0144 \text{ min}^{-1} \\ k_2 &= 0,0036 \text{ min}^{-1} \end{aligned}$$

20) Conversion à l'équilibre

à l'équilibre $r = 0 \Rightarrow k_1 C_{Aeq} = k_2 C_{Ceq}$

$$\begin{aligned} C_{Aeq} &= C_{A0}(1 - X_{Aeq}) \\ C_{Ceq} &= C_{C0} + C_{A0} X_{Aeq} \end{aligned} \Rightarrow k_1 C_{A0}(1 - X_{Aeq}) = k_2 C_{A0} X_{Aeq}$$

$$\Rightarrow X_{Aeq} = \frac{k_1}{k_1 + k_2}$$

$$X_{Aeq} = \frac{0,0144}{0,018} = 0,8$$

30) $t_s = 2h$, $X_A = ?$

$$t_s = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{-r_A} = C_{A0} \int_0^{X_{AF}} \frac{dX_A}{k_1 C_A - k_2 C_C}$$

$$-r_A = k_1 C_A - k_2 C_C = k_1 C_{A0}(1 - X_A) - k_2 C_{A0} X_A = C_{A0} [k_1 - X_A(k_1 + k_2)]$$

$$-r_A = C_{A0} [(k_1 + k_2) X_{Ae} - X_A(k_1 + k_2)] = C_{A0} [(k_1 + k_2)(X_{Ae} - X_A)]$$

$$t_s = \int_0^{X_{AF}} \frac{dX_A}{(k_1 + k_2)(X_{Ae} - X_A)} = -\frac{1}{k_1 + k_2} \ln \left(\frac{X_{Ae} - X_{AF}}{X_{Ae}} \right)$$

$$\frac{X_{Ae} - X_{AF}}{X_{Ae}} = e^{-\frac{t_s(k_1 + k_2)}{C_{A0}}} \Rightarrow X_{AF} = -X_{Ae} \cdot e^{-\frac{t_s(k_1 + k_2)}{C_{A0}}} + X_{Ae}$$

$$X_{AF} = -0,8 \cdot e^{-0,60(0,018)} + 0,8 = 0,7077 \approx 0,71$$

$$X_{AF} \approx 0,71$$

4°/ temps de cycle

$$\text{temps cycle} = \text{temps mort} + t_p = 2 + 1 = 3 \text{ h} \quad (0,5)$$

Nombre de cycles par jour: $N = \frac{24}{3} = 8 \text{ cycles/jour}$

5°/ $2,5 \text{ kg/jour} \rightarrow \frac{2,5}{8} = 0,3125 \text{ kg/cycle} \quad (0,5)$

$$M_c = 116 \text{ g/mol} = 0,116 \text{ kg/mol}$$

$$n_c = \frac{0,3125}{0,116} = 2,69 \text{ mol} \quad (0,5)$$

6°/ Quantité de A à introduire dans le cycle.

$$C_c = C_{A0} X_{Af} \Rightarrow C_{A0} = \frac{C_c}{X_{Af}} \Rightarrow n_{A0} = \frac{n_c}{X_{Af}} = \frac{2,69}{0,71} \approx 3,79 \text{ mol} \quad (0,5)$$

7°/ Masse totale de la charge initiale

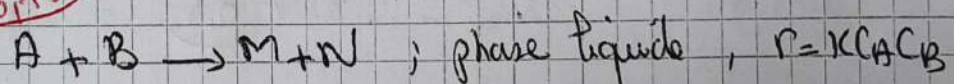
$$\frac{n_{B0}}{n_{A0}} = 10 \Rightarrow n_{B0} = 10 n_{A0} = 10 \times 3,79 = 37,9 \text{ mol} \quad (0,5)$$

$$\text{Masse de A: } 3,79 \times 60 = 227,4 \text{ g} \quad (0,25)$$

$$\text{Masse de B: } 37,9 \times 74 = 2806,6 \text{ g} \quad (0,25)$$

$$\text{Masse totale: } 227,4 + 2806,6 = 3034 \text{ g} \approx 3,032 \text{ kg} \quad (0,25)$$

Exercice N°3 0,75



$$k = 0 \text{ l/mol}\cdot\text{min} \quad (R_{A0}) \quad v = 10,6 \text{ l} \quad ; \quad Q = 300 \text{ l/h}$$

$$\tau_a = \frac{C_{A0} X_{As}}{-r_{As}} = \frac{C_{A0} X_{As}}{k C_A C_B} = \frac{C_{A0} X_{As}}{k C_{A0}^2 (1-X_{As})(M-X_{As})} \quad (0,25)$$

$$C_{As} = C_{A0} (1-X_{As}) \quad (0,25)$$

$$C_{Bs} = C_{B0} - C_{A0} X_{As} \quad (0,25)$$

$$\tau_a = \frac{v_{R_{A0}}}{Q} = \frac{X_{As}}{k C_{A0} (1-X_{As})(M-X_{As})} = 2,52 \text{ min} \quad (0,25)$$

$$M = \frac{C_{B0}}{C_{A0}} = \frac{11}{0,18} = 61,1 \quad (0,25)$$

$$\Rightarrow k \tau_a C_{A0} (1-X_{As})(M-X_{As}) = X_{As}$$

$$\Rightarrow k \tau_a C_{A0} X_{As}^2 - X_{As} (k \tau_a C_{A0} + k \tau_a C_{A0} M + 1) + k \tau_a C_{B0} M = 0$$

(3)

$$4,2336 X_{A5}^2 - 11,0568 X_{A5} + 5,8212 = 0 \quad (0,5)$$

$$\Delta = 23,63 \quad X_{A5} = 0,73 \quad (73\%) \quad (0,5)$$

20) REP $X_{A5} = 73\%$

$$\tau_p = C_{A0} \int_0^{X_{A5}} \frac{dx_A}{-r_A} = C_{A0} \int_0^{X_{A5}} \frac{dx_A}{k(C_{A0}(1-x_A))(M-x_A)} = \frac{1}{kC_{A0}} \int_0^{X_{A5}} \frac{dx_A}{(1-x_A)(M-x_A)} \quad (0,5)$$

$$\int \frac{dx_A}{(1-x_A)(M-x_A)} = \frac{1}{M-1} \int \frac{dx_A}{1-x_A} + \frac{1}{1-M} \int \frac{dx_A}{M-x_A} \quad (0,5)$$

$$\tau_p = \frac{1}{kC_{A0}} \frac{1}{M-1} \ln \left(\frac{M-x_{A5}}{M(1-x_{A5})} \right) = \frac{1}{2,1 \cdot 0,8} \frac{1}{1,375-1} \ln \left[\frac{1,375-0,73}{1,375(1-0,73)} \right] =$$

$$\tau_p = 0,876 \text{ min} \quad (0,5)$$

$$V_{REP} = \tau_p \cdot Q = \frac{0,876 \cdot 300}{60} = 4,39 \text{ l} \quad (0,5)$$

30) $M' = \frac{14}{0,8} = 1,75$; $\tau_a = \frac{X_{A5}}{kC_{A0}(1-x_{A5})(M'-x_{A5})} \quad (0,25)$

$$\Rightarrow k\tau_a C_{A0} X_{A5}'^2 - X_{A5}' (k\tau_a C_{A0} + k\tau_a C_{A0} M' + 1) + k\tau_a C_{A0} M' = 0$$

$$\Rightarrow 4,2336 X_{A5}'^2 - 12,6468 X_{A5}' + 7,4088 = 0 \quad (0,5)$$

$$\Delta = 34,367 \quad X_{A5}' = 0,80 \quad (0,5)$$

Conclusion: L'excès du réactif B, fait augmenter le taux de conversion (0,5)

Lorsqu'on utilise l'excès stoechiométrique de B par rapport à A, on améliore les performances du RAO