Réponse الإجابة

التصحيح النموذجي :

Exercice I :

Cstr : Accumulation = in − out + generation

$$V\frac{dC_A}{dt} = F(C_{A0} - C_A) + Vr_A$$

PFR : $$F\frac{dC_A}{dV} = r_A \Rightarrow \frac{dC_A}{dl} = -\frac{k_3}{F}C_A$$

Batch : in = 0 out = 0

$$\Rightarrow \frac{dC_A}{dt} = r_A \Rightarrow \frac{dC_A}{dt} = -kC_A$$

2- Assumptions

- Cstr : $F_{in} = F_{out}$, $C_{A,out} = C_A$, $T = cst$ (0,5)
- RFR : no axial mixing (C_A varies along "L" reactor length only) (0,5)
- Batch reactor : Perfect mixing , $T = cst$
  $V = cst$ (0,5)

3- Ethanol Production in Lab :

1- Substrate preparation
2- fermentation (1,5)
3- Separation and purification

Exercise II

1- $\frac{dC_A}{dx} = \frac{kS}{F} C_A$ with $C_A(0) = C_{A,in}$ (0,5) (0,5)

2- Analytical solution :

$C_A(x) = C_{A,in} e^{-\frac{kS}{F}x}$ (0,5)

$\tau = \frac{V}{F} = \frac{SL}{F}$ (0,5)

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3. $S = \frac{\pi D^2}{4} = 1,96.10^{-3}\ m^2$ 0,5

$V = S.L = 9,817.10^{-3}\ m^3$ 0,5

4. Matlab script:

```
L = 5;
D = 0,05;
F = 2e-04;
C_A,in = 2;
h = 0,05;
S = Pi * D^2/4
V = S*L
tau = V/F;
```

0,5 0,5 0,5

```
f = PFR = @(x, C_A) ... h*S/F*C_A)
[x, C_A] = ode45(f-PFR, [0 L], C_A,in);
CAout = CA(end)
```

0,5 0,5 0,5

5. Matlab script:

```
figure; hold on;
Plot(x, curve1; linewidth, 2);
Plot(x, curve2; 'r--', linewidth, 2);
xlabel('X Axis');
ylabel('Y Axis');
title('Title');
Legend('curve1', 'curve2')
grid on;
```

0,25 0,25 0,25 0,25 0,25

6. x : Reactor length (m), y : concentration (mol/L) / conversion 0,5

curve 1 : concentration (mol/L) 0,5

curve 2 : conversion 0,5

title : concentration and conversion Profiles in PFR 0,5

7. In PFR: C_A and X_A vary with position
Ideal not with time

8. $C_{A,in} = 1$ mol/L , $C_{A,out} = 0.09$ mol/L

$X_{in} = 0$ $X_{Aout} = \frac{C_{A,in} - C_{Aout}}{C_{A,in}} = 0,91$

9. if $l \to \infty$: $C_A \to 0$ and $X \to 100\%$
if $S' = 2S$, $V' = 2V$ so C_A ↓ and X ↑

10. $X(x) = \frac{C_A(0) - C_A(x)}{C_A(0)}$

11. $C_A = C_A(0)\,(1 - X(x))$

$C_A = C_{A,in}\,(1 - X(x))$

Exercise III. cstrs

1. ODE: 1st $\frac{dC_1}{dt} = \frac{F}{V}(C_{A,in} - C_1) - kC_1$

2nd $\frac{dC_2}{dt} = \frac{F}{V}(C_1 - C_2) - kC_2$

Nth: $\frac{dC_N}{dt} = \frac{F}{V}(C_{N-1} - C_N) - kC_N$

2. f_cstr_inSeries = @(x, C_A) [$\frac{F}{V}(C_{A,in} - CA(1)) - k\,CA(1)$;
$(CA(1) - CA(2)) - k\,CA(2)$;
$(CA(2) - CA(3)) - k\,CA(3)$]

3. figure 2 represents ~~concentration~~ profile in 3 cstrs in series conversion

4. Transient regime [0 ~ 400] 5. $\begin{cases} C_{1,out} = C_{A,in}\left(1 - 0,75\right) \\ X_{A,out} = 75\% \end{cases}$ $= 0,25\,C_{A,in}$