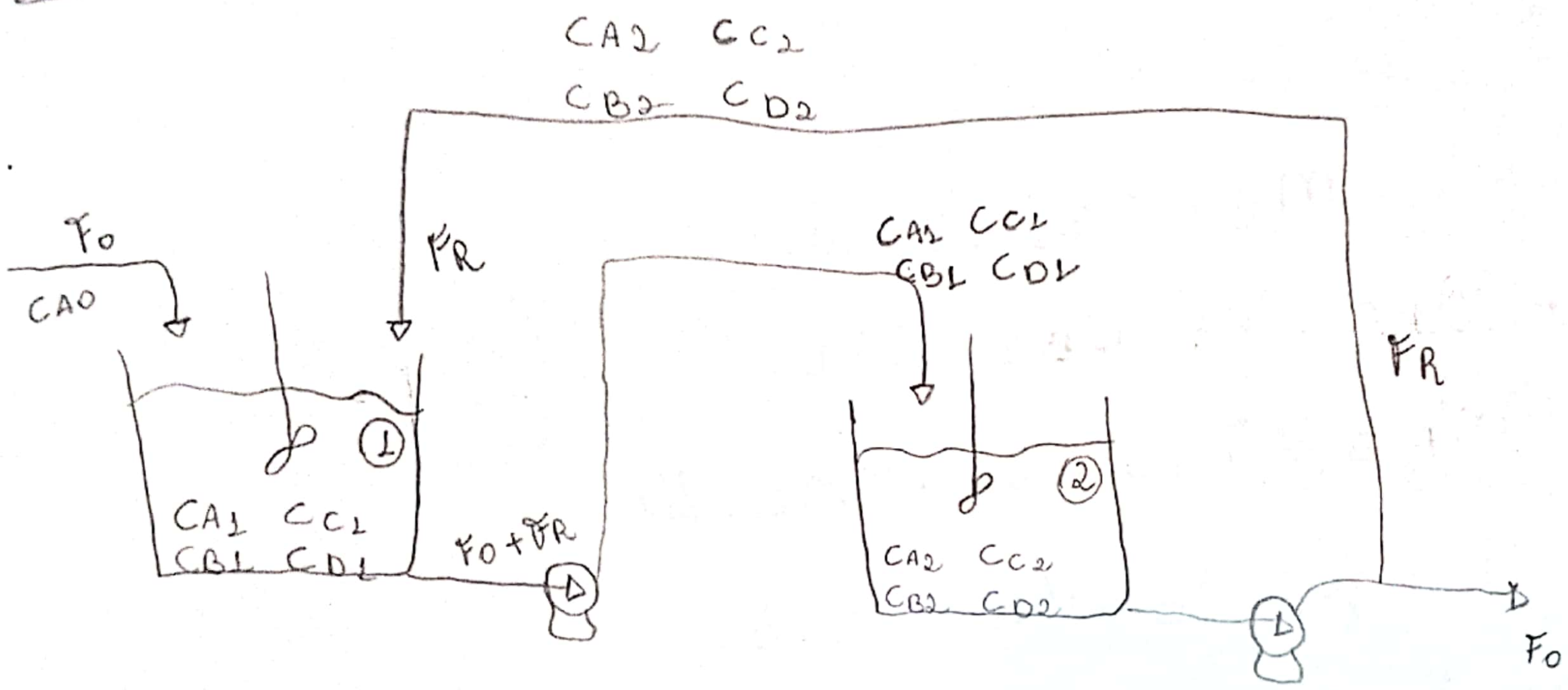
# lista 01

2.




→ hipóteses:

H1: mistura perfeita

H2: isotérmica.

H3: cilindro perfeito

H4: propriedades físicas constantes.

H5: Volume constante. ($F_S = F_O + F_R$)

1. V. D. F = massa

2. V. C = Reator 01 e Reator 02

3. V. E :

→ Para o reator 01:

Componente A:

acúmulo: $m_A = C_{A1} . V . MM_A$

entra: $m_{Ae} = F_0 . C_{A0} . MM_A . \Delta t + F_R\, C_{A2}\, MM_A . \Delta t$

saí: $m_{AS} = F_S . C_{A1} . MM_A . \Delta t$

Reage: $m_{AR} = R_A . V . MM_A . \Delta t$

Componente B:

acúmulo: $m_B = C_{B1} . V . MM_B$

entra: $m_{Be} = F_R . C_{B2} . MM_B . \Delta t$

saí: $m_{BS} = F_S . C_{B1} . MM_B . \Delta t$

reage: $M_{reage} = R_B . V . MM_B . \Delta t$

Componente C:

acúmulo: $m_C = C_{C1} . V . MM_C$

entra: $m_{Ce} = F_R . C_{C2} . MM_C . \Delta t$

saí: $m_{CS} = F_S . C_{C1} . MM_C . \Delta t$

reage: $m_{reage} = R_C . V . MM_C . \Delta t$

Componente D :

Acúmulo : $m_D = C_{D1} \cdot V \cdot MM_D$

entra : $m_{DE} = FR \cdot C_{D2} \cdot MM_D \cdot \Delta t$

sai : $m_{DS} = FS \cdot C_{D1} \cdot MM_D \cdot \Delta t$

Reage : $M_{reage} = R_D \cdot V \cdot MM_D \cdot \Delta t$

4- Conservação de massa:

$$m|_{t+\Delta t} = m_t + m_e(t \to \Delta t) - m_s(t \to \Delta t)$$

→ Componente A:

$$C_{A1} \cdot V \cdot \cancel{MM_A}|_{t+\Delta t} = C_{A1} \cdot V \cdot \cancel{MM_A}|_t + F_0 C_{A0} \cancel{MM_A} \cdot \Delta t$$
$$+ F_R \cdot C_{A2} \cancel{MM_A} \cdot \Delta t - F_S C_{A1} \cancel{MM_A} \cdot \Delta t$$
$$+ R_A \cdot V \cdot \cancel{MM_A} \cdot \Delta t \qquad / \cdot \Delta t$$

$$\lim_{\Delta t \to 0} \left( \frac{C_{A1} \cdot V|_{t+\Delta t} - C_{A1} \cdot V|_t}{\Delta t} \right) = F_0 C_{A0} + F_R \cdot C_{A2} - F_S C_{A1} + R_A V$$

$$\frac{d(C_{A1} \cdot V)}{dt} = F_0 C_{A0} + F_R \cdot C_{A2} - F_S C_{A1} + R_A V$$

$$\cancel{V} \frac{dC_{A1}}{dt} + C_{A1} \underbrace{\frac{dV}{dt}}_{0 \text{ constante}} = \frac{F_0 C_{A0} + F_R \cdot C_{A2} - F_S C_{A1}}{V} + R_A$$

$$\frac{dC_{A1}}{dt} = \frac{F_0 C_{A0} + F_R \cdot C_{A2} - F_S C_{A1}}{V} + R_A$$

Componente B:

$$C_{B1} \cdot V \cdot \cancel{MM_B} \Big|_{\vartheta+\Delta\vartheta} - C_{B1} \cdot V \cdot \cancel{MM_B} \Big|_{\vartheta} = F_R \cdot C_{B2} \cdot \cancel{MM_B} \cdot \Delta\vartheta$$

$$- F_S C_{B1} \cancel{MM_B} \cdot \Delta\vartheta + R_B \cdot V \cdot \cancel{MM_B} \, \Delta\vartheta$$

$$\div \Delta\vartheta$$

$$\lim_{\Delta\vartheta \to 0} \left( \frac{C_{B1} \cdot V \Big|_{\vartheta+\Delta\vartheta} - C_{B1} \cdot V \Big|_{\vartheta}}{\Delta\vartheta} \right) = F_R \cdot C_{B2} - F_S C_{B1} + R_B \cdot V$$

$$\frac{d(C_{B1} \cdot V)}{d\vartheta} = F_R \cdot C_{B2} - F_S C_{B1} + R_B \cdot V$$

$$V \cdot \frac{d(C_{B1})}{d\vartheta} + C_{B1} \overset{0}{\frac{dV}{d\vartheta}} = F_R C_{B2} - F_S C_{B1} + R_B \cdot V$$

$$\frac{d(C_{B1})}{d\vartheta} = \frac{F_R C_{B2} - F_S C_{B1}}{V} + R_B$$

Componente C:

$$\lim_{\Delta\vartheta \to 0} \left( \frac{C_{C_1} \cdot V \cdot \cancel{MM_C}|_{\vartheta+\Delta\vartheta} - C_{C_1} \cdot V \cdot \cancel{MM_C}|_{\vartheta}}{\Delta\vartheta} \right)$$

$$= F_R \cdot C_{C_2} \cdot \cancel{MM_C} - F_S\, C_{C_1} \cdot \cancel{MM_C} + R_C \cdot V \cdot \cancel{MM_C}$$

$$\frac{d(C_{C_1} \cdot V)}{d\vartheta} = F_R \cdot C_{C_2} - F_S\, C_{C_1} + R_C \cdot V$$

$$C_{C_1} \cancel{\frac{dV}{d\vartheta}}^{0} + V \frac{d(C_{C_1})}{d\vartheta} = F_R \cdot C_{C_2} - F_S\, C_{C_1} + R_C\, V$$

$$\frac{d(C_{C_1})}{d\vartheta} = \frac{F_R \cdot C_{C_2} - F_S\, C_{C_1}}{V} + R_C$$

Conservação de massa:

$$\frac{d(C_{D1})}{dt} = \frac{F_R . C_{D2} - F_S C_{D1}}{V} + R_D$$

# Analise das Taxas:

$$\overset{A}{C_2H_5OH} \xrightarrow{K_1} \underline{\overset{B}{C_2H_4}} + H_2O$$

$$\overset{A}{C_2H_5OH} \xrightarrow{K_2} \underline{\overset{C}{CH_3CHO}} + H_2$$

$$\underline{\overset{B}{C_2H_4}} + \underline{\overset{C}{CH_3CHO}} \xrightarrow{K_3} \underline{\overset{D}{C_4H_6}} + H_2O$$

$$\begin{cases} -R_A = K_1 C_A + K_2 C_A \\ -R_B = K_3 C_B C_C - K_1 C_A \\ -R_C = K_3 C_B C_C - K_2 C_A \\ R_D = +K_3 C_B C_C \end{cases}$$

→ Resultado das Taxas:

$$\frac{d(C_{A1})}{d\tau} = \frac{F_0 C_{A0} + F_R \cdot C_{A2} - F_S C_{A1}}{A_1 \cdot h_1} - K_1 C_{A1} - K_2 C_{A1}$$

$$\frac{d(C_{B1})}{d\tau} = \frac{F_R C_{B2} - F_S C_{B1}}{A_1 \cdot h_1} - K_3 C_{B1} C_C + K_1 C_{A1}$$

$$\frac{d(C_{C1})}{d\tau} = \frac{F_R C_{C2} - F_S C_{C1}}{A_1 \cdot h_1} - K_3 C_{B1} C_{C1} + K_2 C_{A1}$$

$$\frac{d(C_{D1})}{d\tau} = \frac{F_R C_{D2} - F_S C_{D1}}{A_1 \cdot h_1} + K_3 C_{B1} C_{C1}$$

Reator 02:

Componente A:

acúmulo: $m_A = C_{A2} \cdot V \cdot MM_A$

entra: $m_{AE} = F_S \cdot C_{A1} \cdot MM_A \cdot \Delta\tau$

sai: $m_{AS} = F_S \cdot C_{A2} \cdot MM_A \cdot \Delta\tau$

reage: $m_{AR} = R_A \cdot V \cdot MM_A \cdot \Delta\tau$

Componente B:

acúmulo : $C_{B2} \cdot V \cdot MM_B$

entra : $F_S \cdot C_{B1} \cdot MM_B \cdot \Delta T$

sai : $F_S \cdot C_{B2} \cdot MM_B \cdot \Delta T$

Reage: $R_B \cdot V \cdot MM_B \cdot \Delta T$

Componente C:

acúmulo : $m_C = C_{C2} \cdot V \cdot MM_C$

entra : $m_{Ce} = F_S \, C_{C1} \cdot MM_C \cdot \Delta T$

sai : $m_{CS} = F_S \cdot C_{C2} \cdot MM_C \cdot \Delta T$

Reage : $m_{CR} = R_C \cdot V \cdot MM_C \cdot \Delta T$

Componente D:

acúmulo : $m_D = C_{D2} \cdot V \cdot MM_D$

entra : $m_{De} = F_S \cdot C_{D1} \cdot MM_D \cdot \Delta T$

sai : $m_{DS} = F_S \cdot C_{D2} \cdot MM_D \cdot \Delta T$

Reage : $m_{CR} = R_D \cdot V \cdot MM_C \cdot \Delta T$

9- Conservação de massa:

$$m_{T+\Delta T} = m_T + m_e (T \to \Delta T) - m_S (T \to \Delta T)$$

Componente B:

$$C_{B2} V \cdot \cancel{MM_B}\Big|_{\vartheta+\Delta\vartheta} - C_{B2} \cdot V \cdot \cancel{MM_B}\Big|_{\vartheta} = F_S\, C_{B1} \cdot \cancel{MM_B}\Delta\vartheta$$

$$- F_S\, C_{B2} \cdot \cancel{MM_B} \cdot \Delta\vartheta + R_B \cdot V \cdot \cancel{MM_B} \cdot \Delta\vartheta \qquad \% \cdot \Delta\vartheta$$

$$\lim_{\Delta\vartheta \to 0}\left( \frac{C_{B2} V \cdot|_{\vartheta+\Delta\vartheta} - C_{B2} \cdot V|_{\vartheta}}{\Delta\vartheta} \right) = F_S (C_{B1} - C_{B2}) + R_B \cdot V$$

$$\frac{d(C_{B2} V)}{d\vartheta} = F_S (C_{B1} - C_{B2}) + R_B \cdot V$$

$$C_{B2} \cancel{\frac{dV}{d\vartheta}}^{\,0} + \frac{d(C_{B2})}{d\vartheta} V = F_S (C_{B1} - C_{B2}) + R_B \cdot V$$

$$\boxed{\frac{d(C_{B2})}{d\vartheta} = \frac{F_S}{V} (C_{B1} - C_{B2}) + R_B}$$

$H_3$:

$$\frac{d(C_{B2})}{d\vartheta} = \frac{F_S}{A_2 h_2} (C_{B1} - C_{B2}) - K_3 C_{B2} C_{C2} + K_1 C_{A2}$$

Analogamente, fica:

$$\frac{d(C_{A2})}{d\tau} = \frac{F_S}{A_2 h_2}(C_{A1} - C_{A2}) - K_1 C_{A2} - K_2 C_{A2}$$

$$\frac{d(C_{C2})}{d\tau} = \frac{F_S}{A_2 h_2}(C_{C1} - C_{C2}) - K_3 C_{B2} C_{C2} + K_2 C_{A2}$$

$$\frac{d(C_{d2})}{d\tau} = \frac{F_S}{A_2 h_2}(C_{D1} - C_{D2}) + K_3 C_B C_C.$$

→ Análise de graus de liberdade:

nº variáveis: $h_1, h_2, A_1, A_2, F_0, F_R, C_{A1}, C_{A2}, C_{A0}$
$C_{B1}, C_{B2}, C_{C1}, C_{C2}, C_{D1}, C_{D2}, K_1, K_2$
$K_3, = 18$

nº variáveis conhecidas: $A_1, A_2, K_1, K_2, K_3 = 5$

nº de equações: 8

$IF = 18 - 5 - 8 = 5$

$(F_0, F_R, C_{A0}, C_{A2}, C_{B2})$

Ex 01 -

$$A \underset{K_{1f}}{\overset{K_{1r}}{\rightleftarrows}} B \xrightarrow{K_2} C$$

Taxas: $-R_A = K_{1r} C_A - K_{1f} C_B$

$-R_B = R_A + K_2 C_B$

$R_C = K_2 C_B$

Ex 01 -

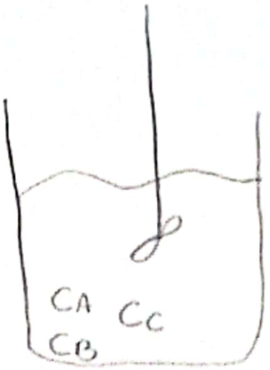
$$A \underset{K_{1f}}{\overset{K_{1r}}{\rightleftharpoons}} B \xrightarrow{K_2} C$$

Taxas: $-R_A = K_{1r} C_A - K_{1f} C_B$

$-R_B = R_A + K_2 C_B$

$R_C = K_2 C_B$

7




H1: cilindro perfeito

H2: isotérmico

H3: não tem fluxo de entrada e de saída.

1 - V.D.F = Massa

2 - V.C = Reator

3 - V.E = Massa

i) B.M.G

acúmulo: $m = \rho . V$

entra: 0

saí: 0

ii) B.M.C.

Componente A

Acúmulo: $m_A = C_A . V . MM_A$

reage: $m_{A\,reage} = R_A . V . MM_A . \Delta t$

Componente B:

Acúmulo: $m_B = C_B . V . MM_B$

reage: $m_{AR} = R_B . V . MM_B . \Delta t$

Componente C:

acúmulo: $m_C = C_C \cdot V \cdot MM_C$

reage: $m_{CR} = R_C \cdot V \cdot MM_C \cdot \Delta\vartheta$

4- conservação de massa:

→ comp A:

$$\lim_{\Delta\vartheta \to 0} \left( \frac{C_A V|_{\vartheta+\Delta\vartheta} - C_A V|_{\vartheta}}{\Delta\vartheta} \right) = R_A \cdot V$$

$$\frac{d(C_A V)}{d\vartheta} = R_A \cdot V$$

vol. constante

$$\cancel{V} \frac{d(C_A)}{d\vartheta} + C_A \cdot \cancel{\frac{dV}{d\vartheta}}^{\to 0} = R_A \cancel{\cdot V}$$

$$\frac{dC_A}{d\vartheta} = R_A$$

Assim,

$$\frac{dC_B}{d\vartheta} = R_B \quad ; \quad \frac{dC_C}{d\vartheta} = R_C$$

Para Taxa A:

$$\frac{dC_A}{d\tau} = -K_{1n} C_A + K_{1f} C_B$$

Para a Taxa B:

$$\frac{dC_B}{d\tau} = K_{1n} C_A - K_{1f} C_B - K_2 C_B$$

Para a Taxa C:

$$\frac{dC_C}{d\tau} = K_2 C_B$$