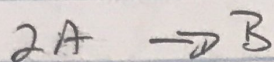


Tut 1.4 2019

PBR



PBR

→ Gas phase

→ Elementary reaction

→ isothermal

→ feed is pure A

→ $P_0 = 5 \text{ atm}$

→ $P = 20 \text{ atm}$

→ $X = 0,3$

Basis : 1 kmol feed per second

	Initial	Δ	Final
A:	1	-X	1-X
B:	0	$+\frac{1}{2}X$	$\frac{1}{2}X$
	$F_{T0} = 1$	$-\frac{1}{2}X$	$F_T = 1 - 0,5X$

$$\therefore F_{A0} = 1$$

$$F_{B0} = 0$$

$$F_{T0} = 1$$

$$F_A = 1-X$$

$$F_B = 0,5X$$

$$F_T = 1 - 0,5X$$

$$Q_0 = 1 \quad @ T_0$$

$$\therefore r_A' = -k' C_A^2$$

$$\text{But } C_A = \frac{F_A}{Q} \quad \text{and} \quad Q = Q_0 \frac{F_T}{F_{T0}} \frac{P_0}{P} \frac{RT}{RT_0}$$

$$Q = F_T \frac{P_0}{P}$$

2,

$$\begin{aligned}\therefore r_A' &= -k' \left(\frac{F_A}{\phi} \right)^2 \\ &= -k' \left(\frac{F_A}{F_T} \frac{P}{P_0} \right)^2\end{aligned}$$

$$\Rightarrow r_A' = -k' \left(\frac{1-x}{1-0,5x} \right)^2 \left(\frac{P}{P_0} \right)^2 \quad \dots \quad (1)$$

$$r_B' = -\frac{1}{2} r_A' \quad \dots \quad (2)$$

$$\frac{dF_A}{dw} = -F_{A0} \frac{dx}{dw} = r_A'$$

$$\frac{dx}{dw} = \frac{-r_A'}{1} \quad \dots \quad (3)$$

$$\frac{dP}{dw} = -k \left(\frac{F_T}{F_{T0}} \right) \left(\frac{P_0}{P} \right)$$

$$\frac{dP}{dw} = -k (1-0,5x) \left(\frac{P_0}{P} \right) \quad \dots \quad (4)$$

$$\therefore k' = 0,695 \frac{\text{m}^6}{\text{mol} \cdot \text{s}}$$

$$k = 10,431 \frac{\text{atm}^2}{\text{kg}}$$

3 //

a) CSTR
 $w = 1 \text{ Kg}$
 $P_0 = P = 20 \text{ atm}$

rate balance:
$$r_A' = \frac{F_A - F_{A0}}{w}$$

$$= \frac{(1-X) - 1}{1}$$

$$r_A' = -X$$

rate law:
$$r_A' = -k' \left(\frac{1-X}{1-0,5X} \right)^2$$

$$\therefore X = k' \left(\frac{1-X}{1-0,5X} \right)^2$$

Using fsolve, $X = 0,4$

b) $k_1' = 0,695$

If m doubles, then F_{A0} doubles

Since
$$r_A' = -k_1' \left(\frac{F_A}{Q} \right)^2$$

new ~~for~~ rate,
$$r_{A,1}' = -k_1' \left(\frac{2 F_A}{Q} \right)^2 = -4k_1' \left(\frac{F_A}{Q} \right)^2$$

$$\therefore k_2' = 4k_1'$$

$\longrightarrow \text{D}$

4

for the ergun k_1 in:

$$\frac{dP}{dz} = -k_1 \left(\frac{F_1}{F_0} \right) \left(\frac{P_0}{P} \right)$$

$$\text{where } k_1 = \frac{G}{P_0 D_p} \frac{(1-\epsilon)}{\epsilon^3} \left[\frac{150(1-\epsilon)\mu}{D_p} + 1.75G \right] \times \left(\frac{1}{A_c(1-\epsilon)^2} \right)$$

↳ for turbulent flow

let the constant, $\alpha_1 = \frac{G^2}{D_p}$

where mass flow rate decreases by factor of 4 and particle size doubles, the new constant is:

$$\alpha_2 = \frac{(G/4)^2}{2D_p}$$

So k_1 changes by a factor of:

$$\frac{\alpha_2}{\alpha_1} = \frac{(G/4)^2}{2D_p} \cdot \frac{D_p}{G^2} = \frac{1}{32}$$

$$\therefore \text{new } k_2 = \frac{k_1}{32}$$

→

new $X = 0.845$ (Python)