B.Tech. Seventh Semester (Chemical Engineering) (CGS)

11658 : Chemical Reaction Engineering - I : 7 CH 02

P. Pages : 2 **AW - 3377**

Time : Three Hours Max. Marks : 80

Notes : 1. Answer **three** question from Section A and **three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and chemical equations should be given wherever necessary.

SECTION - A

1. For irreversible reactions in series **14**

$$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$

Obtain the expression for

$$\boxed{t_{max} = \frac{1}{k_{log\,mean}} = \frac{\ln(k_2/k_1)}{k_2 - k_1}}$$

and also for the maximum concentration of R.

OR

2. Aqueous A at a concentration $C_{A0} = 1$ mol/liter is introduced into a batch reactor where it reacts away to form product R according to stoichiometry $A \rightarrow R$. The concentration of A in the reactor is monitored at various times, as shown below: **14**

t, min	0	100	200	300	400
$C_A, mol/m^3$	1000	500	333	250	200

For $C_{A0} = 500\, mol/m^3$ find the conversion of reactant after 5 hours in the batch reactor.

3. Obtain the relation between concentration, time and rate constant for the Autocatalytic reactions. Plot conversion - time and rate- concentration curves for autocatalytic reaction. **13**

OR

4. The following data are obtained at 0° C in a constant - volume batch reactor using pure gaseous A: **13**

Time, min	0	2	4	6	8	10	12	14	∞
Partial pressure of A, mm	760	600	475	390	320	275	240	215	150

The stoichiometry of the decomposition is $A \rightarrow 2.5R$. Find a rate equation which satisfactorily represents this decomposition.

5. Find the first-order rate constant for the disappearance of A in the gas reaction $2A \rightarrow R$ if, on holding the pressure constant, the volume of the reaction mixture, starting with 80% A, decreases by 20% in 3 min. **13**

OR

6. Find the first-order rate constant for the disappearance of A in the gas reaction $A \rightarrow 1.6R$ if the volume of the reaction mixture, starting with pure A increases by 50% in 4 min. The total pressure within the system stays constant at 1.2 atm, and the temperature is 25° C. **13**

SECTION - B

7. Derive performance equations for plug flow reactor. Explain graphically the representation of the performance equation for plug flow reactor. **14**

OR

8. a) A gaseous feed of pure A(1 mol/liter) enters a mixed flow reactor (2 liters) and reacts as follows: **7**

$$2A \rightarrow R, \quad -r_A = 0.05 C_A^2 \frac{\text{mol}}{\text{liter} \cdot \text{sec}}$$

Find what feed rate (liter/min) will give an outlet concentration $C_A = 0.5$ mol/liter.

b) Liter/s of a 20% ozone - 80% air mixture at 1.5 atm and 93°C passes through a plug flow reactor. Under these conditions ozone decomposes by homogeneous reaction. **7**

$$2O_3 \rightarrow 3O_2, \quad -r_{ozone} = kC_{ozone}^2, \quad k = 0.05 \frac{\text{liter}}{\text{mol} \cdot \text{s}}$$

What size reactor is needed for 50% decomposition of ozone?

9. We plan to replace our present mixed flow reactor with one having double the volume. For the same aqueous feed (10 mol A/liter) and the same feed rate find the new conversion. The reaction kinetics are represented by **13**

$$A \rightarrow R, \quad -r_A = kC_A^{1.5}$$

and present conversion is 70%

OR

10. Explain the size comparison of single reactors, mixed versus plug flow reactors, for first and second order reactions. **13**

11. The kinetics of the aqueous-phase decomposition of A is investigated in two mixed flow reactors in series, the second having twice the volume of the first reactor. At steady state with a feed concentration of 1 mol A/liter and mean residence time of 96 sec in the first reactor, the concentration in the first reactor is 0.5 mol A/liter and in the second is 0.25 mol A/liter. Find the kinetic equation for the decomposition. **13**

OR

12. Consider the autocatalytic reaction $A \rightarrow R$, with $-r_A = 0.001\ C_A C_R$ mol / liter·s. We wish to process 1.5 liters/s of a $C_{A0} = 10$ mol/liter feed to the highest conversion possible in the reactor system consisting of four 100-liter mixed flow reactors connected as you wish and any feed arrangement. Sketch your recommended design and feed arrangement and determine C_{Af} from this system. **13**

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