B.Tech. Seventh Semester (Food, Pulp & Paper, Oil & Paint & Petro Technology) (CGS)

11057 : Chemical Reaction Engineering - I : 7 CT 02

P. Pages : 3 | AU - 2945

Time : Three Hours | Max. Marks : 80

Notes :
1. All question carry equal marks.
2. Answer **three** question from Section A and **three** question from Section B.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Diagrams and chemicals equations should be given wherever necessary.
6. Illustrate your answer necessary with the help of neat sketches.
7. Use of slide rule logarithmic tables, Steam tables, Moller's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.
8. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. a) Classify the chemical reactions with suitable example. **7**

b) Show the relation between K_p and K_y. **7**

OR

2. a) Define rate constant, How will you find the unit of rate constant explain with suitable example. **5**

b) Discuss about the factors affecting the rate of reaction. **5**

c) Differentiate between chemical kinetics and chemical thermodynamics. **4**

3. a) Explain the Arrhenius law of temperature dependency of rate constant. Also show that Arrhenius law is a good approximation to the temperature dependency of both collision and transition state theories. **8**

b) The activation energy of a reaction is about 19500 cal/mol. How much faster is the reaction takes place at 30°C to 10°C. **5**

OR

4. a) Calculate the activation energy for the decomposition of benzene diazonium chloride to give chlorobenzene and nitrogen. Using the following information for this first order reaction **6**

$K\ (s^{-1})$	0.00043	0.00103	0.00180	0.00355	0.00717
T (k)	313.0	319.0	323.0	328.0	333.0

b) If $(-r_A) = -d_{CA} / dt = 0.2$ mol / (l.s.) when $C_A = 1$ mol/l. What is the reaction rate when $C_A = 10$ mol/l ? Assume the reaction is 1st order. **4**

c) The activation energy of a bimolecular reaction is about 8707 cal/mol. How much faster is this reaction takes place at 500 k than at 400 k. 3

5. a) Define the fractional change in volume (Σ_A) of reaction system. 2

b) The half life of a first order reaction A → B is 10 min. What per unit of A remains after 60 min ? 4

c) The first order reversible liquid phase reaction $A \rightleftharpoons R$ takes place in a batch reactor. 7

After 8 min, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction taking $C_{AO} = 0.5$ mol / ℓ and $C_{RO} = 0$.

OR

6. a) A 10 minutes experimental run shows that 75% of liquid reactant A is converted to product by a ½ order rate. What would be the amount of A converted in 30 minutes run ? 4

b) In case of first order reaction. Show that time required for 75% conversion is double the time required for 50% conversion. 3

c) Differentiate between Integral method and differential method of analysis. 6

SECTION - B

7. a) Derive the performance equation for ideal batch reactor for variable and constant volume reaction system. Also represent graphically. 8

b) A homogeneous gas reaction A → 3R has a reported rate at 200°C is 6

$-r_A = 10^{-1} C_A$ (cmol / (l.s.)) . Find the space time required for 80% conversion of a 50% A and 50% inert feed to a plug flow reactor operating at 200°C and 5 atm. Pressure Initial Concentration of A is 0.0625 mol/l.

OR

8. a) Differentiate between batch reactor and continuous reactors. 4

b) The elementary liquid phase reaction $A + 2B \underset{K_2}{\overset{K_1}{\rightleftharpoons}} R$ with rate equation 10

$$-r_A = -\frac{1}{2} r_B = (12.5 \text{ lit}^2 / \text{mol}^2.\text{min}) C_A C_B{}^2 - (1.5 \text{ min}^{-1}) C_R \left(\frac{\text{mol}}{\text{lit min}} \right)$$

is to lake place in a 6 lit. steady state MFR. Two feed stream one containing 2.8 mol A / lit and other containing 1.6 mol B/lit are to be introduced at equal volumetric flow rate into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream ? Assume a constant density throughout.

9. a) A first order reaction is to be carried out in series of two MFR. Show that the total volume of two reactors is minimum when the reactors are of equal size. 8

b) Explain the rate concentration curve for autocatalytic reaction. **5**

OR

10. a) How will you select the reactor for auto catalytic reaction ? **7**

b) Explain the size comparison of single MFR with PFR. **6**

11. Consider the competitive liquid phase reactions. **13**

$$A + B \xrightarrow{K_1} R\,(\text{desired}) \quad \frac{d_{CR}}{dt} = 1.0\, C_A C_B^{0.3}\ \text{mol}/(\text{l.min})$$

$$A + B \xrightarrow{K_2} S\,(\text{un desired}) \quad \frac{d_{CS}}{dt} = 1.0\, C_A^{0.5} C_B^{1.8}\ \text{mol}/(\text{l.min})$$

For 90% conversion of A find the concentration of R in the product stream. Equal volumetric flow rates of A and B are fed to the reactor and each stream has a concentration of 20 mol/l.

The flow in the reactor follows

i) Plug flow ii) Mixed flow.

OR

12. a) Discuss optimum temperature progression in brief. **6**

b) Liquid reactant A decomposes as follows : **7**

$A \rightarrow R,\ r_R = K_1 C_A^2 \quad K_1 = 0.4\ m^3/(\text{mol.min})$

$A \rightarrow S,\ r_S = K_2 C_A \quad K_2 = 2\ (\text{min})^{-1}$

A feed to aqueous A ($C_{AO} = 40\ \text{mol}/m^3$) enters a reactor decomposes and a mixture of A, R and S leaves, Find C_R, C_S and τ for $X_A = 0.9$ in a mixed flow reactor.

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