A 317

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

Fifth Semester

Industrial Bio-Technology

IB 332 — CHEMICAL REACTION ENGINEERING

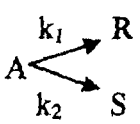
Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Distinguish between Homogeneous reactions and heterogeneous reaction.

2. Show the concentration profile for the reaction.



if $k_1 > k_2$

3. Does the following reaction elementary? Justify $N_2 + 3H_2 \rightarrow 2NH_3$.

4. What are zero order reactions? Give an example.

5. List out the ways by which the rate of reaction can be increased.

6. What are auto catalytic reactions? State the reactor most suited for the same?

7. Define Dispersion number. State its limitation.

8. Distinguish between instantaneous and fractional yield.

9. Write the monod model. What is inhibition?

10. What is meant by wash out condition in continuous culture vessel?

PART B — (5 × 16 = 80 marks)

11. (i) The pyrolysis of ethane proceeds with an activation energy of about 75,000 cal. How much faster is the decomposition at 650°C than at 500°C? (6)

(ii) The aqueous reaction $A \longrightarrow R + S$ proceeds as follows :

Time, min :	0	36	65	100	160	α
CA, mol/lit :	0.1823	0.1453	0.1216	0.1025	0.0795	0.0494

$C_{A0} = 0.1823$ mol/liter; $C_{R0} = 0$, c_{S_0} = 55 mol/lit. Find the rate equation for this reaction. (10)

12. (a) Derive the rate equation for the enzyme substrate reaction

$$S + E \underset{k_2}{\overset{k_1}{\rightleftharpoons}} (\text{S.E.})^* \xrightarrow{k_3} \text{E+P}$$

where the total enzyme concentration $(E_0) = (E) + \{AE)^*]$. State the assumptions involved in it and explain the method of finding the kinetic parameters.

Or

(b) (i) From the first principles, derive an expression for the maximum concentration of intermediate and time at which it occurs for a series reaction. (8)

$$A \xrightarrow{K_1} R \xrightarrow{k_2} S$$

(ii) Derive the design equation for a CSTR. Explain the method of finding the volume of reactor graphically. (8)

13. (a) (i) The kinetics of the aqueous phase decomposition of A is investigated in two mixed 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/lit and in the second is 0.25 mol A/lit. Find the kinetic equation for the decomposition. (10)

(ii) A company has two mixed reactors of unequal size for producing a specified product formed by homogeneous first order reaction. How should these reactors be connected to achieve a maximum production rate? (6)

Or

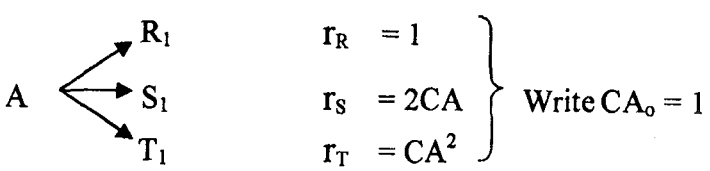
(b) (i) Derive the design equation for an ideal plug flow reactor operating at steady state. (6)

(ii) It is suspected that the gas reaction A, B and R is an elementary reversible reaction $A + B \underset{k_2}{\overset{k_1}{\rightleftharpoons}} R$ and the reaction is carried out in an isothermal plug flow reactor.

Develop the isothermal performance equation for these kinetics for a feed of A, B, R and inert.

Show how to test this equation for an equimolar feed of A and B.(10)

14. (a) For the parallel decomposition of A, where R is desired



What is the maximum C_R expected in isothermal operation

(i) in a mixed reactor. (8)

(ii) in a plug flow reactor. (8)

Or

(b) (i) Explain the method of finding the optimum temperature progression and how is it used to find the optimum volume of reactor in case of PFR, CSTR and for reversible, irreversible, exothermic and endothermic cases. (8)

(ii) Explain the multiple steady state in CSTR for exothermic reactions. (8)

15. (a) (i) Explain C curve, E curve and F curve. Derive the relation between them. (8)

(ii) For the following experimental data obtained by pulse feed of tracer, find out mean residence time, variance and dispersion number : (8)

Time t min :	0	5	10	15	20	25	30	35
Tracer concentration gm/lit :	0	3	5	5	4	2	1	0

Or

(b) (i) Explain various types of biochemical reactions and the factors affecting the growth rate. (8)

(ii) Discuss the continuous culture cultivation and derive an expression for $Y_{X/S}$ and $Y_{P/S}$ using the mass balance. (8)