Exam.Code:0908
Sub. Code: 33364

2055

B.E. (Biotechnology) Fourth Semester

BIO-413: Chemical Reaction Engineering

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section.

x-x-x

1. Attempt the following:-

a) What are transition complexes?

b) Express temperature dependency of the reaction rate constant with the help of a plot.

c) Explain the relevance of RTD studies with possible causes of non-idealities in real reactors.

d) Differentiate between a chemical process and a bioprocess.

e) For the equation $A + 2B \rightarrow 3R$; compare the relative rate constants for all the components.

f) Define space time.

g) What are ideal contacting patterns?

h) Define Optimum temperature progression.

i) Deduce material balance for any component (reactant/product) for any one ideal reactor.

j) Suggest a suitable ordering of reactors (plug, small mixed, large mixed) for any n^{th} order reaction if i) $n>0$ ii) $n<0$. **(10)**

Section-A

2. i) The irreversible reaction A + B = AB has been studied kinetically, and the rate of formation of product has been found as $r_{AB} = k C_A^2$. Suggest reaction mechanism for this rate expression if the chemistry of reaction explains that the intermediate consists of an association of reactant molecules. Assume that a chain reaction does not occur.

ii) Solve:

C_A	2	2	3
C_B	125	64	64
$-r_A$	50	32	48

(6,4)

3. Enzyme E catalyzes the transformation of reactant A to product R;

$$-r_A = (200\ C_A\ C_{E0}) / (2 + C_A) \quad \text{mol/liter.min}$$

If enzyme is introduced at initial concentration of 0.001 mol/liter and reactant at 10 mol/liter of initial concentration into a batch reactor, find the time required for the reactant concentration to drop to 0.025 mol/liter. Assume negligible change in enzyme concentration during reaction. **(10)**

P.T.O.

4. i) A gaseous feed of pure A (1 mol/liter) enters a mixed flow reactor (2 liters) and reacts as follows: $2A \rightarrow R$ $\quad -r_A = 0.05\ C_A^2$ mol/liter. sec

Find what feed rate (liter/min) will give an outlet concentration of A as 0.5 mol/liter.

ii) For a constant density reaction system ($aA + bB \rightarrow rR + sS$), find the concentration or partial pressure of the reacting material as a function of the total pressure at any time t and initial partial pressure and initial total pressure of the system. **(6,4)**

Section-B

5. i) A gas stream consisting of radioactive Xe-138 (half-life=14 min) is passed through a holdup of 2 tanks in series (both well-mixed) and of such size that the mean residence time of gas is 2 weeks in each tank. It is suggested to replace the two tanks with a long tube. What must be the size of this tube compared to the original holdup of 2 tanks? Also, determine the mean residence time of gas in this tube for same extent of radioactive decay.

ii) Recommend the type of reactor configuration(s) would you choose for series reaction scheme $A \rightarrow R \rightarrow S$ for achieving the desired product distribution. **(5,5)**

6. Discuss in details the qualitative and quantitative product distribution for the reactions in parallel. **(10)**

7. i) Discuss in details the kinetics of substrate utilization for a microbial fermentation in a batch culture. Express graphically how would you determine k_S from the given data?

ii) With the help of the plots, compare the toxin and substrate limiting microbial growth. **(6,4)**

x-x-x