Exam.Code:0908
Sub. Code: 6703

1048

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.

a) Explain the terms Space-time and space-velocity.

b) Differentiate between order and molecularity of reaction.

c) Define fractional change in volume for any system.

d) 0.5 liter/sec of gaseous reactant A is introduced into a mixed reactor of volume 2 liters. Calculate its space time.

e) Name three ideal contacting patterns.

f) For the homogenous decomposition of ozone with rate $-r_{O3} = k [O_3]^2[O_2]^{-1}$ find the overall order and molecularity of the reaction.

g) What do you understand by Arrhenius Plot for a reaction?

h) For the equation $B + 2D \rightarrow 3T$ compare the relative rate constants for all the components. Also account for sign – or +.

i) Write a material balance equation with schematic representation for a continuous bioreactor.

j) How are biochemical reactions different from chemical reactions? 1 x 10

SECTION-A

2. Under the influence of oxidizing agents, hypophosphorous acid(A) is transformed into phosphorous acid (P):

$A \rightarrow P$

It is established that at low concentration of oxidizing agent, $r_p = k$ [oxidizing agent][A] and at a high concentration of oxidizing agent, $r_p = k'[H^+][A]$. To explain the observed kinetics, it has been postulated that, with hydrogen ions a catalyst, normal unreactive hypophosphorous acid(A) is transformed reversibly into an active form, which then reacts with the oxidizing agent to give phosphorous acid (P). Show that the mechanism explained above is consistent with the observed kinetics.

(10)

P.T.O.

3. a) 100 liters/hr of radioactive fluid having a half-life of 20 hr is to be treated by passing it through two ideal stirred tanks in series, V = 40,000 liters each. In passing through this system, how much will the activity decay?

   b) Explain giving suitable examples what are reaction in series. For an elementary reaction in series A→R→S, find the expression for maximum concentration of R and when it is reached during a batch operation if k1 = k2 (reaction rate constants are equal) and [A] = C_{Ao}; C_{Ro} = C_{So}= 0.

   (4+6)

4. Enzyme E (C_{E0} = 0.001 mol/lit) catalyzes the transformation of reactant A (C_{A0} = 10 mol/lit) to product R. The reaction kinetics can be described as $-r_A = 200\, C_A\, C_{E0}/2 + C_A$. Find the time needed for the concentration of the reactant to drop to 0.025 mol/lit in a plug flow reactor. Assume that the concentration of the enzyme remains unchanged during the reaction. Compare the time if the same is carried out in a MFR.

   (10)

SECTION-B

5. a) Describe the Monod model for specific growth rate. Explain how to find out k_M and k_S in Monod model by linearizing it.

   b) With the help of graph, describe a substrate limiting cell-growth and product limiting cell-growth.

   (5+5)

6. a) Starting with the energy balance, deduce an expression for the heat of reaction at exit temperature as a function of molar specific heats of reactants and products if heat of reaction at inlet temperature is known.

   b) Contrast the effect of temperature and pressure on equilibrium conversion for an exothermic and endothermic reaction.

   (5+5)

7. State distinguishing factors between single and multiple types of reactions. Define the "selectivity parameter" for a parallel reaction. Explain the various possibilities of parallel reactions. Recommend a suitable flow reactor for each case.

   (10)

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