Exam.Code:0908
Sub. Code: 33364

2015

B.E. (Biotechnology) Fourth Semester

BIO-413: Chemical Reaction Engineering

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

NOTE: Attempt <u>five</u> 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) Describe the role and significance of ε_A in the reactor design.

   b) Describe the role of agitators in reactors.

   c) Define space time and residence time. Explain law of mass action.

   d) The rate law for the reaction ($2A + B \rightarrow C$) is $-r_A = kC_A^2C_B^2$ with $k_A = 25$ $(dm^3/mol)^2/s$. what are k_B and k_C?

   e) What are the main characteristics of a plug flow reactor?

   f) Express Instantaneous and overall fractional yields for parallel reactions.

   g) Give significance of Arrhenius law, and describe heterogeneous reactions.

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

   i) What are competitive and non-competitive inhibitions in enzymatic reactions?

   j) What are elementary and non-elementary types of reactions? Give example. 1 each

SECTION-A

2. a) Derive the Michelis and Menten rate for enzyme substrate reaction

   b) What are autocatalytic reactions? Briefly discuss various types of kinetic models described for non-elementary reactions. 5 + 5

3. A zero order homogeneous gas reaction, A →r R proceeds in constant volume batch reactor, with 20 % inerts and the pressure rises from 1 to 1.3 atm in 2 minutes.
   If the same reaction takes place in a constant pressure batch reactor, what is the fractional volume change in 4 minutes, if feed is at 3 atm and consists of a 40 % inerts. 10

P.T.O.

4. a) A series reaction A $\rightarrow$R$\rightarrow$ S , with k_1 and k_2 as rate constant for the first and second steps actively with $C_{R0}= C_{S0} =0$; is to be conducted in a plug flow reactor. Both the steps are first order .Obtain an expression for a space-time corresponding to maximum concentration of R. Also find C_{Rmax} if $k_1=k_2$.

b) Derive the performance equation (for constant density system) for an ideal plug flow reactor and discuss the design procedure. 6+4

SECTION-B

5.a) An enzyme is used extensively for the production of high-fructose syrup as per thereaction glucose $\rightarrow$fructose. ΔH° for this reaction is 5.73 kJ $gmol^{-1}$; ΔS = 0.0176 kJ $gmol^{-1}$ K^{-1}. Calculate the equilibrium constants at 50°C and 75°C.

b) What is understood by 'optimum temperature progression'? Illustrate with an example of reversible exothermic reaction using a given feed material. 5 + 5

6. Derive the microbial growth rate model as given by Monod equation. What is max specific substrate utilization rate and endogenous decay constant? Discuss all four stages of microbial growth and depict them using a graph. 10

7. a) Give a detailed account on the qualitative and quantitative product distribution of series reactions and series –parallel reactions.

b) Describe quantitative treatment in a batch and mixed flow fermenter.

7+3

x-x-x