K/L/TX

Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BBIT304L - Biochemical Engineering
Class NBR(s): 1240 / 4178
Slot: G1+TG1
Time: Three Hours
Max. Marks: 100

➢KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
➢DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction: Write and explain the assumptions whenever made.

Answer ALL Questions
(10 X 10 = 100 Marks)

1. A reaction is first order in A and second order in B

   a) Write the differential rate equation.

   b) How is the rate affected on increasing the concentration of B three times?

   c) How is the rate affected when concentration of both A and B are doubled?

2. A penicillin solution containing 300 units/ml has a half-life of 8 days in plasma. What will the concentration be in 7 days? Assuming penicillin is eliminated from plasma through a first order linear process.

3. Develop the relationship between standard state free energy change and equilibrium constant using the given stoichiometry.

   $aA+bB \rightarrow cC+dD$

4. Lactic acid fermentation is typically represented by the following reaction:

   $C_6H_{12}O_6$ (glucose) → 2 $C_3H_6O_3$ (lactic acid)

   In this process, glucose is anaerobically converted into lactic acid, which can be used in food products, bioplastics, and pharmaceuticals.

   The standard Gibbs free energy of formation for each compound is as follows (at 298 K):

   - ΔG°_f (glucose) = -917.2 kJ/mol
   - ΔG°_f (lactic acid) = -518.2 kJ/mol

   Calculate the Gibbs free energy change (ΔG) and the equilibrium constant (K_{eq}) for the lactic acid fermentation reaction at a certain temperature.

5. Discuss the steps in Integral method of data analysis and derive the kinetic expression for the unimolecular first order irreversible reaction.

6. Describe in detail the different method of estimating kinetic parameters of enzymatic reaction. Highlight the advantages and the limitations of each method.

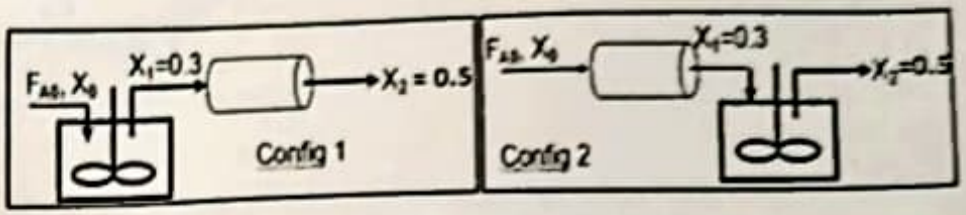
7. Discuss the concept of enzyme inhibition and mention its types. Derive the kinetic expression for competitive enzyme inhibition and explain the significance of the resulting equation.

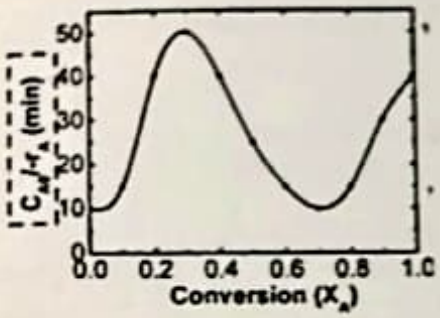
8. Compare and contrast: chemical and biochemical engineering. Emphasize the significance of kinetics in food industry.

9.a) Illustrate plug flow reactor and label all components in the input and output stream. Also develop the performance equation for the system.

OR

9.b) A product is produced by a nonisothermal, nonelementary, multiple-reaction mechanism. Assume the volumetric flow rate is constant and same in both reactors. Data for this reaction is shown in the graph. Use this graph to determine which of the 2 following configurations gives the smaller total reactor volume. Justify your results.





10.a) Rates of hydrolysis of *p*-nitrophenyl-β-D-glucopyranoside by β-glucosidase, an irreversible unimolecular reaction, were measured at several concentrations of the substrate. The initial reaction rates were obtained as given in Table. Determine the kinetic parameters of this enzyme reaction.

$[S]$ (gmol/m^3)	v (gmol/m^3 s)
5.0	4.84×10^{-4}
2.5	3.88×10^{-4}
1.67	3.18×10^{-4}
1.25	2.66×10^{-4}
1.0	2.14×10^{-4}

OR

10.b) An enzyme catalyses the reaction $S \leftrightarrow P$. V_{max} of forward reaction is 22 µmoles lit^{-1} min^{-1}, V_{max} of the reverse reaction is 14 µmoles lit^{-1} min^{-1}. In which direction and how fast will the reaction proceed if [S] = $2K_{mS}$ and [P] = $7\ K_{mp}$

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