CBCS SCHEME

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18BT52

# Fifth Semester B.E. Degree Examination, July/August 2021
## Chemical Reaction Engineering

Time: 3 hrs. Max. Marks: 100

**Note:** ***Answer any FIVE full questions.***



1 a. Derive rate equation for first order rate of reaction A → R both in terms of concentration and conversion. **(08 Marks)**

b. The activation energy of a chemical reaction is 17982 cal/mol in the absence of a catalyst and 11980 cal/mol with the catalyst. By how many times with the rate of the reaction will grow in the presence of a catalyst , if the reaction proceeds at $25^0$C. **(06 Marks)**

c. At $25^0$C, the rate constant for the hydrolysis of ethyl acetate by NaOH is 6.5 ℓ/(mol) (min) starting with concentration of base and ester of 0.03 mol/ℓ of each. What proportion of ester will be hydrolysed in 10min. **(06 Marks)**

2 a. Compare differential and integralysis of reaction data of a reaction mixture. **(04 Marks)**

b. Derive rate equation for second order rate of reaction A + B → R in terms of conversion. **(12 Marks)**

c. Decomposition of a gas in second order. When the initial concentration of gas is $5 \times 10^{-4}$ mol/ℓ, it is 40% decomposed in 50min. Calculate the value of rate constant. **(04 Marks)**

3 a. Derive performance equation for mixed flow reactor and plug flow reactor. **(10 Marks)**

b. In an isothermal batch reactor the conversion of a liquid reactant A is 70% in 13min. Find the space time and space velocity necessary to effect thin conversion in a plug flow reactor and in a mixed flow reactor. Consider first order reaction. **(10 Marks)**

4 a. Derive the performance equation of equal size CSTR are connected in parallel. Explain space velocity and space time. **(08 Marks)**

b. An aqueous feed of A and B (400ℓ/min) with $C_{A_o}$ = 100 mmol/ℓ and $C_{B_o}$ = 200 mmol/ℓ is to be converted into product in a plug flow reactor. The kinetics and stoichiometry of the reaction are given by A + B → , $-r_A = 200\ C_A\ C_B$ (mol/ℓ.min). Estimate the volume of plug flow reactor required to achieve 99% conversion of A to product. **(12 Marks)**

5 a. Explain the experimental method to determine residence time distribution (pulse input) and list out the properties of tracer. **(08 Marks)**

b. The data given below represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel. $\bar{t}$ and tabulate and construct E curve.

| t min | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $C_{pulse}$ (g/ℓ) (tracer output conc$^n$) | 0 | 3 | 5 | 5 | 4 | 2 | 1 | 0 |

**(12 Marks)**

6 a. Discuss residence time distribution in mixed flow reactor. **(12 Marks)**

b. Enumerate the relationship between the F and E curve in non ideal flow. **(08 Marks)**

7 a. Compare Competitive and Non – competitive inhibition. **(08 Marks)**

b. The Km value of an enzyme is known to be 0.01 mol/ℓ. To measure the rate catalysed by enzyme, you measure the initial rate of the reaction and find that 10% of the initial substrate concentration is $3.4 \times 10^{-4}$ mol/h. Assume that the reaction rate can be expressed by M –m kinetics. i) What is the reaction rate? ii) What is the concentration of substrate after 15 mins? **(12 Marks)**

8 a. Compare LB plot and Eadie – Hoftree plot and find $k_m$ and $V_{max}$ from graph. **(08 Marks)**

b. Determine the M – M parameter $V_m$ and $k_{mn}$ for

$$\text{urea} + \text{urease} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} [ES] \xrightarrow{k_3} NH_3 + CO_2 + E.$$

The rate equation is given as a function of concentration of urea.

| Urea conc$^n$ Kmole/m$^3$ [S] | 0.2 | 0.02 | 0.01 | 0.05 | 0.02 |
|---|---|---|---|---|---|
| Rate Kmole/m$^3$ sec [V] | 1.082 | 0.55 | 0.38 | 0.2 | 0.09 |

**(12 Marks)**

9 a. Derive Monod model of growth kinetics with ideal reactor kinetics. **(06 Marks)**

b. Aerobic degradation of Benzoic acid by mixed culture of micro organisms is given by $C_6H_5COOH + aO_2 + bNH_3 \rightarrow cC_5H_7NO_2 + dH_2O + eCO_2$.

i) Determine the stoichiometric coefficient if RQ = 0.9.

ii) Determine the yield coefficients by $Y_{X/S}$ & $Y_{X/O_2}$. **(14 Marks)**

10 a. Explain Primary and Secondary product formation kinetics. **(10 Marks)**

b. Write a short note on Growth Filamentous bacteria. **(10 Marks)**

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