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B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH5DCCR1 **Max Marks: 100**
Course: Chemical Reaction Engineering-1 **Date: 20.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1. a) List the various forms by which rate of reaction can be expressed. **05**

b) State the factors affecting the rate of reaction. **05**

c) A reaction $2HI(g) \rightarrow H_2(g) + I_2(g)$, studies over a range of temperatures. Results obtained are below. **10**

Temperature (K)	633	666	697	715	781
Rate constant $k\times10^4$ (L/mole.s)	0.17	1.07	5.01	10.5	15.1

a. Find out the values of activation energy graphically
b. Determine by what factor the rate increases when temperature rises from 300 K to 310 K.

UNIT - II

2. a) With an example explain the difference between elementary and non-elementary reactions. **06**

b) List the different kinetic models for non-elementary reactions. **04**

c) Experiments shows that the reaction between $H_2(g)$ and $I_2(g)$ to produce $HI(g)$ proceeds with rate $\frac{1}{2}\frac{d[HI]}{dt} = k[H_2[I_2]$. Suggest a two-step mechanism which is consistent with this rate. **10**

UNIT - III

3. a) Derive the integrated performance equation for plug flow reactor for first order reaction for changing density. **10**

b) The laboratory measurements of rate v/s concentration for reactant A are given below. Compare the volumes of mixed flow reactor and plug flow reactor required to achieve 60% conversion. The feed conditions are the same in both the cases and molar flow rate of A entering the reactor is 10 m/s. **10**

X_A	0	0.2	0.4	0.6	0.8
$-r_A$ mol/(L s)	0.182	0.143	0.1	0.0667	0.0357

OR

4. a) Reactant A decomposes as follows: $A \xrightarrow{k_1} R \xrightarrow{k_2} S$,where $k_1 = 0.1\ min^{-1}\ and\ k_2 = 0.1\ min^{-1}$. It is desired to produce R from 1000 L/h of feed (C_{A0}=1 mol/L, C_{R0} = C_{S0}=0). Find the volume of plug flow reactor to maximize concentration of R. **10**

b) Determine the integrated rate expression for a second order irreversible bimolecular reaction in terms of concentration and conversion where $C_{A0} \neq C_{B0}$. **10**

UNIT - IV

5. a) Derive an expression for space time τ_N for a series of equal size and N number of mixed reactors assuming first order reaction. **10**

b) A first order reaction is carried out in a plug flow reactor with initial reactant concentration of 0.9 mol/L. The conversion of the reaction found to be 90%. If a CSTR, 10 times as large as the plug flow reactor, were arranged in series with the existing unit. Which unit needs to be arranged first (in series) to enhance the production rate. **10**

OR

6. a) Explain the contacting patterns for various combinations of high and low concentrations of the reactants in flow operations. **08**

b) Consider the aqueous reactions in plug flow reactor. **12**

$$A + B_{\to S(undesired)}^{\to R(desired)}$$

$$\frac{dC_R}{dt} = 1.0 {C_A}^{1.5} {C_B}^{0.3}$$

$$\frac{dC_S}{dt} = 1.0 {C_A}^{0.5} {C_B}^{1.8}$$

For 90% conversion of A, find the concentration of R in the product stream. Equal volumetric flow rates of A and B streams are fed to the reactor, and each stream has a concentration of 20 mol/L of reactant.

UNIT - V

7. a) Derive the energy balance equation for a mixed flow reactor under non-adiabatic condition. **10**

b) Explain optimum temperature progression of non-isothermal reaction. **10**

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