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Total No. of Pages : 02

Total No. of Questions : 09

B.Tech.(Petroleum Refinery Engineering) (2013 Batch) (Sem.-4)

**CHEMICAL REACTION ENGINEERING-I**

Subject Code : BTPC-406/BTCH-405

Paper ID : [72429]

Time : 3 Hrs.

Max. Marks : 60

**INSTRUCTION TO CANDIDATES :**

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.
3. SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.

**SECTION A****1. Answer briefly :**

- a. Define space-time and space velocity.
- b. What is a recycle reactor? Recycle reactor is suitable for which kind of system?
- c. Give expression for obtaining mean conversion, in a non-ideal reactor, using only RTD information.
- d. What is half-life of a reaction?
- e. Define yield and selectivity for a reaction?
- f. Give mathematical expression for E curve for a single CSTR. Also, sketch this curve.
- g. Differentiate between elementary and non-elementary reactions.
- h. Under what conditions you would avoid using differential method of data analysis?
- i. What is multiplicity of steady states?
- j. Write material balance for reactant A in a semi-batch reactor, for the elementary liquid phase reaction:  $A + B \rightarrow C$ .

**SECTION-B**

- Q2 The pyrolysis of ethane proceeds with an activation energy of about 300 kJ/mol. How much faster is the decomposition at 650°C than at 500°C?

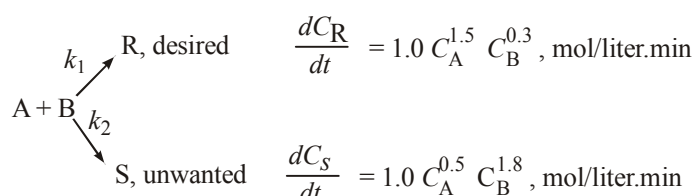
- Q3 Derive the expression for the concentrations of the species A, R, and S as a function of time for the series reaction:  $A \rightarrow R \rightarrow S$
- Q4 Aqueous A reacts to form R ( $A \rightarrow R$ ) and in the first minute in a batch reactor its concentration drops from  $C_{A0} = 2.03$  mol/liter to  $C_{At} = 1.97$  mol/liter. Find the rate equation for the reaction if the kinetics are second-order with respect to A.
- Q5 Why optimum temperature progression in a non-isothermal reactor is desired? How optimum temperature progression can be approximated in a packed bed catalytic reactor.
- Q.6 Derive the performance equation for PFR.

### SECTION-C

- Q7 A homogeneous gas phase reaction  $A \rightarrow 3R$  has a reported rate at 215°C,  
 $-r_A = 10^{-2} C_A^{1/2}$ , [mol / liter · sec]
- Find the space-time needed for 80% conversion of a 50% A-50% inert feed to a plug flow reactor operating at 215°C and 5 atm ( $C_{A0} = 0.0625$  mol/liter).
- Q8 A reactor is to be used to run the following reaction, RTD data for this reactor is given below,  
 $A \rightarrow R$  with  $-r_A = 0.05 C_A$  mol/liter · min

Time, min	1	3	5	7	9	11	13	15
Concentration (arbitrary)	0	0	10	10	10	10	0	0

- Calculate the mean and variance of the data.
  - Calculate  $X_A$  assuming plug flow
  - Calculate  $X_A$  assuming mixed flow.
  - Calculate  $X_A$  using RTD data.
- Q9 Liquid reactant A decomposes as follows :



For 80% conversion of A, find the concentration of R in the product stream from a mixed flow reactor. Equal volumetric flow rates of the A and of B streams are fed to the reactor, and each stream has a concentration of 20 mol/liter of reactant.