Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 09

B.Tech.(Petroleum Refinary 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_{Af}= 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,

$$-r_A = 10^{-2} C_A^{1/2}, \quad [\text{mol/liter}\cdot\text{sec}]$$

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

a. Calculate the mean and variance of the data.

b. Calculate X_A assuming plug flow

c. Calculate X_A assuming mixed flow.

d. Calculate X_A using RTD data.

Q9 Liquid reactant A decomposes as follows :

$$A + B \xrightarrow{k_1} R,\ \text{desired} \qquad \frac{dC_R}{dt} = 1.0\, C_A^{1.5}\, C_B^{0.3},\ \text{mol/liter.min}$$

$$A + B \xrightarrow{k_2} S,\ \text{unwanted} \qquad \frac{dC_S}{dt} = 1.0\, C_A^{0.5}\, C_B^{1.8},\ \text{mol/liter.min}$$

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.