Roll No. | | | | | | | | | | | | | **Total No. of Pages : 03**

Total No. of Questions : 09

B.Tech.(Petroleum Refinary Engineering) (2013 Batch) (Sem.–4)

CHEMICAL REACTION ENGINEERING-I

Subject Code : BTPC-406/BTCH-405

M.Code : 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

Q1. Answer briefly :

a) Give the variables affecting the rate of reaction.

b) Give the characteristics of plug flow reactor.

c) Differentiate between space time and residence time.

d) What will be the effect of increase in reaction order on the ratio of mixed flow reactor and plug flow reactor volumes?

e) Define the terms ''Selectivity'' and ''Yield''.

f) How does the concentration level of reactants affect the product distribution in parallel reactions?

g) Give the applications of RTD.

h) What is the effect of temperature on equilibrium conversion?

i) The rate constants of a certain reaction are 1.6×10^{-3} and 1.625×10^{-2} s^{-1} at 10°C and 30°C, respectively. Calculate activation energy of this reaction.

j) A 2nd order reaction is to be carried out in 3 CSTR's of Volume 100 liter, 150 liter and 200 liter. How these should be connected?

SECTION B

Q2. The rate of homogeneous decomposition nitrous oxide, $N_2O \rightarrow N_2 + \frac{1}{2} O_2$ has been found to be represented by

$$-r_{N_2O} = \frac{k_1[N_2O]^2}{1+k_2[N_2O]}$$

Suggest a reaction mechanism which is in consistent with this rate law.

Q3. Derive the performance equation for a recycle reactor. Write the performance equation for the two extremes of the recycle ratio.

Q4. An aqueous phase reaction $A \rightarrow 2R$ is carried out in a CSTR having volume of 5 liters and the following data is obtained.

Run	Feed rate (cm^3/sec)	Temperature of the run (°C)	Concentration of R in the effluent (mol/liter)
1	2	13	1.8
2	15	13	1.5
3	15	84	1.5

Find the rate equation for this reaction and also evaluate the activation energy of the reaction, assuming the applicability of Arrhenius law.

Q5. An aqueous feed of A and B (400 liter/min, 100 mmol A/liter, 200 mmol B/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction $A + B \rightarrow R$; is represented as

$$-r_A = 200\ C_A C_B \text{ mol/(liter-min)}$$

Find the volume of reactor needed for 90% conversion of A to product.

Q6. Explain the stimulus response techniques for study of flow pattern in reaction vessels. Obtain the relation between E, F and C curves.

SECTION C

Q7. A series reaction $A \xrightarrow{1st\,order} B \xrightarrow{Zero\ order} C$ is taking place in a CSTR. Derive the concentrations of A and B as functions of residence time τ, the rate constants (k_1 and k_2) and the initial concentration of A (C_{A0}). Assume that the concentrations of B and C in the reactor entrance stream are zero.

Q8. An irreversible gaseous reaction A $\rightarrow$ B at 10 atm and 144°C has to be carried out in two reactor system. The volumetric feed (360 liter/min) contains 50 mole% A, and 50 mole% inerts is required to be processed. The laboratory measurement of rate of reaction ($-r_A$) as a function of conversion (X_A) at 10 atm and 144°C is as follows :

X_A	0	0.2	0.4	0.6	0.8	0.9
$-r_A$ **(mol/liters)**	0.0053	0.005	0.004	0.0025	0.00125	0.0006

If the reaction is carried out in two reactor system in series with X_{A1} = 0.40 as intermediate conversion (from 1st reactor) and X_{A2} = 0.85 as final conversion, estimate the total volume of two reactors when :

i) The reactors are both mixed flow ii) He reactors are both plug flow.

Q9. 75% conversion for a liquid phase reaction A + B $\rightarrow$ 2C has been achieved in a 300 liter CSTR. Equal mass flow rate of A and B (1.5 mol/s) at a temperature of 27°C and fed to the reactor. Specific heats (in J/mol-K) of A, B and C are 200, 180 and 190, respectively. The reactor is jacketed by water at a temperature of 20°C. The overall heat transfer coefficient has been estimated at 225 J/(m^2.s.K), and the heat transfer area is 1m^2. Mixing is ensured through an agitator, which contributes a work of 15 KW to the reactor. The heat of reaction is –35,000 J/mole of A. Calculate the steady state temperature in the reactor by assuming that the heat of reaction is independent of temperature.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.