Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech

PCCH 4305

Sixth Semester (Special / Back) Examination – 2013

CHEMICAL REACTION ENGINEERING

BRANCH : CHEMICAL

QUESTION CODE : E 309

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.
Answer all parts of a question at a place.

1. Answer the following questions : 2×10

(a) At 25°C, the rate constant for the hydrolysis of ethyl acetate by NaOH is 7.56 (l/mol).$(min)^{-1}$ starting with concentration of base and ester of 0.05mol/l of each. What proportion of ester will be hydrolyzed in 15 mins ?

(b) Differentiate between space time and space velocity.

(c) The primary reaction occurring in the homogeneous decomposition of nitrous oxide is found to be:

$N_2O \rightarrow N_2 + (½)\,O_2$

With 60 mole % inerts and 40 mole % of N_2O present initially, determine the fractional change in volume of the reaction system.

(d) Differentiate between constant volume and pressure batch reactor.

(e) Write down the factors which affect the rate of reaction of particles.

(f) The rate constants of a certain reaction are 1.6×10^{-3} and $1.625 \times 10^{-2}\ s^{-1}$ at 10°C and 30°C. Calculate the activation energy.

(g) What are the fundamental postulates of transition state theory ?

(h) How does (k_1 / k_2) affect the product distribution ?

(i) Phosphine decomposes when heated as per the reaction:

$4\,PH_3\,(g) \rightarrow P_4\,(g) + 6H_2\,(g)$

At a given instant the rate at which phosphine decomposes is 2.4×10^{-3} mol/l.s. Express the rate in three different ways using differential notation and show the relationship between them.

(j) The design of reactor gets affected by density variation during the reaction. Comment on the statement.

P.T.O.

2. (a) Derive the integral rate equation for first order reactions in terms of conversion. 6

(b) A 10 minutes experimental run shows that 75% of liquid reactant A is converted to product by a half-order rate. What would be the amount of A converted in 30 minutes ? 4

3. (a) The primary reaction occurring in the homogeneous decomposition of nitrous oxide is found to be : 6

$$N_2O \rightarrow N_2 + (1/2)\,O_2$$

with rate : $-r_{N2O} = k_1[N_2O]^2/(1 + k'[N_2O])$

Devise a mechanism to explain this observed rate.

(b) Define chain and non-chain reactions with suitable examples. 4

4. (a) In an isothermal batch reactor 70% of a reactant A is converted in 13 minutes. Find the space time and space velocity needed to effect this conversion in a plug flow reactor and in a mixed flow reactor. Assume first order kinetics. 6

(b) Derive the performance equation for ideal steady-state plug flow reactor. 4

5. (a) A gaseous feed of pure A with $C_{AO} = 1$ mol/l enters a mixed flow reactor of volume 2 litres. The kinetics of a reaction is given by $2A \rightarrow R$, $-r_A = 0.05\ (C_A)^2$mol/(l.s)

Find the feed rate (l/min), which will give an outlet concentration C_A = 0.5 mol/l. 4

(b) Discuss about the product distributions for reactions in parallel. 6

6. A mixed flow reactor of volume 2000 l processes an aqueous feed (100 l/min) containing A (C_{AO} = 100 mol/l). The reaction is reversible and represented by $A \Leftrightarrow R$, with rate as :

$-r_A = 0.04\,C_A - 0.01\,C_R$, mol/l.min

Find the equilibrium conversion and actual conversion in the reactor. 10

7. A parallel liquid phase reaction

$$A \xrightarrow{k_1} R, \quad R \xrightarrow{k_2} S$$

has the rate constants $k_1 = 52\ h^{-1}$ and $k_2 = 0.82\ h^{-1}$. Find the moles of R produced in 15 min. Take $C_{AO} = 8.59$mol/l and $C_{RO} = C_{SO} = 0$. 10

8. Write short notes on any **two** of the following : 5×2

(a) Residence time distribution

(b) Differential rate analysis method

(c) Selectivity

(d) Elementary and non-elementary reactions.
