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

Total number of printed pages – 2

B. Tech

PCCH 4305

Sixth Semester Examination – 2013

CHEMICAL REACTION ENGINEERING

BRANCH : CHEMICAL

QUESTION CODE : A170

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.

1. Answer the following questions : 2×10

(a) Compare the collision and transition state theories with Arrhenius law.

(b) How do you represent an elementary equation ?

(c) Devise a relationship between total pressure of the system and partial pressure of the reacting materials of gas phase reaction :

$$N_2O \rightarrow N_2 + (½)\,O_2$$

(d) State the performance equation for batch reactor for variable volume reaction system. Define all the terms used in equation.

(e) What reaction schemes and conditions would you use to have maximum concentration of R for the following parallel reaction ?

$$A + B \rightarrow R \text{ (desired)}, \; r_R = 15.e^{-273/T}.C_A^{0.5}.C_B$$

$$A + B \rightarrow S \text{ (undesired)}, \; r_S = 200.e^{-2000/T}.C_A.C_B$$

(f) Differentiate between space time and space velocity.

(g) Mention some disadvantages of tubular reactor.

P.T.O.

(h) Consider a gaseous feed at $T_0 = 1000$ K, $P_0 = 5$ atm, $C_{AO} = 100$, $C_{BO} = 200$ enters a flow reactor in which $A + B \rightarrow 5R$ occurs. Find C_A.

(i) State the steps for the reaction to be taken place on the surface of the catalyst.

(j) Differentiate between integral and differential method of analysis.

2. Experiment shows that the homogeneous decomposition of ozone proceeds with rate : $-r_{O3} = k\,[O_3]^2[O_2]^{-1}$.

(a) What is the overall order of reaction ? 5

(b) Suggest a two-step mechanism to explain this rate and state how you would further test this mechanism. 5

3. Under suitable conditions A decomposes as follows :

$A \xrightarrow{k_1} R \xrightarrow{k_2} S$, where, $k_1 = k_2 = 0.1\ min^{-1}$ at $t = 0$, $C_{A0} = 1$ mol/l, $C_{R0} = C_{S0} = 0$

R is to be produced from 1000 l/h of feed.

What size of plug flow reactor will maximize the concentration of R ? What is that concentration in the effluent stream from this reactor ? 10

4. (a) Derive the performance equation for a steady state plug flow reactor for constant and variable density systems. 6

(b) Differentiate between constant volume and pressure batch reactor. 4

5. A mixed flow reactor of volume 2000l 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

6. Compare the size of mixed flow reactor and plug flow reactor for first order reaction and second order reaction. 10

7. Elaborate the important characteristics of catalyst and the factors which affect the rate of reaction of particles. 10

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

(a) Differential rate analysis method

(b) Optimum recycle operations

(c) CSTR

(d) Residence time distribution.
