1T00525 - T.E.(CHEMICAL)(Sem V) (Choice Based) / 31704 - Chemical Reaction Enginering-I

Time 3 hours 80 Marks

N.B. (1) Question No.1 is compulsory.

(2) Attempt any three questions.

(3) Assume suitable data wherever necessary with proper justification

Q1 a. The half life periods for decomposition of PH_3 for different initial pressures are given below: (05)

P,torr	707	79	37.5
$t_{1/2}$, min	84	84	84

Find out the order of reaction.

Q1 b. Derive Performace Equation of PFR? (05)

Q1 c. The rate constants of a certain reaction are 1.6 x10^{-3} and 1.625 x10^{-2} s^{-1} at 10^0 C and 30^0 C. Calculate the activation energy. (05)

Q1 d. Substance A in liquid reacts to produce R and S as follows. (05)

A→R (first order)

A→S (first order)

A feed (C_{A0}=2, C_{R0}=0, C_{S0}=0) enters two mixed flow reactors in series (τ_1= 2.5 min, τ_2= 5 min) Knowing the composition in the first reactor (C_{A1}=0.8,C_{R1}=0.8,C_{s1}=0.4). Find the composition leaving the second reactor.

Q2 a. The reaction between H_2(g) and I (gas) to produce HI (gas) proceeds with a rate (12)

$$\frac{1}{2}\frac{d[HI]}{dt} = k[H_2][I]^2$$

Suggest a two step mechanism which is consistent with this rate.

Q2 b. The decomposition of NH_3 on tunsgsten wire at 856^0C yielded the following results. (08)

$$2NH_3 \rightarrow N_2 + 3H_2$$

Using integral analysis method determine the order of reaction
and find the rate constant in terms of moles, liters etc as appropriate

t, sec	0	200	400	600	1000
P (mm Hg)	206	228	250	273	318

Q3 a. Sucrose is hydrolysed at room temperature by the catalytic action of the enzyme as follows: (12)

Sucrose→products

Following kinetic data were obtained in a batch reactor by starting a run with a sucrose concentration C_{AO}=1mol/lt and ad enzyme concentration C_{EO}= 0.01 mol/lt. Check with integral analysis whether these data can reasonably fit a kinetic equation of type. Evaluate constants k and M

$$-r_A = \frac{kC_A C_{EO}}{C_A + M}$$

M: Michaleis Constant

Time, (h)	1	2	3	4	5	6	7	8	9	10	11
C_A (mol/lt)	0.84	0.68	0.53	0.38	0.27	0.16	0.09	0.040.	0.018	0.006	0.0025

Q3 b. Calculate the first order rate constant for the disappearance of A as per the gas phase reaction A→1.6R if the volume of reaction mixture, starting with pure A ,increases by 50% in 4 minutes. The total pressure of the system remains constant at 1.2 atm and the temperature is 25^{0}C (08)

Q4 a. A homogeneous gas phase reaction A→ 3R follows second order kinetics. Pure A at 5 atm and 350^{0}C at a fed rate of 4 m3/hr is fed to a experimental reactor of 3 cm ID and 2.5 m long gave 60% conversion of A. A commercial plant is to treat 320m3/hr of feed having 50% A, 50% inert at 25 atm and 350^0 C to obtain 80% conversion. How many 2.5 m long of 3cm ID pipes are required? (14)
Should be pipe lengths of 2 m each be arranged in parallel or in series? Justify

Q4 b. A first order reaction is carried out in a single CSTR results in 80% conversion of reactant A. It is proposed to put another similar CSTR in series with the first one. How will this addition affect conversion of reactant? (06)

Q5 a. The irreversible gas phase reaction A+B→C is to be carried out at 10 atm and 227^0 C. in a reactor chain consists of A MFR and PFR .It is required to process 1 lt of feed per second. The feed contains 41 mole% A, 41 mole% B and 18 mole% inerts by volume. The rate of reaction in mol/(l.min) as a function of conversion is as follows. (14)

$-r_A$ mol /lt.s	0.2	0.0167	0.00488	0.00286	0.00204
X_A	0	0.1	0.4	0.7	0.9

Calculate size of MFR and PFR required to achieve $X_{A1} = 0.47$ as intermediate conversion (from reactor 1) and $X_{A2} = 0.8$ as final conversion. Suggest best arrangement.

Q5 b. For the irreversible first order series reaction A→R→S the values of rate constants k_1 and k_2 are $0.17 min^{-1}$ and $0.11 min^{-1}$ respectively for reaction 1 and 2. i) Calculate the time at which the concentration of R is maximum and ii) maximum concentration of R (06)

Q6 For the elementary liquid phase reversible reaction (20)

$$A \rightleftharpoons B$$

Construct a plot of equilibrium conversion as a function of temperature and from this plot determine the adiabatic equilibrium temperature and conversion when pure A at a temperatre of 27^0C (300 K) is fed to reactor.

$\Delta H^{\circ}_{fA} = -40000\ cal/mol$ $\quad$ $\Delta H^{\circ}_{fB} = -60000\ cal/mol$

$C_{pA} = 50 \frac{cal}{mol.K}$ $\quad$ $C_{pR} = 50 \frac{cal}{mol.K}$, K=100000 @298 K
