TE - Chemical - V - CBGS - CRE-I — 16-12-2014

1/4

QP Code : 14997

Duration: 3 hours

Total Marks: 80

a Question no 1 is compulsory
b Attempt any three questions from remaining five questions
c Assume suitable data if needed & justify

Q1 a. What is Damkohler number? State its significance. Write down Damkohler number for first and second order reaction. 05

Q1 b. Define order, molecularity and specific rate constant for a given reaction. 03

Q1 c. State difference between space time and residence time 02

Q1 d. Find the overall order of the following irreversible reaction from the following constant volume data obtained by using equimolar quantities of A and B @ 296 deg K 10

$2A+2B \rightarrow C+2D$

Half life (seconds)	265	186	115	104	67
Total Pressure(mm Hg)	200	240	280	320	360

Q2 a. The primary reaction occurring in the homogeneous decomposition of nitrous oxide is found to be 10

$N_2O \rightarrow N_2 + 1/2\ O_2$

With a rate

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

Suggest mechanism.

Q2 b. The liquid phase reaction $P \rightleftharpoons Q+R$ with $C_{PO}=0.1823$ mol/lt, $C_{QO}=0$ and $C_{RO}=55$ mol/lt proceeds as follows. Find the rate expression for this reaction 10

Time, min	0	36	65	100	160	∞
C_P mol/lt	0.1823	0.1453	0.1216	0.1025	0.0795	0.0494

Q3 a. A zero order homogeneous gas phase reaction $A \rightarrow rR$ takes place in a constant volume bomb, P=1 atm when t=0 and P=1.5 atm when t=1 min. If the same reaction with the same feed composition and initial pressure takes place in a constant pressure reactor, Find V at t=1 min if V=1 l at t=0 08

Q3 b. For the irreversible first order series reaction $A \rightarrow R \rightarrow S$ with the values of rate constant $k_1 = 0.17\ min^{-1}$ and $k_2 = 0.11\ min^{-1}$ respectively. Derive and Calculate (i) the time at which the concentration of R is maximum and (ii)maximum concentration of R. 12

Q4 A gas mixture containing 50 mol% A and 50 mol% inerts at 10 atm enters a reactor system with a flow rate of 360 lt/min at 144 deg C. The laboratory measurements of the rate as a function of conversion at 144 deg C and 10 atm are : 20

X_A	0	0.2	0.4	0.6	0.8	0.9
$-r_A$	0.0053	0.005	0.004	0.0025	0.00125	0.0006

If the reaction is carried out in two reactors in series with 40% conversion in the first reactor and 85% overall conversion, Estimate the total volume of the two reactors when (1) the reactors are both mixed flow (2) the reactors are both plug flow (3) reactors are mixed flow reactor followed by plug flow reactor (4) reactors are plug flow reactor followed by mixed flow reactor.
Justify the best system for a given reaction.

Q5 a. Determine the equilibrium conversion for the following elementary reversible reaction between 273 deg K and 373 deg K. 15

$A \rightleftharpoons R$

At 298 deg K : ΔG^0 =-14130 J/mol, ΔH^0_R =-75300 J/mol,

$C_{pA} = C_{pR}$ =constant

(1) Construct a plot of temperature v/s conversion
(2) What restriction should be placed on the reactor operating isothermally if 75% or higher conversion is desired?

Q5 b. What is Optimum Temperature progression? Explain with example. 05

Q6 a. We wish to treat 10 lits/min of liquid feed containing 1 mol A /lit to 99% conversion. The stoichiometry and kinetics of the reaction are 15

$A \rightarrow R$

$$-r_A = \frac{C_A}{0.2 + C_A} \quad \text{mol/lt.min}$$

Suggest a good arrangement (minimum size) for doing this using two mixed flow reactors and find the size of the two units needed. Sketch the final design chosen.

Q6 b. . At 500 deg K the rate of bimolecular reaction is ten times the rate at 400deg K. Find the activation energy for this reaction . 05

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