B.Tech. SEM -V (Chemical 2014 Course (CBCS) : SUMMER - 2019

SUBJECT : CHEMICAL REACTION ENGINEERING – I

Day : Saturday
Date : 11/05/2019

S-2019-2640

Time : 10.00 AM TO 01.00 PM
Max. Marks : 60

N. B. :

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labeled diagram **WHEREVER** necessary.
4) Assume suitable data, if necessary.

Q. 1 **a)** Explain activation energy and temperature dependency for reactions. **(05)**

b) On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order. **(05)**

OR

a) Explain the terms molecularity and order of reaction. **(04)**

b) Experiment shows that the homogeneous decomposition of ozone proceeds with a rate **(06)**

$$-r_{O_3} = k\,[O_3]^2\,[O_2]^{-1}\,O$$

i) What is the overall order of reaction?

ii) Suggest a two step mechanism to explain this rate and state how you would further test this mechanism?

Q. 2 **a)** Liquid A decomposes by second order kinetics, and in a batch reactor 50 % of A is converted in a 5 minute run. How much longer would it take to reach 75 % conversion? **(05)**

b) Find the overall order of the irreversible reaction **(05)**

$$2H_2 + 2NO \rightarrow N_2 + 2H_2O$$

From the following constant volume data using equimolar amounts of hydrogen and nitric oxide.

Total Pressure, mm Hg	200	240	280	320	360
Half life, sec.	265	186	115	104	67

OR

a) For the elementary reaction in series: **(05)**

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

$$at\ t = 0, \begin{cases} C_A = C_{A0} \\ C_{R0} = C_{S0} = 0 \end{cases}$$

Find the maximum concentration of R and when it is reached.

b) A 20 minute experimental run shows that 80 % of liquid reactant is converted to product by a ½ order rate. What would be the fraction converted in a half hour run? **(05)**

P. T. O.

Q. 3 **a)** The homogeneous gas decomposition of phosphine **(05)**
$4PH_3\,(g) \rightarrow P_4\,(g) + 6H_2$ proceeds at 649^{0}C with the first order rate
$-r_{PH_3} = (10/hr)\ C_{PH_3}$
What size of plug flow reactor operating at 649^{0}C and 460 kPa can produce 80% conversion of a feed consisting of 40 mol of pure phosphine per hour?

b) Derive the performance equation for ideal batch reactor. **(05)**

OR

Pure gaseous reactant A (C_{A0} = 100 milimole/liter) is fed at a steady rate into a mixed flow reactor (V = 0.1 liter) where it dimrizes (2A→R). For different gas feed rates the following data are obtained: **(10)**

Run number	1	2	3	4
υ_0, liter /hr	30.0	9.0	3.6	1.5
C_{Af}, milimol / liter	85.7	66.7	50	33.4

Find a rate equation for this reaction.

Q. 4 **a)** Derive the performance equation for recycle reactor. **(05)**

b) An aqueous reactant stream (4 mol A/ liter) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at the exit of the plug flow reactor if in the mixed flow reactor $C_A = 1\,mol/liter$. The reaction is second order with respect to A and volume of the plug flow unit is three times that of the mixed flow unit. **(05)**

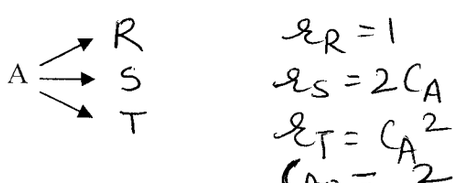
OR

a) A liquid reactant stream (1 mol/liter) passes through two mixed flow reactors in a series. The concentration of A in the exit of the first reactor is 0.5 mol/ liter. Find the concentration in the exit stream of the second reactor. The reaction is second order with respect to A and $V_2/V_1 = 2$. **(06)**

b) Give the best arrangement of a set of ideal reactors. **(04)**

Q. 5 **a)** Explain qualitative discussion about product distribution for first order reaction in series with example. **(05)**

b) The parallel decomposition of A is as follows: **(05)**



Find the maximum expected Cs for isothermal operation in mixed flow reactor.

OR

a) Explain the following terms: **(03)**

i) Overall fractional yield

ii) Instantaneous fractional yield

iii) Selectivity

b) From the following experiment, what we can say about the rate constant of the multiple reaction **(07)**

$$A + B \xrightarrow{k_1} R$$

$$R + B \xrightarrow{k_2} S$$

Half a mole of B is poured bit by bit, with stirring, into a flask containing a mole of A. The reaction proceeds slowly and when B is entirely consumed, 0.67 mole of A remains unreacted.

Q. 6 **a)** Explain effect of temperature on equilibrium conversion at fixed pressure. **(05)**

b) Illustrate optimum temperature progression. **(05)**

OR

Between 0^0C and 100^0C determine the equilibrium conversion for the elementary aqueous reaction **(10)**

$$A \rightleftarrows R \begin{cases} \Delta G^0_{298} = -14130\ J/mol \\ \Delta H^0_{298} = -75300\ J/mol \end{cases} \qquad C_{P_A} = C_{P_R} = \text{constant}$$

Present the results in the form of a plot of temperature versus conversion.

* * * * *