B.Tech. SEM -V (Chemical 2014 Course (CBCS) : WINTER - 2018

SUBJECT : CHEMICAL REACTION ENGINEERING – I

Day : Saturday
Date : 24/11/2018

W-2018-2375

Time : 02.30 PM TO 05.30 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 temperature dependency from: **(05)**

i) Collision theory
ii) Transition state theory

b) Given the reaction $2NO_2 + \frac{1}{2} O_2 = N_2 O_5$, what is the relation between the rates of formation and disappearance of the three reaction components? **(05)**

OR

a) For a first order reaction, the following data is available. Calculate the activation energy for the reaction. $R = 8.314 J/mol.k$. **(06)**

Temperature ^{0}C	300	310	320	330	335
K sec $^{-1}$	0.000195	0.000886	0.00366	0.0139	0.0262

b) Differentiate between molecularity and order of reaction. **(04)**

Q. 2 **a)** Show that the decomposition of hydrogen peroxide in an aqueous solution is a first order reaction. Also calculate the value of rate constant. The following data is available: **(06)**

Time (min)	0	10	20	30	40
N	25	20	15.7	12.5	9.6

N = Number of mL of potassium permanganate required to decompose a definite volume of hydrogen peroxide solution.

b) For a homogeneous first order gas phase reaction: $SO_2 Cl_2 \rightarrow SO_2 + Cl_2$ The half life time is 445 seconds. Calculate the time required for the concentration of $SO_2 Cl_2$ to be reduced to 2 % of the original value. **(04)**

OR

a) Find the overall order of the irreversible reaction. **(07)**
$2H_2 + 2NO \rightarrow N_2 + 2H_2O$ 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

P. T. O.

b) Differentiate between integral and differential method of analysis of data. **(03)**

Q. 3 a) Derive the performance equation for batch reactor. **(05)**

b) A gas phase reaction $2A \rightarrow 3B + C$ is carried out in a variable volume batch reactor. Reaction follows second order kinetics. **(05)**
Rate constant is k=0.05 m^3/kmol.sec.
Initial concentration of A is 0.05 kmol/m^3. Calculate the time required for 50 % conversion of A.

OR

a) Tetra hydrophthalic anhydride is produced by bubbling butadiene in molten maleic anhydride at 110^0C. The concentration of maleic anhydride fed to the (CSTR) reactor is 4.5 gm mole/lit. The solubility of butadiene in maleic anhydride at 110^0C is 1.67×10^{-4} gm mole/cm^3. The second order reaction rate constant is 13.2 cm^3/gm mole-sec. The reaction mixture is maintained uniform by turbine agitator revolving at 850 rpm. The molal flow rate of the maleic anhydride reactant to CSTR is 0.3 gm mol/sec. Calculate the volume of CSTR required to achive 98 % conversion. **(05)**

b) Derive the performance equation for plug flow reactor. **(05)**

Q. 4 A second order reaction carried out in a single CSTR results in 80 % conversion. It is proposed to arrange another similar CSTR in series with the first one. If all the parameters remain same. **(10)**
Calculate:

i) How will this addition affect the conversion of reactant

ii) If same 80 % conversion is maintained, by how much can the production rate be increased?

The second order reaction rate expression is $(-r_A) = k C_A^2$.

OR

A radioactive fluid having half life 23.5 hrs is to be treated by passing it through two ideal CSTRs arranged in series. The volumetric flow rate of radioactive fluid is 125 liters/hr. The volume of each reactor is 48000 liters. Calculate the concentration decrease of radioactive fluid in passing through the reactor system. **(10)**

Q. 5 a) Write a detail note on qualitative discussion about product distribution for parallel reactions. **(04)**

b) Consider the aqueous reactions: **(06)**

$$A+B \xrightarrow{k_1} R \text{ (desired)} \qquad \frac{dC_R}{dt} = 1.0\, C_A^{1.5} C_B^{0.3}, \text{ mol/liter min}$$

$$A+B \xrightarrow{k_2} S \text{ (unwanted)} \qquad \frac{dC_S}{dt} = 1.0\, C_A^{0.5} C_B^{1.8}, \text{ mol/liter.min}$$

For 90 % conversion of A find the concentration of R in the product stream. Equal volumetric flow rates of the A and B streams are fed to the reactor, and each stream has a concentration of 20 mol/liter of reactant. The flow in the reactor follows plug flow:

OR

Substance A in the liquid phase produces R and S by the following reactions: **(10)**

$$A \rightarrow R \qquad r_R = k_1 C_A^2$$
$$A \rightarrow S \qquad r_S = k_2 C_A$$

The feed $\left(C_{A_0} = 1.0,\ C_{R_0} = 0,\ C_{S_0} = 0.3\right)$ enters two mixed flow reactors in series $\left(\tau_1 = 2.5 \text{ min},\ \tau_2 = 10 \text{ min}\right)$. Knowing the composition in the first reactor $\left(C_{A_1} = 0.4,\ C_{R_1} = 0.2,\ C_{S_1} = 0.7\right)$. Find the composition leaving the second reactor.

Q. 6 **a)** Discuss on equilibrium constants from thermodynamics. **(06)**

b) Show graphically effect of temperature on equilibrium conversion as predicted by thermodynamics. **(04)**

OR

a) Illustrate about optimum temperature progression. **(06)**

b) Represent graphically energy balance for adiabatic operation. **(04)**

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