B.Tech Sem - VI (2007 Course) (Chemical Engg.) : WINTER - 2018
SUBJECT : CHEMICAL REACTION ENGINEERING – I

Day : Wednesday **W-2018-2838** Time : 10.00 AM TO 01.00 PM
Date : 14/11/2018 Max. Marks : 80

N. B. :
1) **Q. No.1** and **Q. No. 5** are **COMPULSORY**. Out of remaining attempt **ANY TWO** questions from section – **I** and section – **II.**
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer books.
4) Use of non-programmable calculator is **ALLOWED.**
5) Assume suitable data, if necessary.

SECTION - I

Q. 1 **a)** Explain in detail and temperature dependency from Arrhenius law. **(05)**
b) Differentiate between integral method of analysis of data and differentiate method of analysis of data. **(05)**
c) Derive the performance equation of ideal batch reactor. **(04)**

Q. 2 **a)** Show that the following scheme: **(06)**

$$N_2O_5 \underset{k_2}{\overset{k_1}{\longleftrightarrow}} NO_2 + NO_3^*$$
$$NO_3^* \rightarrow NO^* + O_2$$
$$NO^* + NO_3^* \rightarrow 2NO_2$$

is consistent with, and can explain, the observed first order decomposition of N_2O_5.

b) For the stiochiometry $A + B \rightarrow$ (Products) find the reaction orders with respect to A and B. **(07)**

i)

CA	4	1	1
CB	1	1	8
$-rA$	2	1	4

ii)

CA	2	2	3
CB	125	64	64
$-rA$	50	32	48

Q. 3 **a)** After 8 minutes in a batch reactor reactant $(CA_0 = 1\ mol/litre)$ is 80 % converted after 18 minutes, conversion is 90 %. Find a rate equation to represent this reaction. **(06)**
b) A 10 – minute experimental run shows that 75 % of liquid reactant is converted to product by a 1/2 order rate. What would be the fraction converted in a half hour run. **(07)**

Q. 4 An aqueous feed of A and B (400 liter / min, 100 mmol A / liter, 200 mmol B/ liter) is to be converted product in a PFR. The kinetics of the reaction is represented by **(13)**

$$A + B \rightarrow R, \quad -rA = 200\ CA\ CB\ \frac{mol}{liter.\min}$$

Find the volume of the reactor needed for 99.9 % conversion of A to product.

P. T. O.

SECTION - II

Q. 5 **a)** Write a short note on autocatalytic reactions. **(05)**

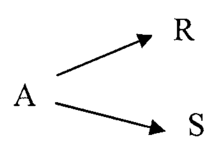
b) Explain in detail quantitative treatment of irreversible first order elementary reaction in PFR. **(05)**

c) Explain in detail adiabatic operations in PFR. **(04)**

Q. 6 **a)** At present connection is 2/3 for our elementary second order liquid reaction $2A \rightarrow 2R$ When operating in an isothermal plug flow reactor with a recycle ratio of unity. What will be the conversion if the recycle stream is shut off? **(06)**

b) 100 liters/hr of radioactive fluid having a half life of 20 hr. is to be treated by passing it through two stirred tanks in series, V = 40,000 liters each. In passing through this system, how much will the activity decay? **(07)**

Q. 7 Liquid reactant A decomposes as follows. **(13)**



$$r_R = K_1\ CA^2$$
$$rs = K_2\ CA$$
$$K_1 = 0.4\,m^3 / mol - \min$$
$$k_2 = 2\ \min^{-1}$$

A feed of aqueous $A\left(CA_0 = 40\ \frac{mol}{m^3}\right)$ enters a reactor, decomposes, and a mixture of A, R and S leaves. Find C_R and C_S and τ for $X_A =$ 0.9 in a mixed flow reactor.

Q. 8 The first order reactions: **(13)**

$A \overset{1}{\rightarrow} R \overset{3}{\rightarrow} S$

$A \overset{2}{\rightarrow} T$

$R \overset{4}{\rightarrow} U$

S is desired.

$$K_1 = 10^9\ e^{-6000/T}$$
$$K_2 = 10^7\ e^{-4000/T}$$
$$K_3 = 10^8\ e^{-9000/T}$$
$$K_4 = 10^{12}\ e^{-12,000/T}$$

are to be run in two MFR in series anywhere between 10^0C and 90^0C. If the reactors may be kept at different temperatures, what should these temperatures be for maximum fractional yield of S? Find this fractional yield.

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