Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 150403

Subject Name: Chemical Reaction Engineering

Date: 16 /12 /2010 **Time: 03.00 pm - 05.30 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** An irreversible series reaction A→R→S is taking place in a constant volume batch reactor. Each individual reaction is of 1st order. Derive an expression for estimating concentrattion of reactants & products at any time t. Also calculate the time at which the C_R is maximum. **07**

(b) What do you understand by instantaneous fractional yield and overall fraction yield of a product? Give different contacting patterns for different concentration of reactant. **07**

Q.2 **(a)** Find the overall order of the irreversible reaction $2H_2+2NO \rightarrow N_2+2H_2O$ from the following constant volume data using equimolar amount of hydrogen & nitric oxide: **07**

Total Pressure, mmHg	200	240	280	320	360
Half life, sec	265	185	115	104	67

(b) Explain Arhenious theory of tempeature dependency along with activation energy and temperature sensitivity of reaction. **07**

OR

(b) Explain differential method of analysis to determine kinetics of reactions. Also differentiate integral method and differential method. **07**

Q.3 **(a)**

(1) The decompostion of H_2O_2 in the presence of silver catalyst is first order. 50 ml of solution of H_2O_2 gives 12.8 ml of O_2 in 6 minute & maximum amount of O_2 obtained from the solution was 40 ml. What is the rate constant & What additional volume of oxygen evolved in next 9 minute. **04**

(2) Define molecularity, order of reaction & auto catalytic reactions. **03**

(b) Calculate the percentage decomposition of nitrous oxide at 895 ^{0}C, after 100 second, which decomposes according to a second order reaction as follows: **07**

$2N_2O \rightarrow 2N_2 + O_2$

The forward reaction rate constant at 895 ^{0}C for the reaction is 977 cc/gmole sec and the reverse reaction rate is negligible. The reaction is carried out in a constant volume batch reactor in which initial pressure is 760 mmHg.

OR

Q.3 **(a)**

(1) Find the first order rate constnat for the disappearance of A in the gas phase reaction A→ 1.6R, if the volume of the reaction mixture, starting with pure A, increases by 50% in 4 minute. The total pressure within the system stays constant at 1.2 atmosphere & the temprature is 25^{0}C. **04**

(2) Find conversion after 1hr in a batch reactor for A→R, $-r_A=3\ C_A^{0.5}$ mol/liter-hr, C_{A0}=1 mol/liter. **03**

(b) A homogeneous gas reaction A → 3R has a reported rate at 215 ^{0}C, $-r_A = 10^{-2} C_A^{1/2}$ mol/liter sec. Find the space time needed for 80 % conversion of a 50% A, 50 % inert feed, a plug flow reactor operating at 215 ^{0}C & 5 atmosphere (C_{A0}= 0.0625 mol/liter) **07**

Q.4 **(a)** Show that the following mehanism for the production of HBr is consistent with the rate expression, **07**

$r_{HBr} = k_1[H_2] [Br_2]^{1/2} /k_2+([HBr]/[Br_2])$

Reacion: $H_2+Br_2 \rightarrow 2HBr$

Mechanism: I) $Br_2 \leftrightarrow 2Br^*$

II) $Br^*+H_2 \leftrightarrow HBr + H^*$

III) $H^* + BR_2 \rightarrow HBr + Br^*$

(b) What are the different types of ideal reactors? Derive the performance equation of Plug flow reactor. **07**

OR

Q.4 **(a)** A first order irreversible reaction A → B is carried out in a plug flow reactor followed by an equal size CSTR in series. The concentration of A in the feed is 1 kgmole/m^3 and the residence time in each reactor is 1/3600 sec^{-1}. Find the conversion of A at the exit of the system. **07**

(b) How will you compare the performance of single batch reactor with the flow reactor and mixed versus plug flow reactor for a first order reaction? **07**

Q.5 **(a)** How mixing of fluid of different composition is the key to the formation of intermediate for irreversible reactions in series? Discuss in detail the qualitative product distribution for series reaction. **07**

(b) A gaseous feed of pure A (1 mol/liter) enters a mixed flow reactor (2 liters) and reacts as follows 2A → R, $-r_A = 0.05 C_A^2$ mol/liter sec. Find what feed rate (liter/minute) will give an outlet concentration C_A = 0.5 mol/liter. **07**

OR

Q.5 **(a)** Consider a feed C_{A0}= 100 mol/liter, C_{A0} =200 mol/liter, C_{A0}=100 mol/liter to a steady flow reactor. The isothermal gas phase reaction is A+3B→ 6R, , if C_A = 40 mol/liter at the reactor exit what is C_B, X_A, & X_B there. **07**

(b) Write short notes on optimum temperature progression. **07**

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