

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 $A \rightarrow R \rightarrow S$ is taking place in a constant volume batch reactor. Each individual reaction is of 1st order. Derive an expression for estimating concentration 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**

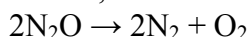
Total Pressure, mmHg	200	240	280	320	360
Half life, sec	265	185	115	104	67

- (b) Explain Arrhenius theory of temperature 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 decomposition 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 °C, after 100 second, which decomposes according to a second order reaction as follows: **07**



The forward reaction rate constant at 895 °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 constant for the disappearance of A in the gas phase reaction $A \rightarrow 1.6R$, 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 temperature is 25°C. **04**
- (2) Find conversion after 1hr in a batch reactor for $A \rightarrow R$, $-r_A = 3 C_A^{0.5}$ mol/liter-hr, $C_{A0} = 1$ mol/liter. **03**

- (b) A homogeneous gas reaction $A \rightarrow 3R$ has a reported rate at 215°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°C & 5 atmosphere ($C_{A0} = 0.0625$ mol/liter) **07**
- Q.4 (a)** Show that the following mechanism for the production of HBr is consistent with the rate expression, **07**
 $r_{\text{HBr}} = k_1[\text{H}_2][\text{Br}_2]^{1/2} / k_2 + ([\text{HBr}]/[\text{Br}_2])$
 Reaction: $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$
 Mechanism: I) $\text{Br}_2 \leftrightarrow 2\text{Br}^*$
 II) $\text{Br}^* + \text{H}_2 \leftrightarrow \text{HBr} + \text{H}^*$
 III) $\text{H}^* + \text{Br}_2 \rightarrow \text{HBr} + \text{Br}^*$
- (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 $A \rightarrow B$ 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 kgmol/m^3 and the residence time in each reactor is $1/3600 \text{ sec}^{-1}$. 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 $2A \rightarrow R$, $-r_A = 0.05 C_A^2$ 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 $A + 3B \rightarrow 6R$, 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**
