Question bank – Chemical Reaction Engineering

Chapter 1: Chemical Kinetics

Short questions:

1. Define rate constant.
2. Give an example of a first order reaction.
3. State Arrhenius equation.
4. Write the order of reaction, $CH_3COOC_2H_5$ + NaOH MCH_3COONa + C_2H_5OH.
5. What is activation energy ?
6. Give examples of an unimolecular reaction.
7. Define heterogeneous chemical reaction with an example.
8. Define molecularity.
9. Define first order reaction with a suitable example.

Long questions:

1. The rate law for decomposition of N_2O_5(L) is, rate=k[N_2O_5], where k= 6.22×10^{-4} sec^{-1}. Calculate the half life of N_2O_5 and the no. of second it will take for an initial concentration of N_2O_5(L) = 0.1M to drop to 0.01M.
2. The partial pressure of azomethane ($C_2H_6N_2$) was observed as a function of time at 600K with the results given below. Confirm that decomposition of azomethane is first order and find the rate constant at this temperature. $C_2H_6N_2$ C_2H_6 + N_2.

Time(sec)	0	1000	2000	3000	4000
Partial pressure(mm of Hg)	820	527	399	278	194

3.
4. The pyrolysis of ethane proceeds with an activation energy of about 75000 cal/mol. How much faster is the decomposition at 650 ^{0}C than at 500 ^{0}C ?
5. Explain the molecularity of a reaction.
6. Differentiate between elementary and non-elementary reactions.
7. The activation energy of a bimolecular reaction is 9150 cal/mol.
   (a) How much faster is this reaction takes place at 500K than at 400K ?
   (b) How much faster is this reaction takes place at 600K than at 500K ?
   Data : R=1.987 cal/mol.K.
8. Explain half life method in detail.
9. A certain reaction, has a rate given by $(-r_A) = 0.005C_A^2$ [mol][cm3.min]$^{-1}$. If the concentration is expressed as mol/litre and time in hour, what would be the unit of rate constant ?
10. Differentiate between molecularity and order of reaction.

11. The half life period for a certain first order reaction is 2.5×10^3 seconds. How long will it take for 1/4 of the reactant to be left behind ?
12. The pyrolysis of ethane proceeds with an activation energy of about 300KJ/mol. How much faster is the decomposition at 650 ^{0}C than at 450 ^{0}C ?
13. Explain in detail the non-elementary reaction.
14. Derive the half life of a first order reaction.
15. For a gas reaction at 400K, the rate is reported as $\frac{-dP_A}{dt} = 3.66P_A^2$, atm/h
    (a) What is the unit of rate constant ?
    (b) What is the Value of the rate constant for this reaction if the rate equation is written as
        (i) $(-r_A) = \frac{-1}{V}\frac{dN_A}{dt} = kC_A^2$, mol/l.h ?
        (ii) $(-r_A) = kC_A^2$, mol/m^3.sec ?

Chapter 2: Interpretation of batch reactor data

Short questions:

1. Write the equation for C_A for a batch reactor system under isothermal, constant pressure and variable volume condition.
2. What is a constant volume batch reactor ?
3. Differentiate between integral and differential method.
4. Name different methods of interpretation of batch reactor data.

Long questions:

1. Derive an integrated rate equation of an irreversible bimolecular type second reaction in terms of conversion.
2. 50% of a first order reaction is completed within 23 minutes. Calculate the time required to complete 90% of the reaction.
3. A gaseous feed with C_{A0} = 100 moles, C_{B0} = 200 moles, C_{I0}(inert)=100 moles enters a steady state flow reactor in which the isothermal gas phase reaction A + 3B 6R takes place. Determine C_B, X_B and X_A at the exit of the reactor if C_A at the exit is 40 moles.
4. In an isothermal batch reactor, the conversion of a liquid reactant A is 70% in 13 minutes. Find the space time and space velocity necessary to effect this conversion in a plug flow reactor and in a mixed flow reactor. Consider first order kinetics.
5. 50% of a first order reaction is completed in 30 minutes. How much time it will take to complete 75% of the reaction ?
6. Derive the integrated rate equation for the first order reaction in terms of conversion.
7. Explain in details the differential method of analysis of rate data.

8. Write briefly about interpretation of batch reactor data by integral method of analysis.
9. Derive the integrated rate equation for irreversible unimolecular type first order reaction in terms of conversion.
10. The rate constant of a zero order reaction is 0.2 mol/(l.hr). What will be the initial concentration of the reactant, if after half an hour, it's concentration is 0.05 mol/lit.
11. If 20% of a first order reaction is over in 30 minutes, how much time it will take to finish 75% of the reaction ?
12. Half life of a first order reaction is 30 minutes. How much time it will take to complete 80% of the reaction.

Chapter 3: Catalysis

Short questions:

1. Why is catalyst more effective when it is finely divided ?
2. What is contact catalysis ?
3. Define promoter with a suitable example.
4. Give examples of two catalysts used in industry.
5. Define a catalyst.

Long questions:

1. Explain the intermediate compound formation theory of catalysis.
2. Explain briefly about negative catalysis.
3. Explain the characteristics of a catalytic reaction.
4. Explain briefly enzyme catalysis.
5. Explain the adsorption theory of catalysis with example.
6. Discuss the theories of catalysis.

Chapter 4: Reactors

Short questions:

1. Write the advantages of semi batch reactor.
2. Write the performance equation for CSTR.
3. Define space velocity.
4. What are the advantages of a batch reactor ?

Long questions:

1. Draw the sketch of a plug flow reactor and write the material balance equation.
2. Derive design equation of a CSTR.

3. State the advantages and disadvantages of a PFR.
4. Explain the working of fluidised bed reactor with a neat diagram.
5. Explain briefly tubular reactor.
6. Derive the design equation for ideal batch reactor.
7. Differentiate between space time and residence time.
8. What are the industrial application of different type of reactors ?
9. Describe the working of a fluidised bed reactor and its industrial application.

Chapter 5: Chemical Equilibrium

Short questions:

1. Define chemical equilibrium.
2. State law of mass action.
3. What is equilibrium constant ?
4. State Le chatelier's principle.

Long questions:

1. What is Le chatelier's principle ?
2. How Le chatelier's principle is applied to manufacturer of ammonia ?
3. Define Le chatelier's principle and discuss the effects of changes in concentration, temperature and pressure on equilibrium constant