Total number of printed pages – 2

Sixth Semester Regular / Back Examination – 2015

CHEMICAL REACTION ENGINEERING

BRANCH : CHEM

QUESTION CODE : J 200

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any five from the rest.
The figures in the right-hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.

1. Answer the following questions :   2 ×10
    (a) Define the types of intermediates formed during a reaction.
    (b) Differentiate between elementary and non-elementary reaction with suitable examples.
    (c) What reaction schemes and conditions would you use to have maximum concentration of R for the following parallel reactions ?

    $A + B \rightarrow R$ (desired), $r_R = 15.e^{-273/T}.C_A^{0.5}.C_B$
    $A + B \rightarrow S$ (undesired), $r_S = 200.e^{-2000/T}.C_A.C_B$

    (d) State the relationship between F and E curves.
    (e) Devise a relationship between total pressure of the system and partial pressure of the reacting materials of gas phase reaction :

    $$N_2O \rightarrow N_2 + (½) O_2$$

    (f) Differentiate between the transition state theory and collision theory.
    (g) A certain reaction has a rate given by :

    $$-r_A = 0.005 \, C_A^2, \, mol/cm^3.min$$

    If the concentration is to be expressed in mol/lit and time in hours, what would be the value of rate constant ?
    (h) State the advantages of semi-batch reactor.
    (i) Define the recycle ratio.
    (j) What is mean residence time ?

2. Compare the mixed flow reactor and plug flow reactor for 2nd order reaction. 10

3. (a) Show that the following scheme :

$$N_2O_5 \Leftrightarrow NO_2 + NO_3^*$$
$$NO_2 + NO_3^* \to NO_2 + O_2 + NO^*$$
$$NO^* + NO_3^* \to 2NO_2$$

can explain the observed first order decomposition of N_2O_5. [Given : $2N_2O_5 \to 4NO_2 + O_2$] 8

(b) The pyrolysis of ethane proceeds with an activation energy of about 300kJ/mol. How much faster is the decomposition at 650°C than at 500°C ? 2

4. (a) Derive the integrated rate expression for first order reaction for variable volume system. 6

(b) In a homogeneous isothermal liquid polymerization, 20% of the monomer gets disappeared in 34 minutes for initial monomer concentration of 0.04 and also for 0.8. What is the rate expression for the disappearance of the monomer ? 4

5. (a) Derive the performance equation for the case in which two equal size CSTRs are arranged in series. 3

(b) 100 l/h of radioactive fluid having a half-life of 20 h is to be treated by passing it through two ideal stirred tanks in series. The volume of each stirred tank in series is 40,000 l. In passing through this system, how much has the activity decayed ? The reaction follows first order kinetics. 7

6. An aqueous solution of ethyl acetate is to be saponified with sodium hydroxide. The initial concentration of ethyl acetate is 5 g/l and that of caustic is 0.1 N. The values of 2nd order rate constant (k) at 0°C and 20°C are 0.235 and 0.924 (l/mol)(min^{-1}) respectively. The reaction is irreversible. Calculate the time required to saponify 95% ester at 40°C. 10

7. (a) Qualitatively discuss the product distribution of parallel reactions. 4

(b) In an isothermal batch reactor 70% of a reactant A is converted in 13 minutes. Find the space time and the space velocity needed to effect this conversion in a plug flow reactor and in a mixed flow reactor. 6

8. Write short notes on any **two** : 5×2
   (a) RTD
   (b) Selectivity
   (c) Performance equation of PFR
   (d) Autocatalytic reactions.