Practice Questions for CRE (Block-1)

Topics: Rate law, rate, kinetics, conversion, reactor size

1. Differentiate
    a. Homogeneous and heterogeneous reactions
    b. Order and molecularity
    c. Elementary reactions and non-elementary reactions

2. Draw the energy diagrams for an endothermic reaction with and without catalyst. Why do we need certain amount of energy to start a chemical reaction?

3. Reactions with high activation energy are very temperature sensitive. Justify with the help of a diagram.

4. For an elementary reaction $A + B + C \xrightarrow{k} D$
    i. Rate of reaction doubles when C_B is doubled
    ii. Rate of reaction when C_A and C_B doubles
    iii. Rate of reaction is quadrupled when C_B and C_C doubles

    Find overall order of the reaction.

5. For a gaseous reaction at 400 K, the rate is reported as (assume ideal gas)

    $$\frac{-dP_A}{dt} = 3.66{P_A}^2(\frac{atm}{hr})$$

    a. What is the unit of k
    b. What is the unit of k when rate is expressed as $\frac{-dC_A}{dt} = k{C_A}^2(\frac{kmol}{m^3 hr})$

6. For a non-catalytic homogeneous chemical reaction $A \longrightarrow B$, the rate expression at 300 K is $-r_A(\text{mol m}^{-3}\text{s}^{-1}) = \frac{10C_A}{1+5C_A}$ where C_A is the concentration of A (in mol/m^3).Find the upper limit for the magnitude of the reaction rate ($-r_A$ in mol m^{-3} s^{-1}) rounded off to the first decimal place) at 300 K?

7. An isothermal liquid phase zero order reaction $A \longrightarrow B$ (k=0.5 mol/m^{3}s) is carried out in a batch reactor. The initial concentration of A is 2 mol/m^3. At 3 seconds from the start of the reaction, find the concentration of A in mol/m^3?

8. The half-life of a first order liquid phase reaction is 30 sec. Find the rate constant, in min^{-1}?

9. The liquid phase reaction A $\longrightarrow$ Products is governed by the kinetics $-r_A = k\, C_A^{0.5}$. If the reaction undergoes 75% conversion of A in 10 minutes in an isothermal batch reactor, find the time required (min) for complete conversion of A?

10. You have two CSTRs and two PFRs each with a volume of 1.6 m^3. Use Figure 2-2 in Fogler book to calculate the conversion for each of the reactors in the following arrangements.

a. Two CSTRs in series.
b. Two PFRs in series.

c. Two CSTRs in parallel with the feed, F_{A0} divided equally between the two reactors.

d. Two PFRs in parallel with the feed divided equally between the two reactors.

e. A CSTR and a PFR in parallel with the flow equally divided. Also calculate the overall conversion, X_{OV}

$$X_{OV} = \frac{F_{AO} - F_{ACSTR} - F_{APFR}}{F_{AO}}, \text{ with } F_{ACSTR} = \frac{F_{AO}}{2} - \frac{F_{AO}}{2} X_{CSTR}$$

$$F_{APFR} = \frac{F_{AO}}{2} (1 - X_{PFR})$$

11. For a plug flow reactor

a. Axial diffusivity is infinite, radial diffusivity is zero
b. Axial diffusivity is zero, radial diffusivity is zero
c. Axial diffusivity is zero, radial diffusivity is infinite
d. Axial diffusivity is infinite, radial diffusivity is infinite

12. A zero order reaction is conducted in a CSTR. Under uniform conditions, if the reactant concentration in the fluid entering the reactor is halves, the fractional conversion of the reactant will

a. Decrease by a factor of 2
b. Increase by a factor of 2
c. Remain unaffected because rate of a zero order reaction is independent of concentration
d. Do not agree with the statement