(Following Paper ID and Roll No. to be filled in your Answer Books)

Paper ID : 151611   Roll No.

B.TECH.

Theory Examination (Semester-VI) 2015-16

CHEMICAL REACTION ENGG II

Time : 3 Hours   *Max. Marks : 100*

Note :   (i) Attempt all questions

        (ii) Assume missing data suitably if any.

Section-A

1. **Attempt all questions. All part carries equal marks.**

$$(2\times10=20)$$

(a) Plot the four conditions of rate equation for mass transfer and reaction describing instantaneous and fast reaction with high and low C_B.

(b) Define enhancement factor E.

(c) Describe the SCM model for spherical particle

(d) Define fluidized bed reactor with its mechanism.

(e)   Describe the various properties of solid catalyst.

(f)   Define following :

        (i)   Promoters and inhibitors

        (ii)   Catalyst poisoning

        (iii)   Surface area of catalyst

        (iv)   Pore size

(g)   Define effectiveness factor

(h)   What do you understand by diffusion within porous catalyst ?

(i)   Describe the types of biochemical reactor with their principle of operations in brief.

(j)   What do you understand by rate controlling step? How will you find out for different types of reactions?

Section-B

2.   **Attempt any five question from this section :**

                                                (5×10=50)

(a)   NaOH solution is to be used for the removal of CO_2 from air at 25°C. Assume that the reaction is instantaneous and represented by $CO_2 + 2OH^- = H_2O + CO_3^{--}$

Determine the form of rate equation to be used under the following conditions. Give necessary justification.

(i) CO_2 partial pressure 1000 Pa and NaOH solution is 1.6N

(ii) CO_2 partial pressure is 15000 Pa and NaOH solution is 0.4N.

DATA: $k_g a = 0.80 \dfrac{mol}{Pa.h.m^3}$; $k_l a = 25\ h^{-1}$; $H = 3000$ $(Pa.\ m^3)\ /\ mol$

(b)   On doubling the particle size from R to 2R the time needed for conversion of a particle triples. Determine the contribution of ash diffusion to the overall resistance for particles of size (i) R and (ii) 2R. neglect gas film resistance.

(c)   A fluidized bed reactor of size 20 $cm\ ID \times 2 - m$ long operates at steady state with a solid feed consisting of

30% of $50\mu m$ radius particles

40% of $100\mu m$ radius particles

30% of $200\mu m$ radius particles

(3)   P.T.O.

The fluidizing gas is in the gas phase reactant and has uniform composition. The time required for complete conversion is 5, 10 and 20 minutes for the three sizes of feed under planned operating conditions. The feed rate to the reactor is 1 kg solid/min and fluidized bed contains 10 kg of solids. The solids are hard and remain unchanged in size and weight during reaction. The change in gas phase composition in the bed is negligible. Calculate the conversion of solids.

(d) Calculate the amount of catalyst needed in a packed bed reactor to achieve 80% conversion of 1000 m^3 / hr of pure gaseous A (C_{AQ} = 100 mol/m^3) for :

(i) $A \rightarrow R$ $\quad -r_A^1 = \dfrac{50\,C_A}{1+0.02\,C_A}\left(\dfrac{mol}{h.\,kg\;cat}\right)$

(ii) $A \rightarrow R$ $\quad -r_A^1 = 8C_A^2\left(\dfrac{mol}{h.\,kg\;cat}\right)$

(e) Describe the Shrinking core model with its derivation of three resistance experienced during reaction.

(f) Define the kinetics of solid catalyzed reaction with derivation.

(4)

(g) Derive the performance equation for reactors containing porous catalyst particle.

(h) A sucrose is hydrolyzed at ambient temperatures by the enzyme sucrose as follows :

$$\text{sucrose} \xrightarrow{\ sucrase\ } \text{products}$$
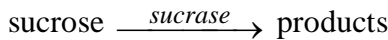
Starting with a sucrose concentration $C_{AO} = 1\ mol/m^3$ and a sucrose (enzyme) concentration $C_{EQ} = 0.01\ mol/m^3$ the following kinetics data are obtained in a batch reactor. Find the equation to represent the kinetics of this hydrolysis reaction

t, h	2	6	10
C_A, mol/m^3	0.68	0.16	0.006

Section-C

Attempt any two questions from this section : **(2×15=30)**

3. We plan to remove 90% of the reactant present in a gas stream by absorption in water. Find the volume of tower required for countercurrent operation.

   DATA :

For gas stream: $F_g = \dfrac{900\,00\,mol}{h}$ at $\pi = 10^5\,Pa$

$P_{Ain} = 1000\ Pa,\ p_{AQut} = 100\ Pa$

For packed bed : $F_i = 900000\ \dfrac{mol}{h}$, $k_{Ag}\,a = 0.36\ \dfrac{mol}{h.m^3\,Pa}$;

$k_{Al}\,a = 72\ h^{-1}$

Molar density of liquid under all conditions is

$C_T = 5556\ mol/m^3$

and $H_A = 18\ \dfrac{(Pa.m^3)}{mol}$; $k = 0\ \dfrac{m^3}{(mol.h)}$

4. Differentiate between Fixed bed reactor and Fluidized bed reactor. And derive the following relation for instantaneous reaction with low C_B

$$-r_A^{11} = -\left(\frac{1}{S}\right)\left(\frac{dN_A}{dt}\right) = \left[\frac{\left(\dfrac{D_{Bl}\,C_B}{D_{Al}\,b} + \left(\dfrac{p_A}{H_A}\right)\right)}{\dfrac{1}{H_A\,k_{Ag}} + \left(\dfrac{1}{k_{Al}}\right)}\right]$$

(6)

5. Describe the steps of free radical chain polymerization reactions such as :

    (a) Initiation

    (b) Propagation

    (c) Chain transfer

    (d) Termination

(7)