Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 09

B.Tech. (Petroleum Refinery Engineering) (2013 Batch) (Sem.–5)

CHEMICAL REACTION ENGINEERING-II

Subject Code : BTPC-501/ BTCH-601

Paper ID : [72654]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt ANY FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt ANY TWO questions.**

SECTION-A

1. Write short notes on :

(a) Discuss briefly the effect of temperature on adsorption.

(b) Give classification of catalysts.

(c) What is the significance of effectiveness factor in solid catalyzed reactions?

(d) Give examples of the situations where shrinking core model closely approximate the reality.

(e) List the reasons for catalyst deactivation.

(f) What is the significance of Thiele modulus?

(g) What are the assumptions of Langmuir adsorption isotherm?

(h) What is the role of catalyst in a reaction? What is a negative catalyst?

(i) Name the important physical properties of catalysts.

(j) List the assumptions in fluid-fluid reaction models.

SECTION-B

2. Our packed bed reactor runs the gas phase reaction A $\rightarrow$ R at 10 atm and 360 °C and gives 90% conversion of pure A feed. The catalyst salesman guarantees that in the absence of any pore diffusion resistance the reaction will proceed on his new improved porous catalyst [De = 2 × 10^{-6} m^3/($m_{cat.}$s)] with a rate given by $-r_A = 0.88\ C_A \frac{mol}{m^3_{cat}.s}$.

   What size of catalyst pellets should we order to achieve the above reaction rate?

3. Draw the interface concentration profiles for reactants A and B (fluid-fluid reaction) and discuss the profiles behavior for (i) intermediate reaction with respect to mass transfer (ii) the extremely slow reaction with respect to mass transfer.

4. Derive the expression for overall rate for a solid catalyzed reaction :

   $$A(g) + B(g) \leftrightarrow C(g) \text{ (overall reaction)}$$

   In terms of fluid phase concentrations, if adsorption of A is assumed to be the rate controlling step.

5. Discuss the advantages and disadvantages of fixed bed and fluidized bed catalytic reactors.

6. For fluid-fluid reactions discuss how are the experiments helpful in determining the kinetic regimes.

SECTION-C

7. Particles of uniform size are 60% converted on the average (shrinking core model with reaction controlling) when flowing through a single fluidized bed. If the reactor is made twice as large but contains the same amount of solids and with the same gas environment what would be the conversion of solids?

8. For the reaction given below, determine the amount of catalyst needed in a packed bed reactor with a very large recycle rate (assume mixed flow) for 35% conversion of gaseous A to R for a feed rate of 2000 mol/hr of pure A at 3.2 atm and 117°C. The reaction rate at this temperature is also known.

   $$A \rightarrow 4R, -r'_A = 96\ C_A, \text{ mol/kg cat} \cdot \text{hr}$$

9. (a) Discuss the important factors for the reactor selection for solid catalyzed reactions.

   (b) Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first-order rate,

   $$-r''_A = k''\ (C_{As} - C_{Ae})$$

   where C_{Ae} is the concentration of A in equilibrium with the solid surface. Develop an expression for the rate of reaction of A accounting for both the mass transfer and reaction steps.