M.Tech. Second Semester (Membrane & Separation Tech.) (F.T.)

13036 : Advanced Reactor Design : 2 MST 4

P. Pages : 2 | AW - 3442

Time : Three Hours | Max. Marks : 80

* 0 3 2 5 *

Notes :

1. Answer **any six** question.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and chemical equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Discuss the reaction, mechanism wherever necessary.
7. Use of pen Blue/Black ink/refill only for writing the answer book.

1. a) What do you mean by configuration of a chemical reactor? Discuss the parameters which need to be considered? **6**

b) What are the various types of reactors and how will you compare batch operation with continuous operation? **7**

2. Explain the classification of catalytic reactions and the role of catalyst and its characteristics in catalytic reaction. Also explain the pore diffusion resistance model applied to determine the effectiveness of a catalyst. **13**

3. Discuss the salient features of operation of a non isothermal reactor. A first order liquid phase exothermic reaction produces 190 kg/hr of a product in a batch operation. Reaction is carried out at 140°C and the rate constant for the reaction is $0.025 min^{-1}$. Heat of reaction is -125 kcal/kg. Density of reaction mixture = 950 kg/m^3. For feeding the reactor and draining the product 1 hr is required. Calculate the volume of batch reactor and heat removal rate if isothermal conditions are to be maintained. Maximum conversion possible is 95%. **13**

4. a) Derive the kinetic expression for deactivation of a catalyst without pore diffusion and why catalyst deactivation occurs? **7**

b) Explain the importance of residence time distribution in a reactor and what are the general factors which can affect dispersion? **7**

5. How will you evaluate the performance of plug flow continuous recycle reactor and how to determine optimum recycle ratio, when autocatalytic reaction is treated in a plug flow reactor. **13**

6. How trickle bed reactors differ from fixed bed reactors and how to develop model equations for such reactor for design purpose. **13**

7. Discuss in details the design parameters of a fixed bed reactor and how will you show that the positional temperature for a given conversion x_A, in such reactors can be expressed as: **13**

$$T = T_o + \frac{(-\Delta H)C_{A_0} \cdot v_o}{\phi_A \cdot G \cdot C_P}(x_A + x_{A_0})$$

ϕ_A – Stoichiometric coefficient ratio all the terms have their usual meanings

8. Discuss the reaction – diffusion phenomena in slurry reactors and how to develop design equation for slurry reactor. **13**

9. How to develop a hydrodynamic model for a fluidized bed reactor? Discuss in terms of pressure drop, minimum and maximum fluidization velocity and the bubble velocity. **13**

10 a) Explain the catalytic reactor design requirements and the methods of preparation of catalyst. **7**

b) A catalytic reaction $A \rightarrow 3R$ is carried out in a mixed flow reactor for 45% conversion of reactant A to product. The feed rate to the reactor is 1800 mol/hr of pure A at 3.5 atmosphere pressure and 110°C. The rate expression for the reaction is $(-r_A) = 79.5 C_A$ Calculate the weight of catalyst bed needed for the operation. **7**
Gas constant R = 0.082 lit – atm/mol.k

****