Exam Date & Time: 31-Dec-2022 (02:30 PM - 05:30 PM)

SS

MANIPAL ACADEMY OF HIGHER EDUCATION

VII Semester End Semester Examination
(PE V) CHEMICAL REACTOR THEORY [CHE 4061] (Make UP)

CHEMICAL REACTOR THEORY [CHE 4061]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) Uniform-sized spherical particles UO_3 are reduced to UO_2 in a uniform environment with the following results:

A)

t, hr	0.180	0.347	0.453	0.567	0.733
X_B	0.45	0.68	0.8	0.95	0.98

(4)

If the reaction follows the SCM, find the rate-controlling mechanism and a rate equation to represent the reduction.

B) For an elementary liquid-phase reaction A↔B. Determine the adiabatic equilibrium temperature and conversion when pure A is fed to the reactor at a temperature of 330K. Data: ΔH^o_A = -20000 cal/mol, ΔH^o_B = -25000 cal/mol; $C_{pA} = C_{pB}$ = 22 cal/ mol K; K = 10000 at 298 K. (4)

C) Write a general energy balance equation for a batch reactor. (2)

2) A catalyst particle consists of cylindrical pores and a single first-order reaction occurs within the pores under isothermal conditions, without any volume change. Develop expressions to find the concentration profile in the pore and also sketch the concentration profile inside the pore. (5)

A)

B) Describe the effectiveness factor and obtain a relation for a first-order reaction. (3)

C) Write a note on promoters and deactivators. (2)

3) Explain in detail the kinetics involved in the Slurry reactor. (5)

A)

B) Explain the interphase behavior for gas-liquid contact systems and the rate equation employed. (3)

C) The general energy balance for a single reaction system with a limiting reactant is:

$$Q - W_S + F_{A0}\sum_{i=1}\theta_i (H_{i0} - H_i) - [F_{A0} X_A \Delta H_{rxn}(T)] = dE/dt$$

With some assumptions this equation can be written as:

$$UA(T_a - T) - [\Delta H_{rxn}(T_{ref}) + \Delta C_p(T - T_{ref})] X_A F_{A0} = F_{A0}\sum_{i=1}\theta_i C_{pi}(T - T_0)$$ (2)

where $\Delta C_p = \sum \nu_i C_{pi}$ for a reaction with stoichiometric coefficients ν_i.

List any four assumptions used to arrive at this expression.

4) With a neat sketch, relate time and conversion for a spherical particle when the controlling resistance is the ash phase. (5)

A)

B) Develop an interim rate expression for the following catalytic reaction when the surface reaction is the rate-controlling step. A → B. (Single site mechanism). (3)

C) Visualize and state the different possible steps (resistances) involved in the kinetics of a Trickle bed reactor. (2)

5) Write a note on Ignition-Extinction temperature and Multiple steady states. (5)

A)

B) List the important assumptions that form the foundation for Langmuir's adsorption isotherm. (3)

C) Name the different types of contact systems that could be categorized as a Multiphase reactors. (2)

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