Exam Date & Time: 23-Nov-2022 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2022

CHEMICAL REACTOR THEORY [CHE 4061]

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

Descriptive Questions

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1)   Derive the BET surface area equation and explain how it is determined experimentally.

                                                                                 (5)

A)

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

C)   Derive an expression for heat load for a non-isothermal mixed flow reactor.   (2)

2)   With a neat sketch, relate time and conversion for a spherical particle, when the controlling resistance is chemical reaction.   (5)

A)

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

C)   Elaborate how the units for the rate constants (1st order) with different bases vary, and how they are interrelated.   (2)

3)   Explain in detail the kinetics involved in Slurry reactors.

                                                                                 (5)

A)

B)   Write a short note on multiple steady states.   (3)

C)   Explain in detail as to how, the resistance for diffusion through the gas film is different for fixed and varying sized particle?   (2)

4)   Say a reaction A + 2B → 2C + D is conducted in an adiabatic CSTR. The reaction rate is first order in A and second order in B. Write and substitute MB and EB equations to find temperature for a conversion of 0.35.   (5)

A)   Data: $k = 0.090 \exp [(40 \text{ kJ/mol})/R (1/303 - 1/T)] (L/mol)^2 (min)^{-1}$

$\Delta H_R = -370.1$ kJ/mol; $Cp_A = 84.5$ J/(mol K); $Cp_B = 137$ J/(mol K); $Cp_C = 170$ J/(mol K); $Cp_D = 75$ J/(mol K); $T_O = 303$ K; $F_{AO} = 10$ mol/min; $F_{BO} = 30$ mol/min; $v_0 = 1000$ L/min; $C_{AO} = 0.01$ mol/L.

B)   Visualize and describe the possible steps that could be involved in the kinetics of a trickle bed reactor.

(3)

C)   Write a note on promoters and deactivators.

(2)

5)   Find an interim rate expression for the following catalytic reaction when surface reaction is controlling. $A + B \rightarrow X + Y$.

(5)

A)

B)   A batch of spherical solids (of single size) is treated by gas in a uniform environment. Solid is converted to a firm non-flaking product according to shrinking core model (SCM). The conversion is 87.5% in reaction time of 1 hour and conversion is complete in 2 hours. Determine the rate controlling mechanism.

(3)

C)   Compare and contrast Physisorption and chemisorption.

(2)

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