Exam Date & Time: 05-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IV SEMESTER B.TECH END SEMESTER EXAMINATIONS, MAY 2024
MANIPAL INSTITUTE OF TECHNOLOGY

CHEMICAL REACTION ENGINEERING [CHE 2223]

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

A

Answer all the questions.

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

1) Develop (guess and then verify) a mechanism that is consistent with the experimentally found rate equation for the following reaction

A) $2A + B \rightarrow A_2B$, with $+r_{A2B} = k[A][B]$ (5)

B) The natural abundance of ^{235}U in uranium is 0.79 atom %. If a sample of uranium is enriched to 3 atom % and then is stored in salt mines under the ground, how long will it take the sample to reach the natural abundance level of ^{235}U (assuming no other processes form ^{235}U; this is not the case if ^{238}U is present since it can decay to form ^{235}U)? The half-life of ^{235}U is $7.13 * 10^8$ years. (3)

C) Discuss Integral method of analysis, by developing an equation for a unimolecular 1st order reaction. (2)

2) The rate of the following reaction has been found to be first-order with respect to hydroxyl

A) ions and ethyl acetate: $A + B \rightarrow C + D$

In a stirred-flow reactor of volume $V = 0.602$ L, the following data have been obtained at 298 K. (5)

flow rate of barium hydroxide solution: 1.16 L/h

flow rate of ethyl acetate solution: 1.20 L/h

inlet concentration of OH^-: 0.00587 mol/L

inlet concentration of ethyl acetate: 0.0389 mol/L

outlet concentration of OH^- : 0.001094 mol/L

Calculate the rate constant. Changes in volume accompanying the reaction are negligible.

B) Develop performance equation for an Ideal batch reactor (3)

C) Differentiate τ and t_m. (2)

3) Pure A ($C_{AO} = 100$) is fed to a mixed reactor, R and S are formed, and the following outlet concentrations are recorded. Find a kinetic scheme to fit this data. Make necessary assumptions and clarify.

A)

Run	C_A	C_R	C_S
1	75	15	10
2	25	45	30

(5)

B) Discuss the graphical procedure to optimize the conversion, when unequal sized MFR's are connected in series. (3)

C) Classify Instantaneous (ψ) and Overall fractional yields (ϕ). How is it different from Selectivity? (2)

4) A pulse study performed on a real reactor. A first order reaction A → R is to be carried out in this reactor of dia. 10 cm and length 2 m. The specific reaction rate is 0.1 min^{-1}. Calculate conversion using a) Ideal PFR; b) Ideal CSTR.

A)

t (s):	0	1	5	15	20	25	30	35	40	60	80
C_A (mg/L)	0	0.25	0.38	0.58	0.51	0.39	0.22	0.11	0.05	0.01	0.0

(5)

B) Analyze series type reactions and assess them qualitatively. (3)

C) Describe the different types of tracer inputs. (2)

5) Derive and provide insights for the Michaelis-Menten equation. (4)

A)

B) Discuss about competitive and non-competitive inhibition in enzymatic reactions. (3)

C) Compare briefly, the different theories of temperature dependency of a rate equation. (3)

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