Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth semester B.Tech degree examinations (S), September 2020

Course Code: CH308

Course Name: CHEMICAL REACTION ENGINEERING-II

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Describe pulse and step input and their responses with suitable figures (6)

b) Form the response data for a pulse input of a reactor given below: (9)

t, min	0	5	10	15	20	25	30	35
C_{out}, g/L	0	3	5	5	4	2	1	0

(i) Calculate the mean residence time.

(ii) Tabulate and construct the E curve and also calculate the area under the E curve.

2 With a figure briefly explain the basics concepts of tank in series model and derive an expression for the model parameter 'number of tanks (n)'. (15)

3 a) Calculate the mean conversion in a reactor for first order, liquid phase, irreversible reaction in a completely segregated fluid: A→Products. (10)

The reaction rate constant is 0.1 min^{-1} at 320 K.

t, min	0	1	2	3	4	5	6
C, g/m^3	0	1	5	8	10	8	6
t, min	7	8	9	10	12	14	
C, g/m^3	4	3	2.2	1.5	0.6	0	

b) Prove that for an ideal reactor the mean residence time is equal to the space time. (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) With a neat diagram list the various steps involved in a reaction occurring in a porous catalyst (5)

b) Assume **desorption step** to be rate limiting and derive an expression for reaction rate for the overall reaction A+B → C. Steps of the reaction are given below: (10)

Adsorption: A+S → AS and B+S → BS

Surface Reaction: AS + BS → CS + S

Desorption: CS → C + S

5 a) With help of figures differentiate between porous and supported catalysts (4)

b) Define overall effectiveness factor? Derive expression for overall effectiveness factor (8)

c) Briefly explain Mears Criterion for external diffusion. (3)

6 a) A catalytic reaction A→ 4B, is studied in a PFR using various amounts of catalyst and 20 L/h pure A feed at 3.2 atm and 117 ^{0}C. The concentration of A in the effluent stream is recorded as follows: (9)

Experiment	1	2	3	4
Catalyst used (kg)	0.02	0.04	0.08	0.16
CA out (mol/L)	0.074	0.06	0.044	0.029

Deduce a rate expression for the reaction assuming 1st order reaction.

b) Derive expression for Internal effectiveness factor (6)

PART C

Answer any two full questions, each carries 20 marks.

7 a) A particle of radius R reacts with a gas and forms a stable non flaking product layer on its surface. With a neat figure representing the problem, derive an expression for conversion of particle using the shrinking core model if chemical reaction controls the overall reaction. (10)

b) Using suitable figures for irreversible reaction, reversible endothermic reaction and reversible exothermic reactions explain the concept of optimum temperature progression. (10)

8 a) With neat figure explain progressive conversion model. Give two examples. (5)

b) With a neat figure, derive the rate equation for mass transfer of gas A being physically absorbed in to a liquid B. (9)

c) Derive an expression for conversion for a non-adiabatic reaction from energy balance. Draw a sketch of conversion vs temperature showing the shifting of adiabatic line due to heat exchange. (6)

9 a) A batch of spherical solids of uniform size is treated by a gas in a constant environment reactor. Solid is converted to for a firm non-flaking product according to shrinking core model. The conversion is 87.5% for a reaction time of 1 hour and reaction is 100% complete in 2 hours. Verify the data given for the three rate controlling mechanisms and infer on the findings. (10)

b) Determine the equilibrium conversion for a reversible first order reaction A $\rightarrow$ B between 273K and 373 K. (10)

At 298 K, ΔG^o = -14130 J/mol, $\Delta H_{RT=298}$ = -75300 J/mol, C_{PA}=C_{PB} = constant

(i) Construct a plot between temperature and conversion

(ii) What temperature restriction should be placed on the reaction if operated isothermally to achieve a conversion of 75% or higher?

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