P P SAVANI UNIVERSITY

Seventh Semester of B. Tech. Examination

December 2021

SECH4021 Chemical Reaction Kinetics – II

08.12.2021, Wednesday **Time: 09:00 a.m. To 11:30 a.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1 The concentration readings as given in table represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel t, and tabulate and plot the exit age distribution E. **[08]**

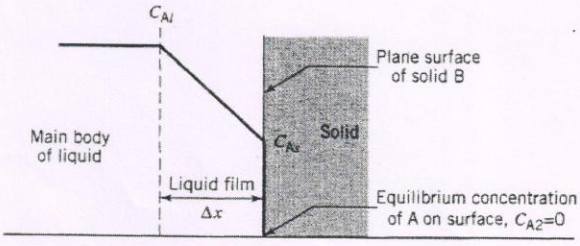
Time (min)	Tracer Output Concentration Cpulse gm/liter fluid
0	0
5	3
10	5
15	5
20	4
25	2
30	1
35	0

OR

Q - 1 Define E, F and C curve and discuss their inter relationship with schematic diagrams. **[08]**

Q - 2 Dilute A diffuses through a stagnant liquid film onto a plane surface consisting of B, reacts there to produce R which diffuses back into the mainstream. Develop the overall rate expression for the L/S reaction. **[08]**

$$A(l) + B(s) \rightarrow R(l)$$



Q - 3 Derive the performance equation for Plug flow and CSTR reactors containing porous **[08]**

catalysts.

Q - 4 Explain:(i) RTD **[06]**

(ii) Micro fluid & Macro fluid

(iii) Early mixing and late mixing

SECTION - II

Q - 1 The catalytic reaction **[08]**

$$A \rightarrow 4R$$

is studied in a plug flow reactor using various amounts of catalyst and 20 liters 1 hr of pure A feed at 3.2 atm and 117°C. The concentrations of A in the effluent stream is recorded for the various runs as follows

Run	1	2	3	4
Catalyst used, kg	0.020	0.040	0.080	0.160
C_{Aout}, mol/liter	0.074	0.060	0.044	0.029

(a) Find the rate equation for this reaction, using the integral method of analysis.

(b) Repeat part (a), using the differential method of analysis.

Q - 2 Spherical particles of zinc blende of size R = 1 mm are roasted in an 8% oxygen stream at 900°C and 1 atm. The stoichiometry of the reaction is **[08]**

$$2ZnS+3O_2 \rightarrow 2ZnO+2SO_2$$

Assuming that reaction proceeds by the shrinking-core model calculate the time needed for complete conversion of a particle and the relative resistance of ash layer diffusion during this operation.

Data:

Density of solid, $\rho_B = 4.13$ gm/cm^3 = 0.0425 mol/cm^3

Reaction rate constant, k" = 2 cm/sec

For gases in the ZnO layer, De = 0.08 cm^2/sec

Note that film resistance can safely be neglected as long as a growing ash layer is present.

Q - 3 Discuss with neat sketch the slurry reactor. Also mention its importance in Industry. **[08]**

Q - 4 Describe the physical properties of catalyst. **[06]**

****

P P SAVANI UNIVERSITY

Seventh Semester of B. Tech. Examination

December 2021

SECH4021 Chemical Reaction Kinetics – II

08.12.2021, Wednesday **Time: 09:00 a.m. To 11:30 a.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1 Derive the equation for a first order reaction using the segregation model when the RTD is equivalent to an ideal PFR and ideal CSTR. **[08]**

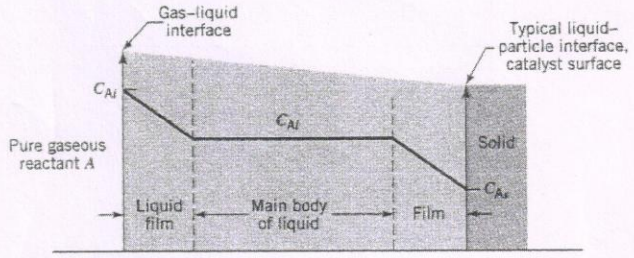
OR

Q - 1 Explain Dirac delta function for RTD for ideal plug flow reactor. **[08]**

Q - 2 Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first-order rate, where C_A, is the concentration of A in equilibrium with the solid surface. Develop an expression for the rate of reaction of A accounting for both the mass transfer and reaction steps. **[08]**

OR

Q - 2 In slurry reactors, pure reactant gas is bubbled through liquid containing suspended catalyst particles. Let us view these kinetics in terms of the film theory, as shown in Fig. Thus, to reach the surface of the solid, the reactant which enters the liquid must diffuse through the liquid film into the main body of liquid, and then through the film surrounding the catalyst particle. At the surface of the particle, reactant yields product according to first-order kinetics. Derive an expression for the rate of reaction in terms of these resistances. **[08]**



Q - 3 Define and discuss enhancement factor and Hatta Modulus for fluid – fluid reactions. **[08]**

Q - 4 Discuss the advantage and limitation of Shrinking Core Model. **[06]**

SECTION – II

Q – 1 The catalytic reaction **[08]**

$$A \rightarrow 4R$$

is run at 3.2 atm and 117°C in a plug flow reactor which contains 0.01 kg of catalyst and uses a feed consisting of the partially converted product of 20 liters/ hr of pure unreacted A. The results are as follows:

Run	1	2	3	4
C_{Ain}, mol/liter	0.100	0.080	0.060	0.040
C_{Aout}, mol/liter	0.084	0.070	0.055	0.038

Find a rate equation to represent this reaction.

Q – 2 Uniform-sized spherical particles UO_3, are reduced to UO_2, in a uniform environment with **[08]**

the following results: 473 K flowing through the annular space. If the

Run	1	2	3	4	5
t, hr	0.180	0.347	0.453	0.567	0.733
X_B	0.45	0.68	0.80	0.95	0.98

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

Q – 3 Explain: (i) Catalyst promoters **[08]**
(ii) Catalyst inhibitors
(iii) Catalyst poisons
(iv) Molecular sieves

Q – 4 Describe with neat sketch the trickle bed reactor. Also mention its importance in Industry. **[06]**

****