Code No: R05320802 **Set No. 1**

III B.Tech II Semester Regular Examinations, Apr/May 2008
CHEMICAL REACTION ENGINEERING-II
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A pulse test on a piece of reaction equipment gave the following results: The output concentrations rose linearly from zero to 0.5 μmol/dm^3 in 5 min, then fell linearly to zero in 10 min after reaching the maximum value.
   (a) What is the mean residence time? If the flow rate were 150 gal/min, what would be the total reactor volume? A second order reaction with $kC_{A0} = 1.2$ min^{-1} is carried out in the system.
   (b) If the reactor were plug flow with the same flow and volume, what would be the conversion? [16]

2. (a) Write about dispersion model and mention its applications and limitations
   (b) Water is drawn from a lake, flows through a pump and passes down a long pipe in turbulent flow. A slug of tracer (not an ideal pulse input) enters the intake line at the lake and is recorded downstream at two locations in the pipe L meters apart. The mean residence time of fluid between recording points is 100sec and variance of the two recorded signals is
   $\sigma_1^2 = 800$ sec^2 $\sigma_2^2 = 900$ sec^2

   What would be the spread of an ideal pulse response for a section of this pipe, free from end effects and of length L/5? [8+8]

3. (a) Give a brief account of the tanks-in-series model.
   (b) A reactor with a number of dividing baffles is to be used to run the reaction A → R with $-r_A = 0.05C_A$ mol/liter.min. A pulse tracer test gives the following curve.

Time, min	0	10	20	30	40	50	60	70
Concentration Reading	35	38	40	40	39	37	36	35

   How many tanks in series is this vessel equivalent to? [8+8]

4. (a) Find the expression for conversion of a macrofluid in two equal-size mixed reactors for a zero-order reaction. If conversion is 99% for the microfluid, what is it for a macrofluid having the same reaction rate?
   (b) Discuss about mixing of two miscible fluids. [10+6]

5. What is pore size? How it effect the catalyst activity? Explain the method of estimating pore size and its distribution? [16]

6. Discuss the spectrum of kinetic regimes in a porous catalytic reaction system and explain the factors that influence the rate of reaction of particles. [16]

7. In a plug flow reactor a catalytic reaction A→4R is carried out with initial concentration of A (C_{Ao}) as 0.12mol/lit. The packed bed contains 0.025kg of catalyst. The feed consists of partially converted product of 45 lit/hr of pure unreacted A
Data available:

Run	1	2	3	4
C_A in, mol/lit	0.12	0.096	0.072	0.048
C_A out mol/lit	0.1008	0.084	0.066	0.0456

Determine the rate equation to represent this reaction. [16]

8. particles react with gas of given composition and at given temperature to give a solid product. What can you say about the kinetics of the reaction if the rate of reaction per gram of solid is
   (a) Proportional to the diameter of particles.
   (b) Proportional to the square of the particle dia.
   (c) Independent of particle size.

   Comment on controlling mechanisms also. [16]

⋆⋆⋆⋆⋆

Code No: R05320802 **Set No. 2**

III B.Tech II Semester Regular Examinations, Apr/May 2008
CHEMICAL REACTION ENGINEERING-II
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A pulse test on a piece of reaction equipment gave the following results: The output concentrations rose linearly from zero to 0.5 μmol/dm^3 in 5 min, then fell linearly to zero in 10 min after reaching the maximum value.
   (a) Calculate in tabular form the values of E(t) and F(t) at 1 min intervals
   (b) What is the mean residence time? If the flow rate were 150 gal/min, what would be the total reactor volume? A second order reaction with $kC_{A0} = 1.2$ min^{-1} is carried out in the system. [16]

2. (a) Write about dispersion model and mention its applications and limitations
   (b) An injected slug of tracer material flows with its carrier fluid down a long, straight pipe in dispersed plug flow. At point A in the pipe the spread of tracer is 16m. At point B, 1 kilometer downstream from A, its spread is 32m. What do you estimate its spread to be at a point C, which is 2 kilometers downstream from point A? [8+8]

3. Fluid flows at a steady rate through ten well-behaved tanks in series. A pulse of tracer is introduced into the first tank, and at the time this tracer leaves the system is measured giving
   maximum concentration = 100 mmol/litre
   tracer spread = 1 min
   If ten more tanks are connected in series with the original ten tanks,
   (a) What would be the maximum concentration of leaving tracer?
   (b) How does the relative spread change with number of tanks? [12+4]

4. Reactant A ($C_{A0} = 64$ mol/m^3) flows through a plug flow reactor ($\tau = 50$ s) and reacts away as follows
   $A \rightarrow R \qquad -r_A = 0.005\, C_A^{1.5}$ mol/m^3.s
   Determine the conversion of A if the stream is
   (a) a microfluid
   (b) a macrofluid. [6+10]

5. Define the terms void volume and solid density. Explain how they are estimated. Distinguish between micro and macro pores of a solid catalyst bed. [16]

6. Discuss the spectrum of kinetic regimes in a porous catalytic reaction system and explain the factors that influence the rate of reaction of particles. [16]

7. How much catalyst is needed in packed bed reactor for 80% conversion of $1000m^3/hr$ of pure gaseous A (C_{Ao} = $1000 mol/m^3$) if the stoichiometry and rate are given as A→R, $-r'_A = 8C_A^2$ mol/kg-hr. [16]

8. What is the difference between progressive conversion model and the shrinking core model? Explain with suitable examples. [16]

⋆⋆⋆⋆⋆

Code No: R05320802 **Set No. 3**

III B.Tech II Semester Regular Examinations, Apr/May 2008
CHEMICAL REACTION ENGINEERING-II
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆⋆⋆⋆⋆

1. A pulse test on a piece of reaction equipment gave the following results: The output concentrations rose linearly from zero to 0.5 μmol/dm^3 in 5 min, then fell linearly to zero in 10 min after reaching the maximum value.

   (a) What is the mean residence time? If the flow rate were 150 gal/min, what would be the total reactor volume? A second order reaction with $kC_{A0} = 1.2$ min^{-1} is carried out in the system.

   (b) If the reactor were plug flow with the same flow and volume, what would be the conversion? [16]

2. (a) Write about dispersion model and mention its applications and limitations

   (b) Water is drawn from a lake, flows through a pump and passes down a long pipe in turbulent flow. A slug of tracer (not an ideal pulse input) enters the intake line at the lake and is recorded downstream at two locations in the pipe L meters apart. The mean residence time of fluid between recording points is 100sec and variance of the two recorded signals is
   $\sigma_1^2 = 800$ sec^2 $\sigma_2^2 = 900$ sec^2

   What would be the spread of an ideal pulse response for a section of this pipe, free from end effects and of length L/5? [8+8]

3. A reactor with a number of dividing baffles is to be used to run the reaction $A \rightarrow R$ with $-r_A = 0.05\ C_A$ mol/liter. min.

Time, min	0	10	20	30	40	50	60	70
Concentration reading	35	38	40	40	39	37	36	35

   (a) How many tanks in series is this vessel equivalent to?

   (b) Calculate X_A assuming mixed flow.

   (c) Calculate X_A assuming the tanks-in-series model. [6+5+5]

4. (a) Find the expression for conversion of a macrofluid in two equal-size mixed reactors for a zero-order reaction. If conversion is 99% for the microfluid, what is it for a macrofluid having the same reaction rate?

   (b) Consider a single reacting macrofluid being processed in turn in batch, plug flow and mixed flow reactors. How does the degree of segregation affect the conversion in each case? [10+6]

5. Consider an irreversible gas-phase reaction A(g) → B (g). Which requires a solid catalyst 'C' which is non-porous. Develop a rate of reaction at the catalyst surface in terms of measurable quantities? [16]

6. What are the maximum and minimum orders of reaction predicted for an enzyme reaction A + B → C if both A and B require two competitive enzyme sites. [16]

7. Distinguish between slow and fast deactivation of catalysts. What are the different experimental devices used for studying the above two types of deactivation? Explain with sketches. [16]

8. Derive a rate equation for instantaneous reaction of any order between A from gas and B from liquid i.e A+bB →P, visualizing two-film theory. [16]

⋆⋆⋆⋆⋆

Code No: R05320802

Set No. 4

III B.Tech II Semester Regular Examinations, Apr/May 2008
CHEMICAL REACTION ENGINEERING-II
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A large tank (860 liters) is used as a gas-liquid contactor. Gas bubbles flows up through the vessel and out at the top, liquid flows in at one part and out the other at 5 liters/s. To get an idea of the flow pattern of liquid in this tank a pulse of tracer (M = 150 gm) is injected at the liquid inlet and measured at the outlet, as shown in figure 1.
   (a) Is this a properly done experiment?
   (b) If so, find the liquid fraction in the vessel.
   (c) Determine the E curve for the liquid.
   (d) Qualitatively what do you think is happening in the vessel? [4+4+4+4]

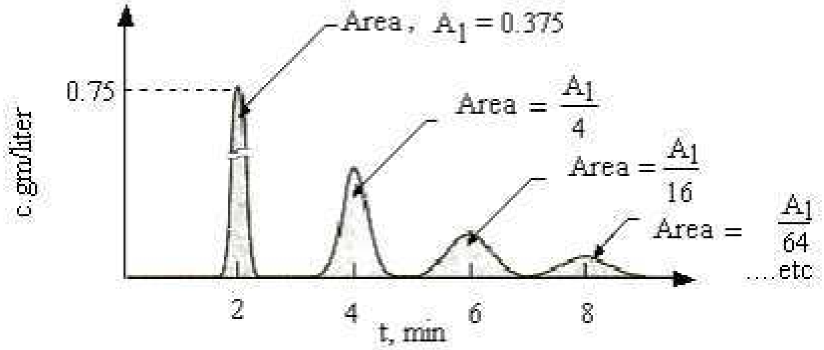

Figure 1

2. (a) Discuss about axial dispersion and the dispersion model. What are its limitations and applications?
   (b) A tubular reactor has been sized to obtain 98% conversion and to process 0.03 m^3/s. The reaction is a first order irreversible isomerization. The reactor is three meters long with a cross sectional area of 25 cm^2. After being built a pulse of tracer test on the reactor gave the following data: $t_m = 10$ sec and $\sigma^2 = 65$ sec^2. What conversion can be expected in the real reactor? [8+8]

3. (a) Using the tanks-in-series model calculate the conversion for the first order isomerization A → B with $k = 0.18$ min^{-1}. The results of a tracer test carried out on this reactor are as follows:

t (s)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (mg/liter)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

(b) Compare your result in part (a) with the conversion calculated from a PFR and a CSTR. [8+8]

4. (a) For a first-order reaction with $\varepsilon = 0$ show that the performance equations for a macrofluid in plug flow and a microfluid in plug flow are identical.

   (b) Discuss about mixing of two miscible fluids. [10+6]

5. Why carbon gets deposited on a catalyst in a cracking reaction. Is it possible to estimate the weight percent of carbon formed on the catalyst surface. Explain the phenomenon. [16]

6. In slurry reactor pure reactant gas is bubbled through the liquid to reach the surface of solid. Thus to reach the surface of 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 1st order kinetics. Sketch the concentration profile of the gaseous reactant A. List out the resistances offered to the over all rate of reaction. [16]

7. How do you distinguish between a differential reactor and an integral reactor. Compare and constract? [16]

8. Show that t/τ = 1- r_c/R = 1- (1 - $X_B)^{1/3}$ when the overall rate is controlled by a chemical reaction List out the assumptions. [16]

⋆⋆⋆⋆⋆