Code No: NR410802 **NR**

**IV B.Tech I Semester Supplementary Examinations, November 2005**
**CHEMICAL REACTION ENGINEERING-II**
**(Chemical Engineering)**

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

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

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1. The first order reaction

   $A \rightarrow B$

   Is carried out in a 10-cm-diameter tubular reactor 6.36m in length. The specific reaction rate is 0.25 $min^{-1}$. Following are the results of a tracer test carried out in this reaction

   | 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 |

   Calculate conversion using

   (a) the closed vessel dispersion model

   (b) the tanks-in-series model. [10+6]

2. Carry out the liquid phase, second order dimerization
   $2A \rightarrow B$; $-r_A = kC_A^2$
   for which k = 0.01 $m^3$/mol-min at the reaction temperature. The feed is pure A with $C_{A0}$ = 8 mol/$m^3$. The reactor is non ideal and perhaps could be modeled as two CSTRs with interchange. The reactor volume is 1000 $m^3$, and the feed rate of dimerization 25 $m^3$/min. A tracer test is run on this reactor and the results are given in column.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| t(min) | C(mg/m3) | E(t)($min^{-1}$) | 1-F(t) | E(t) / (1-F(t))($min^{-1}$) |
| 0 | 112 | 0.0280 | 1.000 | 0.0280 |
| 5 | 95.8 | 0.0240 | 0.871 | 0.0276 |
| 10 | 82.2 | 0.0206 | 0.760 | 0.0271 |
| 15 | 70.6 | 0.0177 | 0.663 | 0.0267 |
| 20 | 60.9 | 0.0152 | 0.584 | 0.0260 |
| 30 | 45.6 | 0.0144 | 0.472 | 0.0242 |
| 40 | 34.5 | 0.00863 | 0.353 | 0.0244 |
| 50 | 26.3 | 0.00658 | 0.278 | 0.0237 |
| 70 | 15.7 | 0.00393 | 0.174 | 0.0226 |
| 100 | 7.67 | 0.00192 | 0.087 | 0.0221 |
| 150 | 2.55 | 0.000638 | 0.024 | 0.0266 |
| 200 | 0.90 | 0.000225 | 0.003 | 0.075 |

Columns 3 to 5 are calculated from 1 and 2.

The bounds on the conversion for different possible degrees of micro mixing for the RTD of this reactor are to be known. What are they ? [16]

3. (a) Define the following terms:
    i. Micro fluid
    ii. Macro fluid
    iii. Degree of segregation
    iv. Earliness of mixing

   (b) Explain the difference in behaviour of micro fluids and macro fluids in mixed flow reactor. [8+8]

4. Two small samples of solids are introduced in to a constant environment oven and kept there for one hour under these conditions, 4 mm particles are 58% converted and 2 mm particles are 87.5% converted. Find the rate controlling mechanism for the conversion of solids and the time needed for complete conversion of 1 mm particles. [16]

5. Spherical particles of zinc blende of radius 1 mm are roasted in an 8% oxygen stream at 900C and 1 atm. The reaction is
   $2ZnS + 3O2 \rightarrow 2Zno + 2SO2$
   Assuming that the reaction proceeds by shrinking core model and neglecting the film resistance.

   Calculate the time needed for complete conversion of a particle and the relative resistance of ash layer during this operation.
   Data:Density of solid = $4.13 Kg/m^3$
   Rate constant = 0.02 m/s
   Effective diffusivity = $0.08 Cm^2/S$. [16]

6. Derive a rate equation for an instantaneous reaction of any order between A and B, fluid-fluid reaction
   $A(gas) + bB(liquid) \rightarrow product$
   And sketch the concentration profiles assuming a two-film theory. [16]

7. (a) What is meant by effectiveness factor?
   (b) Derive an expression for an isothermal first order reaction to show the dependence of the factor on the parameters. Single pore model is applicable. [4+12]

8. (a) The first order isomerization A $\longrightarrow$B is being carried out isothermally in a batch reactor on a catalyst that is decaying as a result of aging. Derive an equation for conversion as a function of time.
   (b) Explain about the following terms in catalyst deactivation.
      i. deposited poisons
      ii. chemisorbed poisons
      iii. selectivity poisons
      iv. stability poisons
      v. diffusion poisons. [6+10]

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