Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (CHE)/SEM-2/CH-8/2010

2010

ADVANCED REACTOR ANALYSIS

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* of the following. 5 × 14 = 70

1. A liquid phase reaction A + B → C is carried out in a CSTR to produce 1,00,000 kg/day of the product C (Mol. wt. 60). The aqueous solution of A (Mol. wt. 60) is continuously fed to the reactor containing 2 kmol/ m^3 of A along with an aqueous solution of B of same concentration and at same volumetric flow rate. Calculate the volume of reactor needed for achieving 90% conversion of A. The second order rate constant is given as 0·08 m^3/(kmol). (sec) at the temperature of the reaction. 14

2. A tracer is introduced in a reactor and its concentration is measured at the outlet as follows :

Time (min)	1·0	2·0	3·0	4·0	5·0	10·0	20·0	30·0
Tracer Conc. (gm/min)	1·8	1·6	1·38	1·2	1·08	0·6	0·15	0·05

The fluid volume in the reactor is 1·5 m^3 and the volumetric flow rate is 0·1 m^3/min. Calculate mean residence time in the reactor and compare it against hydraulic residence time. 14

3. a) Develop an expression for optimum conversion for maximum profit for a 2nd order reaction $2A \rightarrow B$ carried out in a batch reactor. 6

b) For the following reaction sequence mention the optimum temperature trajectory for the following cases :

$$\begin{array}{ccccc} A+B & \xrightarrow{1} & Q & \xrightarrow{3} & S \text{ (desired)} \\ \downarrow 2 & & \downarrow 4 & & \\ P & & R & & \end{array}$$

Case I	$E_1 > E_2$,	$E_3 > E_4$
Case II	$E_1 < E_2$,	$E_3 < E_4$
Case III	$E_1 < E_2$,	$E_3 > E_4$
Case IV	$E_1 > E_2$,	$E_3 < E_4$

8

4. Write short notes on the following :

a) Autothermic Operation. 6

b) Catalyst Effectiveness Factor. 4

c) Ills of nonoideal reactors. 4

5. Prove that for simultaneous reactions of identical orders, yield of selectivity is the same in a CSTR & PFR. 14

6. Describe with the help of mathematical expression 'steady state multiplicity' for a CSTR for liquid phase reactions. Discuss stability of a CSTR. 14

7. For longitudinal dispersion model with a 1st order chemical reaction the following relation of concentration against dispersion number has been obtained. Derive an expression for L_D/L_P against dispersion number for all other conditions remaining same.

$$\frac{C_A}{C_{A_0}} = \frac{4\beta e^{u_x L/2D}}{(1+\beta)^2 e^{\beta u_x L/2D} - (1-\beta)^2 e^{-\beta u v_x L/2D}}$$

where $\beta = \left[1 + 4\Re\left(\frac{D}{u_x L}\right)\frac{L}{u_x}\right]^{\frac{1}{2}}$

Solve the above problem for small dispersion number $\frac{D}{v_x L}$

L_D = length of dispersed flow reactor

L_P = length of plug flow reactor. 14