Dr Rahul Saha. 2/12/2022 80

Roll no. ..... (M)

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National Institute of Technology, Hamirpur

B. Tech. (Chemical Engineering) - 5th Semester

End Semester Examination (November, 2022)

CH – 312 Chemical Reaction Engineering I

Duration: 3 Hours **Marks: 50**

Note

- *Attempt all questions.*
- *Wherever necessary, draw diagram and label properly to explain the concept.*
- ***If any additional data/information are required kindly assume it***

Q1. Answer the following questions **(12 Marks)**

a) Residence time distribution (RTD)

b) Homogeneous and heterogeneous reactions

c) Molecularity and order of reactions

d) Draw E curve and F curve for Plug flow, Mixed flow and Arbitrary flow

e) Half life time and Zero order reaction

f) Just draw the graphical representation of performance equation for Ideal Batch Reactor in terms of concentration and conversion

Q2. For an irreversible biomolecular type second order reaction (A + B → Product), derive the integral form of expression in terms of concentration and conversion with graphical representation. **(8 Marks)**

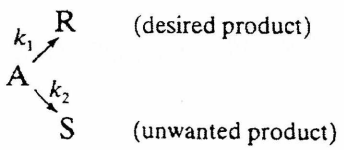
Q3. The elementary second order, liquid phase reaction A + B → C + D is conducted in an isothermal plug flow reactor of 1 m^3 capacity. The inlet volumetric flow rate is 10 m^3/h and $C_{AO} = C_{BO}$ = 2 kmol / m^3. At these conditions, conversion of A is 50%. Now, if a stirred tank reactor of 2 m^3 capacity is installed in series, upstream of the plug flow reactor, then what conversion can be expected in the new system of reactors? The rate equation is $-r_A = kC_A^2$ since $C_{AO} = C_{BO}$. **(10 Marks)**

(81)

Q4. The concentration reading as given in table below represents 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. (Use graph paper) **(6 Marks)**

Time t, min	Tracer Output Concentration, C_{Pulse} gm/liter fluid
0	0
5	3
10	5
15	5
20	4
25	2
30	1
35	0

Q5. For a reaction as shown below **(6 Marks)**



(desired product)

(unwanted product)

With corresponding rate equations

$$r_R = \frac{dC_R}{dt} = k_1 C_A^{a_1} \qquad \text{and} \qquad r_S = \frac{dC_S}{dt} = k_2 C_A^{a_2}$$

Determine the conditions and the nature of reactors for the formation of desired products. Also, draw the contacting pattern for various combinations of high and low concentration of reactors in continuous and non-continuous operations.

Q 6. Explain the tank in series model with materials balance equations and derive the expression for equal size mixed flow reactor in series for first order reactions. Draw detail diagram with proper labelling and notation wherever applicable.

(8 Marks)

----------End of Question Paper----------