

INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date 25.11.2010

Time : 3 Hrs Full Marks : 50

Autumn, 2010

III-yr.B.Tech.(Hons)

Subject No : CH31009

Subject Name : Reaction Engineering

No. of Students :65

Department : Chemical Engineering

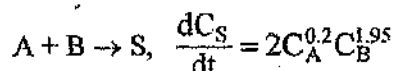
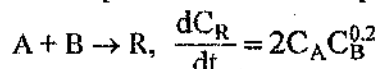
Instructions : Attempt all questions. Assume the missing parameters.

Part-A

1. (a) What do you mean by effective diffusivity ?
(b) The dehydrogenation of propene is done at atmospheric pressure using a chromia-alumina catalyst at 530°C. The catalyst is spherical in shape having diameter 0.45cm. The experimental data suggest a 1st order rate constant=0.94 cm³/s.gm of cat. The pore radius is given as 110 Å. Assuming Knudsen diffusivity and estimating the pore volume as 0.35 cm³/g, predict an effectiveness factor for the catalyst. Use parallel pore model with a tortuosity factor 3.0.
[2+8=10]
2. What are the limitations of shrinking core model? Show with figure how the reaction is progressing for a non-catalytic solid-gas reaction with time for different controlling steps.
[3+5]
3. Which methods are used to determine the pore volume of a solid catalyst? What do you mean by a 'Bidisperse pore system' for a solid catalyst?
[2+2=4]
4. Show how the initial rate varies with the reactant concentration for a gas phase solid nonporous catalytic reaction, $A \rightarrow B$, where the effect of adsorption and desorption steps are neglected and dual site mechanism is assumed.
[4]

Part-B

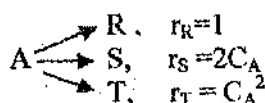
5. (a) You want to produce R as desired product from the following liquid phase parallel reactions



Sketch the best contacting patterns for both continuous and non continuous operations.

[5]

- (b) For the parallel decomposition of A, where R is desired,



with $C_{A0} = 1$

What is the maximum C_R we may expect in isothermal operations

(a) in a mixed reactor (b) in a plug flow reactor

[3+3]

6. A first-order reaction is to be treated in a series of two mixed reactors. Show that the total volume of the two reactors is minimum when the reactors are equal in size.

[6]

7. The RTD analysis for a reactor is performed using a pulse-input of a tracer. The following output signal is obtained.

time, sec	10	20	30	40	50	60	70	80
tracer concentration	0	3	5	5	4	2	1	0

(a) Show the E or $J'(\theta)$ -curve.

(b) What conversion can we expect in the reaction if conversion in a mixed flow reactor employing the same space time is 82.18%?

(c) If the vessel is well represented by a dispersion model, what is the conversion?

(d) Show that for mixed reactor, $J'(\theta) = \frac{1}{\theta} e^{-\theta/\bar{\theta}}$ and compare the actual RTD plot with mixed reactor $J'(\theta)$ with the same $\bar{\theta}$ using a graph sheet.

[2+2+2+2]