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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH6DCCR2 **Max Marks: 100**
Course: Chemical Reaction Engineering-II

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) What are the factors which make up the contacting flow pattern? Discuss how RTD can be measured from pulse input experiment. **06**

b) Evaluate E as a function of time up to t =180 s for a vessel using the tanks-in series model. **06**

C_{in} with t = 220 s and $\sigma^2 = 100\ s^2$

C_{out} with t = 280 s and $\sigma^2 = 1000\ s^2$

c) The effluent concentration is measured as a function of time for a pulse input into a closed vessel. The results are tabulated below: **08**

t (s)	0	1	2	4	5	6	7	8	9	10	12	13	14	15
C (mg/l)	0	0.1	0.2	0.4	0.5	0.45	0.40	0.35	0.30	0.25	0.15	0.10	0.05	0

A second order reaction with $kC_{Ao} = 1.2\ min^{-1}$ is carried out in the system.

(i) Calculate mean residence time and total reactor volume if the flow rate is 570 L/min.

(ii) Find the conversion of this reaction using an ideal plug flow reactor, real reactor mixed flow reactor.

UNIT - II

2 a) Derive the formula for Hatta number and also discuss its role in finding whether reaction under consideration is fast or slow. **08**

b) Air with gaseous A bubbles through a tank containing aqueous B. Reaction occurs as follows: $A(g) + 2B(l) \rightarrow R(l), -r_A = kC_AC_B^2,\ k = 10^6 m^6/mol^2 h$ **12**

For this system

$k_{Ag}a = 0.01 \frac{mol}{h\ m^3 Pa}$ $\qquad k_{Al}a = 20\ h^{-1}$

$f_l = 0.98,\ H_A = 10^5\ Pa\ m^3/mol$, very low solubility

$a = 20\frac{m^2}{m^3}$ $\qquad D_{Al} = D_{Bl} = 10^{-6} m^2/h$

For a point in the absorber-reactor where

$$P_A = 5 \text{ X } 10^3 \text{ Pa and } C_B = 100\frac{mol}{m^3}$$

(a) What is the percentage resistance in the gas film, in the liquid film, in the liquid?

(b) Locate the reaction zone.

(c) What is the order of reaction?

(d) Calculate the rate of reaction in mol/m^3h.

OR

3 a) Show the relationship of size versus time for shrinking particles in the Stoke's regime. **07**

b) A batch of solids of uniform size is treated by gas in a uniform environment. The solid is converted to give a non-flaking product according to the shrinking-core model. Conversion is about 7/8 for a reaction time of 1 h, the conversion is complete in two hours. What is the rate controlling mechanism? **06**

c) Derive an expression to calculate the time required for complete combustion of spherical particle when resistance to ash film is controlling. **07**

UNIT - III

4 a) The mechanism of decomposition of cumene on the catalyst surface is given by: **12**
Reaction:

$$C_6H_5CH(CH_3)_2 \rightarrow C_6H_6 + C_3H_3$$
$$C(g) \rightarrow B(g) + P(g)$$

Mechanism:

$$C + S \leftrightarrow C.S \quad \ldots\ldots\ldots \text{adsorption}$$
$$C.S \leftrightarrow B.S + P(g) \ldots\ldots\ldots \text{surface reaction}$$
$$B.S \leftrightarrow B(g) + S \ldots\ldots\ldots\ldots \text{desorption}$$
$$I + S \leftrightarrow I.S.$$

where, I is an adsorbing inert in the feed that occupies sites on the catalyst surface. Find the rate expression if surface reaction controls.

b) Explain BET theory and discuss how it is used to calculate the total surface area and specific surface area of the material. **08**

UNIT - IV

5 a) Explain in brief about different ways and mechanisms of catalyst deactivation. **10**

b) Consider a reaction in a mixed reactor under changing flow condition so that concentration is constant. Let parallel deactivation occurs. Assume the main reaction to be n^{th} order and the deactivation reaction to be of first order in activity 'a'. Determine catalyst deactivation kinetics. **10**

OR

6	a)	What is Thiele modulus? What is the significance of the Thiele modulus in catalysis?	**06**
	b)	What is effectiveness factor? Derive effectiveness factor for single cylindrical pore assuming first order reaction.	**14**

UNIT – V

7	a)	Elucidate on how to determine rates for catalytic reactions occuring in (i) Integral reactor and (ii) Differential reactor.	**12**
	b)	What is a slurry reactor? Discuss slurry reaction kinetics.	**08**

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