

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

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E.

Branch: Chemical Engineering

Course Code: 19CH6DCCR2

Course: Chemical Reaction Engineering-II

Semester: VI

Duration: 3 hrs.

Max Marks: 100

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 $\sigma^2 = 100$ s²

C_{out} with $t = 280$ s and $\sigma^2 = 1000$ s²

- 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 $kC_{A0} = 1.2$ 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: $A(g) + 2B(l) \rightarrow R(l)$, $-r_A = kC_A C_B^2$, $k = 10^6$ m⁶/mol²h **12**

For this system

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

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

$$a = 20 \frac{\text{m}^2}{\text{m}^3}$$

$$D_{Al} = D_{Bl} = 10^{-6} \text{m}^2/\text{h}$$

For a point in the absorber-reactor where

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

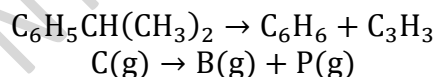
- What is the percentage resistance in the gas film, in the liquid film, in the liquid?
- Locate the reaction zone.
- What is the order of reaction?
- Calculate the rate of reaction in $\text{mol}/\text{m}^3\text{h}$.

OR

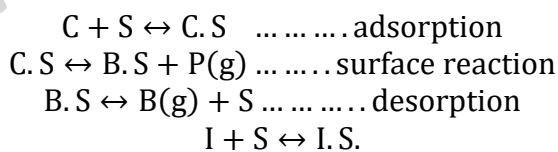
- Show the relationship of size versus time for shrinking particles in the Stoke's regime. **07**
 - A batch of solids of uniform size is treated by gas in a uniform environment. The solid is converted to give a non-flaking product according to the shrinking-core model. Conversion is about 7/8 for a reaction time of 1 h, the conversion is complete in two hours. What is the rate controlling mechanism? **06**
 - Derive an expression to calculate the time required for complete combustion of spherical particle when resistance to ash film is controlling. **07**

UNIT - III

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



Mechanism:



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

- 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

- Explain in brief about different ways and mechanisms of catalyst deactivation. **10**
 - 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 occurring in (i) Integral reactor **12**
and (ii) Differential reactor.
b) What is a slurry reactor? Discuss slurry reaction kinetics. **08**

SUPPLEMENTARY EXAMS 2024