

B.TECH. SEM -VI (CHEMICAL 2014 COURSE (CBCS) :
SUMMER - 2018

SUBJECT: CHEMICAL REACTION ENGINEERING - II

Day: **Wednesday**
Date: **06/06/2018**

S-2018-2387

Time: **02.30 PM TO 05.30 PM**
Max. Marks: 60

N.B.:

- 1) All questions are **COMPULSORY**.
- 2) Figures to the right indicate **FULL** marks.

Q.1 Derive the relation for unreacted core model for spherical particle when (10)
chemical reaction controls.

OR

Q.1 On doubling the particle size from R to 2R the time needed for conversion of (10)
a particle triples. Determine the contribution of ash diffusion resistance to the
overall resistance for particle of size:
i) R and ii) 2R. Neglect gas film resistance.

Q.2 a) Draw concentration profile for mass transfer with chemical reaction for all (05)
types of reaction.

b) It is proposed to remove CO₂ from air by counter current contact with water at (05)
25^oC.

- i) What are the resistances of the gas and liquid films for this operation?
- ii) Suggest simplest form of rate equation for tower design.

Data=

$$K_{Aga} = 0.01 \text{ mol/ hr.m}^3 \text{ pa.}$$

$$K_{Ala} = 20 \text{ hr}^{-1}$$

$$H_A = 10^5 \text{ pa. m}^3 / \text{mol.}$$

OR

Q.2 The concentration of an undesirable, impurity A in air (at $\pi = 1 \text{ bar} = 10^5 \text{ pa}$) (10)
is to be reduced from 01% to 0.02% by absorption in pure water. Estimate the
height of tower needed for countercurrent operation.

$$\text{Data} = K_{Aga} = 0.32 \text{ mol / (h m}^3 \text{ .pa)}$$

$$K_{Ala} = 0.10 \text{ h}^{-1}$$

The solubility of A in water is given by Henry's law constant:

$$H_A = 12.5 \text{ (Pa.m}^3 / \text{mol)}$$

The flow rates of gas and liquid per m² of tower cross section are

$$F_g / A_{Cs} = 1 \times 10^5 \text{ mol / (h.m}^2)$$

$$F_l / A_{Ca} = 7 \times 10^5 \text{ mol / (h.m}^2)$$

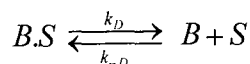
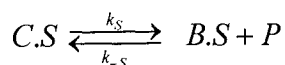
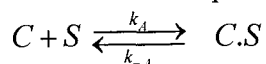
The molarity of liquid under all conditions is $C_T = 56000 \text{ mol/m}^3$.

Q.3 a) Explain mechanism of catalytic reaction. (05)

b) Explain Langmuir adsorption isotherm in detail. (05)

OR

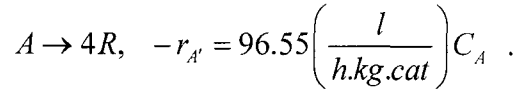
Q.3 The reaction sequence for decomposition of cumene is as follows: (10)



Find the rate expression when adsorption is rate limiting.

P. T. O.

- Q.4** How much catalyst is needed in a packed bed reactor (assume plug flow) for 35% conversion of A to R for a feed of 2000 mol/h of pure gaseous A at 3.2 atm and 117°C if the stoichiometry and rate are given by (10)



$$C_{A0} = 0.1 \text{ mol/lit } \epsilon = 3$$

OR

- Q.4** The catalytic reaction $A \rightarrow 4R$ is run at 3.2 atm and 117°C in a plug flow reactor which contains 0.01kg of catalyst and uses a feed consisting of the partially converted product of 20 lit/ hr of pure unreacted A. The results are as follows: (10)

Run	1	2	3	4
C_{Ain} mol/lit	0.100	0.080	0.060	0.040
C_{Aout} mol /lit	0.084	0.070	0.055	0.038

Find the rate equation to represent this reaction.

- Q.5** Derive the relation for diffusion and reaction in spherical catalyst pellet. (10)

OR

- Q.5** Write notes on: (10)
- Internal effectiveness factor
 - Chemical vapor decomposition reactors.
 - Mass transfer and reaction in packed bed

- Q.6** The data given below represents a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. (10)

Calculate the mean residence time of fluid in the vessel \bar{t} , and tabulate and construct E curve

t, min	0	5	10	15	20	25	30	35
C_{Pulse} . g/l tracer output cone)	0	3	5	5	4	2	1	0

OR

- Q.6** a) What is the role of RTD in determining reactor behavior? (05)
 b) Explain step and pulse experiment. (05)

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