

**B.Tech. SEM -VI (Chemical 2014 Course (CBCS) : WINTER - 2018**

**SUBJECT : CHEMICAL REACTION ENGINEERING – II**

Day : Thursday  
Date : 15/11/2018

**W-2018-2442**

Time : 10.00 AM TO 01.00 PM  
Max. Marks : 60

**N. B. :**

- 1) All questions are **COMPULSORY**.
- 2) Figures to the right indicate **FULL** marks.
- 3) Draw neat and labeled diagram **WHEREVER** necessary.
- 4) Assume suitable data, if necessary.

**Q.1** Uniform sized spherical particles  $UO_3$  are reduced to  $UO_2$  in a uniform (10) environment with the following results:

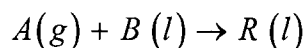
t, hr	0.180	0.347	0.453	0.567	0.733
$X_B$	0.45	0.68	0.80	0.95	0.98

If the reaction follows the SCM, find the controlling mechanism and a rate equation to represent this reduction.

**OR**

- a) Illustrate about linearizing a non-linear rate equation. (05)
- b) Derive the relation for spherical particles when chemical reaction is rate (05) controlling.

**Q.2** An undesirable impurity in air (A) is to be removed from air by absorption in (10) water which contains reactant B, Chemicals A and B react in the liquid as follows:



The reaction is extremely rapid  $50 K = \infty$

A in air entering the tower = 0.6 % (600Pa)

A in air leaving the tower = 0.1 % (100Pa)

The air flows through the tower at  $\pi = 10^5 Pa$ .

Data is as follows:

$$Data \quad K_{A_g} a = 0.20 \text{ mol / (hr. m}^3 \text{ Pa)}$$

$$K_{A_l} a = 0.5 / \text{hr}$$

$$H_A = 15 \text{ (Pa. m}^3 \text{) / mol}$$

$$C_T = 56000 \text{ mol / m}^3$$

The flow rate per  $m^2$  of tower cross section are :

$$Fg / Acs = 1 \times 10^5 \text{ mol / (h.m}^2 \text{)}$$

$$Fl / Acs = 8.7 \times 10^5 \text{ mol / (h.m}^2 \text{)}$$

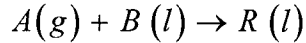
The concentration of B in water entering the tower  $C_B = 400 \text{ mol / m}^3$ .

Assume that the diffusivities of A and B in water are the same. Calculate the height of tower required for counter current operation.

**P. T. O.**

OR

An undesirable impurity in air (A) is to be removed from air by absorption in water which contains reactant B, Chemicals A and B react in the liquid as follows: (10)



The reaction is extremely rapid  $50 K = \infty$

A in air entering the tower = 0.8 % (800Pa)

A in air leaving the tower = 0.2 % (200Pa)

The air flows through the tower at  $\pi = 10^5 Pa$ .

Data is as follows:

$$Data \quad K_{A_g} a = 0.20 \text{ mol} / (\text{hr. m}^3 Pa)$$

$$K_{A_l} a = 0.5 / \text{hr}$$

$$H_A = 15 (Pa. m^3) / \text{mol}$$

$$C_T = 56000 \text{ mol} / m^3$$

The flow rate per  $m^2$  of tower cross section are :

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

$$F_l / A_{cs} = 8.7 \times 10^5 \text{ mol} / (h.m^2)$$

The concentration of B in water entering the tower

$C_B = 50 \text{ mol} / m^3$ . Assume that the diffusivities of A and B in water are the same. Calculate the height of tower required for counter current operation.

Q. 3 a) Discuss adsorption isotherm in detail. (06)

b) Explain catalyst deactivation with example. (04)

OR

a) Discuss catalyst preparation methods in detail. (05)

b) Show with example that promoters are helpful for catalytic reactions. (05)

Q. 4 The catalytic reaction  $A \rightarrow 4R$  (10)

is run at 3.2 atm and  $117^\circ C$  in a plug flow reactor which contains 0.01 kg of catalyst and uses a feed consisting of the partially converted product of 20 liters/hr. of pure unreacted A. The results are as follows:

Run	1	2	3	4
$C_{A \text{ in}}$ mol/lit	0.100	0.080	0.060	0.040
$C_{A \text{ out}}$ mol/lit	0.084	0.070	0.055	0.038

Find a rate equation to represent this reaction.

OR

Catalytic  $A \rightarrow 4R$  is studied in a plug flow reactor using various amounts of catalyst and 20 liters/hr of pure A feed at 3.2 atm and  $117^\circ C$ . The concentration of A in the effluent stream is recorded for the various runs as follows: (10)

Run	1	2	3	4
Catalyst used,kg	0.020	0.040	0.080	0.1600
$C_{A \text{ out}}$ mol/lit	0.074	0.060	0.044	0.029

Find the rate equation for this reaction.

- Q. 5** Discuss the following terms: (10)
- i) Internal effectiveness factor
  - ii) Overall effectiveness factor
  - iii) Chemical vapor diffusion reactors

**OR**

Derive the relation for single cylindrical pore for pore diffusion resistance (10) combined with surface kinetics when reaction is of first order.

- Q. 6** Explain the following: (10)
- i) The pulse experiment
  - ii) The step experiment

**OR**

The concentration readings in table represent a continuous response to a pulse (10) 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  $E$ .

Time $t$ , min	0	5	10	15	20	25	30	35
Tracer O/P Concentration, $C_{\text{pulse}}$ gm/liters fluid	0	3	5	5	4	2	1	0

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