T-E-VI Sem- Chem.

(32)

chemical Reaction Engg-II

26/05/2016

TE/VI/CBGS/CHEM./CRE-II

Q.P. Code : 722601

(3 Hours) [Total Marks : 80

N. B. (i) Question number **one is compulsory.**

(ii) Answer any **three** questions from the rest.

(iii) Assume suitable data wherever necessary

1. a) Write short note on Shrinking core model and Progressive conversion model (05)

b) What is significance of Hatta number in Fluid Fluid reactions? (05)

c) Explain Segregation model (05)

d) Determine the pore volume and catalyst particle porosity for the sample of activated silica from following data: (05)

Mass of catalyst sample placed in chamber=101.5 gm.

Volume of Helium displaced by sample = 45.1 cm^3

Volume of Mercury displaced by sample = 82.7 cm^3

2. a) It is proposed to remove CO_2 from air by countercurrent contact with water at 25°C. (10)

i) Find the resistance of the gas and liquid films for this operation?

ii) Suggest the simplest form of rate equation for tower design.

iii) For this absorption operation, would you expect reaction with absorption to be helpful? If so, why?

Data: For CO_2 between air and water,

$k_g a$=0.80 mol/(h.m^3.Pa)

$k_l a$=25 hr^{-1}

H=3000(Pa.m^3)/mol

b) For the gas-liquid reaction of the type (10)

$$A_{(gas)} + bB_{(l)} \rightarrow R$$

$$-r_A = kC_A C_B$$

Discuss the reaction regime and give their rate expressions with proper diagrams for the following cases:

i) Instantaneous reaction with high C_B

ii) Fast reaction with low C_B

TURN OVER

3. a) Derive the conversion time expression for the case of Chemical reaction controlling in a gas solid non catalytic reaction. (10)

b) An ore of uniform size particles is to be roasted in a fluidized bed reactor. The time required for complete conversion of solid particles is 20 min and the mean residence time of particles in the bed is 48 min. The solids remain unchanged in size during reaction. Calculate the fraction of the original ore remaining unconverted assuming: (10)

i) The chemical reaction step to be rate controlling.

ii) The ash diffusion step to be rate controlling.

4. A tracer with number of dividing baffles is to be used to carry out the reaction $A \rightarrow R$ with $-r_A = k C_A$, $k = 0.25\ min^{-1}$ (20)

The results of a pulse tracer test are given below

t, min	0	1	2	3	4	5	6	7	8	9	10	12	14
Tracer output Concentration (mg/l)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

a) Plot C (t), E (t) and F (t) curves.

b) Calculate mean residence time.

c) Find the conversion expected in the tank-in-series model and how many tanks in series would you suggest to model this reactor.

d) Calculate conversion assuming Mixed Flow reactor

Q.5) Ethanol can be produced by catalytic vapor phase hydration of ethylene at 135 atm and 573 K. (20)

$$C_2H_4 + H_2O \rightleftarrows C_2H_5OH$$

$$A + B \rightleftarrows R$$

The rate expression for this reaction is

$$-r' = \frac{0.018\, k_A k_B (p_A p_B - p_R/K)}{(1 + k_A p_A + k_B p_B)^2} \quad , \quad \frac{mol}{(gm\ catalyst\ h)}$$

Where $k_A = k_B = 0.003$

The equilibrium constant is given by,

$$RT \ln K = 30\,T - 9730 \text{ where} \qquad R = 1.987 \text{ cal/(mol K)}$$

The total feed rate to a PFR is 10 kg/h with equimolar amounts of ethylene and steam. Find the weight of catalyst needed to achieve 20% conversion of ethylene.

Q.6. Write short note on any <u>two:</u> (20)

a) Tanks in series Model

b) Slurry Reactor

c) Fluidized Bed Reactor
