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RN-7323

B. E. - IV (Sem. VII) (Chem.) Examination

May / June – 2010

Chemical Reaction Engg. - II

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - 4 (Sem. 7) (Chem.)**

Name of the Subject :

☛ **Chemical Reaction Engg. - II**

☛Subject Code No. : **7 3 2 3** ☛Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Answer each section in a **separate** answer book.

(3) Figures to the right indicate full marks.

(4) Draw neat and clean figures wherever required.

(5) Assume suitable data wherever required.

SECTION - I

1 (a) Answer the following : **10**

(i) In a fluid-fluid reaction, draw the concentration profile for instantaneous reaction with low CB [Ac(gas) and B (liq)] **2**

(ii) Mention any two resistances that are viewed to act in series when a reactant A is bubbled through liq B containing suspended solid catalyst. **2**

(iii) State any two limitations of the shrinking core model. **2**

(iv) Write the equation for particles of unchanging size when diffusion through Ash layer controls for time required for complete conversion. **2**

(v) Define film conversion parameter, m and state controlling rate factor for m >> 1 and m << 1. **2**

(b) Discuss kinetic regimes for mass transfer and reaction in case of fluid-fluid reaction with concentration profile for each case. **8**

(c) Discuss two steps occurring in succession for unreacted core model for spherical particles of unchanging size. 2

2 Answer the following (any **two**) 16

(a) Spherical particles of an ore of size R = 5 mm are roasted isothermally in an air stream. The time-conversion data obtained are as follows :

t, (min)	15	30	60
X_β	0.334	0.584	0.88

Assume that reaction follows the SCM.

(i) Find the rate controlling mechanism

(ii) Determine time needed for complete conversion of spherical particles of size R = 0.5 mm, all other parameters remain unchanged.

(b) Solid particles of uniform size are 80% converted, according to the shrinking core model (SCM) with ash diffusion SHP as rate as rate controlling, on passing through a reactor with uniform gas environment. What would be the conversion of solids if the reactor is made twice as large - all else remaining unchanged?

(i) Case I : The solids are in plug flow

(ii) Case II : The solids are in mixed flow.

(c) An ore of uniform size particles is to be roasted in a fluidised 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.

(i) Chemical reaction step as rate controlling

(ii) Ash diffusion step as rate controlling.

3 Answer the following (any **two**) 14

(a) Derive an expression to show that fractional conversion of reactant A in its passage through the reactor is governed by three dimensionless groups: a reaction rate, dispersion no and the reaction order n.

(b) Discuss degree of segregation for self-mixing of a single fluid for batch reactor, plug flow and mixed flow reactor.

(c) We plan to remove 90% of the reactant present in a gas stream by absorption in water. Find the volume of water required for countercurrent operation.

Data given : for gas stream

Fg = 90000 mol/h at $\pi = 10^5$ Pa

Pair = 1000 Pa, PAout = 100 Pa.

For the packed bed:

Fe = 400000 mol/h, K_{Age} = 0.36 mol/ch.m^3.Pa)

K_{Ala} = 72 h^{-1}

Molar density of liquid under all condition is Cr = 55556 mol/m^3.

and H_A = 18 (Pa.m^3)/mol, K=0 m^2/(mol.h)

SECTION - II

4 (a) Answer the following : **1×10=10**

(i) Nonideality in a reactor arises due to
- (a) recycling of fluid
- (b) dead zones
- (c) turbulence and vortices at the inlet and outlet
- (d) all a, b, c

(ii) For a _____ exit, atge distribution (E) continuously decreases with time.
- (a) CSTR
- (b) PFR
- (c) Packed bed reactor
- (d) Talk reactor with bypassing.

(iii) Unit of cumulative age distribution is _____.
(a) sec, (b) sec^{-1} (c) sec^2 (d) unit less

(iv) Tanks in series model are a _____ parameter model.

(v) When dispersion number approaches zero, there will be
- (a) no dispersion, mixed flow
- (b) no dispersion, plug flow
- (c) large dispersion, mixed flow
- (d) large dispersion, plug flow

(vi) The rate of a heterogenous reaction is function if _____ (choose among humidity, pressure, concentration, mass transfer, momentum transfer)

(vii) The amount of physical adsorption decrease as the temperature _____
- (a) is raised
- (b) is constant
- (c) decreases
- (d) below the critical temperature.

(viii) What is an intrinsic rate?

(ix) Write down the clausius-claypryrn equation for the adsorption of two phase system.

(x) Define activity of a catalyst.

(b) Derive the reaction kinetics for the pore diffusion resistance combined with surface kinetics, and prove that the effectiveness factor is a function of thiele modulus.

5 Answer any **two** : **2×8=16**

(a) Describe the experimental methods to determine the rate of reaction.

(b) A small diameter pipe 32 m long runs from the fermentation room of a winery to the bottle filling cellar. Sometimes red wine is pumped through the pipe, sometimes white and whenever the switch is made from one to the other a small amount of 'house blend' rose is produced (8 bottles). Because of some construction in the winery the pipeline length will have to be increased to 50 m. For the same flow rate of wine, how many bottles of rose may we now expect to get each time we switch the flow?

(c) How much catalyst is needed in a packed bed reactor for 80% conversion of 1000 m^3/hr pure gaseous A (C_{AO} = 100 mol/m^3)

$A \rightarrow R, \quad -r'_A = 8C_{A^2}$

6 Answer any **two** : **2×7=14**

(a) Gaseous A reacts (A $\rightarrow$ R) in an experimental reactor. From the following conversion data at various conditions find a rate equation to represent the reaction.

$v_0, m^3/hr$	3	2	1.2
X_A	0.2	0.3	0.5

mixed flow C_{AO} = 10 mol/m^3, w = 4 gm

(b) Classify the reactors with suspended solid catalysts.

(c) Explain the following two methods for the pore volume distribution.

(i) H_g penetration method

(ii) N_2 - desorption method.