B.TECH SEM – VII (2007 COURSE) (CHEMICAL ENGG.) :
WINTER - 2017

SUBJECT : CHEMICAL REACTION ENGINEERING – II

Day : **Friday** Time : **02.30 PM TO 05.30 PM**
Date : **12/01/2018** **W-2017-2543** Max. Marks : 80

N.B.:

1) **Q.No.1** and **Q.No.5** are **COMPULSORY**. Out of the remaining questions attempt **ANY TWO** questions from each section.
2) Answers to both the sections should be written in the **SEPARATE** answer books.
3) Draw neat and labeled diagrams **WHEREVER** necessary.
4) Use of non programmable **CALCULATOR** is allowed.
5) Figures to the right indicate **FULL** marks.
6) Assume suitable data if necessary.

SECTION – I

Q.1 **a)** Draw contacting patterns for heterogeneous reaction systems. **[04]**

b) Derive unreacted core model for chemical step is rate controlling. **[07]**

c) Give steps in involved in catalytic reactions. **[03]**

Q.2 **a)** Gaseous reactant A diffuses through a gas film to the surface of solid B where it reacts with B according to a reversible first order rate, $-r_A'' = k''\left(C_{As} - C_{Ae}\right)$, mol $\left(m^2.s\right)$ where C_{Ae} is the concentration of A in equilibrium with the solid surface. Derive an expression for the rate of reaction of A that accounts for both the mass transfer and reaction steps. **[08]**

b) What is mean by linearizing a nonlinear rate equation? **[05]**

Q.3 **a)** In a uniform gas environment, 4mm solid particles are 87.5% converted to product in 5 min according to SCM with ash diffusion step as rate controlling. The solids remain unchanged, in size during reaction. Find the mean conversion that can be obtained in a fluidized bed reactor operating with the same environment as before, using a feed consisting of equal amounts of 2mm and 1mm particles. The mean residence time of solids in a fluidized bed reactor is 30 min. **[10]**

b) Write a note on: Progressive conversion model. **[03]**

Q.4 Reactant A is adsorbed on the surface of a catalyst and reacts with another component B in the gas phase. The products of the reaction are C adsorbed on the surface and D in the gas phase. The product C is then desorbed from the surface. The proposed mechanism is: **[13]**

Adsorption : $A(g) + s \rightleftharpoons A.s.$

Surface reaction : $B(g) + A.s \rightleftharpoons C.s + D(g)$

$$r_s = k_s\left(P_B C_{A.s} - \frac{C_{C.s} P_D}{K_s}\right)$$

$Desorption = c.s \rightleftharpoons C(g) + s$

$$r_D = k_D\left(C_{Cs} - \frac{P_C C_v}{k_c}\right)$$

For surface reaction controlling show that

$$r_A'' = rs = \frac{C_t\, k_s\, K_A\left(P_A P_B - P_C\, P_D / K_P\right)}{\left(1 + P_A K_A + P_C / K_C\right)}$$

P.T.O.

SECTION – II

Q.5 **a)** Draw kinetic regimes for fluid- fluid reaction. **[05]**

b) Explain the relationship between E and F curve. **[05]**

c) Write a note on CVD. **[04]**

Q.6 We plan to remove 90% of the reactant present in a gas stream by absorption in water. Find the volume of tower required for counter current operation. **[13]**

Data: For gas stream

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

P_A in = 1000 Pa, P_A out = 100Pa.

For the packed bed : $F_l = 900000$ mol/hr

$K_{Aga} = 0.36$ mol / (hr. m^3. Pa)

$k_{Al} = 72h^{-1}$

$H_A = 18$ (pa. m^3 / mol), $k = 0.1$ m^3 / (mol.h)

Molar density $C_T = 55556$ mol/m^3

Q.7 **a)** Write a note on "Role of RTD in determining reactor behavior. **[06]**

b) Explain pulse and step experiments. **[07]**

Q.8 **a)** Derive the relation for pore diffusion resistance combined with surface kinetics for single cylindrical pore and first order reaction. **[10]**

b) Write a note on chemical vapour deposition (CVD) reaction. **[03]**

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