Code No: NR320802 **NR**

III B.Tech II Semester Supplementary Examinations, April/May 2005
CHEMICAL REACTION ENGINEERING-I
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define reaction rate constant. Develop an expression that facilitates calculation of units of rate constant for any order.

   (b) Determine equilibrium conversion of A at 373oK for the following aqueous reaction.

   A $\underset{k_2}{\overset{k_1}{\rightleftharpoons}}$ R $\qquad \Delta$Go = -3375 K cal/K mole

   ΔH_r^o = -18,000 K cal/K mole

   Assume specific heats of all solutions are equal to that of water.

2. The following initial rate data were reported for two gas phase reversible reaction of diborene (A) and acetone (B) at 114^oC.

   A+B $\rightleftharpoons$ 2R

Run	intial Pressure(torr)		Intial $\times 10^3$ (torr/sec)
	A	B	
1	60.	20.0	0.5
2	8.0	20.0	0.63
3	10.0	20.0	0.83
4	12.0	20.0	1.0
5	16.0	20.0	1.28
6	10.0	10.0	0.33
7	10.0	20.0	0.80
8	10.0	40.0	1.5
9	10.0	60.0	2.211
10	10.0	100.0	3.33

   Determine order with respect to A and B and find the rate constant. Be sure to express K in appropriate units.

3. Consider the reaction A + 3B $\rightarrow$ R + 3S for which the mechanism suggested is

   A + B $\underset{k_2}{\overset{k_1}{\rightleftharpoons}}$ S + X

   B + X $\underset{k_2}{\overset{k_1}{\rightleftharpoons}}$ S + Y

   B + Y $\overset{k_3}{\rightleftharpoons}$ R + S

   (a) Derive the rate law

(b) Show how the rate law transforms when each of the mechanism steps controls the rate.

4. The reaction A + B → R is first order with respect to each of the reactants when conducted in liquid phase in a $1.5m^3$ plug flow reactor using a mole ratio

   M = $C_{Bo}/C_{Ao} = 2$, a 90% conversion is obtained. What mole ratio M will provide the same amount of product, if the reaction is conducted in a 7.5 m^3 backmix reactor.

5. Acetic anhydride is to be hydrolyzed in three stirred tank reactors operated in series. The reaction is first order with k = $0.0806min^{-1}$. Each reactor has a volume of 1.8 $liters$ and the feed rate to the first is 35 $liters/hr$. Compute the percent of hydrolysis accomplished in the three reactors.

6. For the first order series reactions,

   A $\xrightarrow{K_1}$ R $\xrightarrow{K_2}$ S

   Derive $\frac{C_{Rmax}}{C_{AO}}$ and P_{opt} in a PFR.

7. The decomposition of Phosphine is irreversible and first order at 650^0C. $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$

   The rate constant (s^-1) is reported as:

   Log K = - $\frac{18963}{T}$ + 2 log T + 12.130 where T is in O_k.

   In a closed vessel (constant volume) initially containing Phosphine at 1 atm. pressure, what will be the pressure after 50, 100 and 500s. The temperature is maintained at 650^0C.

8. Write detailed notes on:

   (a) Integral and differential methods

   (b) Total volume and total pressure methods.

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