INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date .....FN/AN, **Time** : 2 Hrs **Full Marks** : 30, **Deptt.** Chemical Engineering
No. of Students :82, Mid Autumn Semester Examination
Subject No : CH31009 **Subject Name** : Reaction Engineering
3rd Yr. B. Tech.(H)/M.Tech.Dual

Instructions : Attempt all questions. Assume the missing parameters.

PART-A

1. Answer the following questions.

   (a) For a gas reaction at 400K the rate is given by $-\frac{dp_A}{dt} = 3.67p_A^2, atm/hr$. What are the units of rate constant? What will be the value of the rate constant for the same reaction if the rate equation is expressed as $-r_A = -\frac{1}{V}\frac{dN_A}{dt} = kC_A^2 mol/lit.hr$. [2]

   (b) On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order. [2]

   (c) For the reaction A+B → R (rate equation : $-r_A = k_1 C_A C_B$ *and* $C_{B0}/C_{A0} = 1$), considering an isothermal tubular reactor under plug flow condition, starting from the mass balance equation, derive an equation for volume of the plug flow reactor assuming A as the limiting reactant. [C_{A0} *and* C_{B0} are the initial concentrations of A and B respectively]. [3]

2. At 650°C phosphine vapor decomposes as follows:

$$4PH_3 \rightarrow P_4(g) + 6H_2 \ , \ -r_A = (10hr^{-1})C_{PH3}$$

We wish to treat 10 mols/hr of phosphine vapor in a feed containing 2/3-phosphine-1/3-inert.

(a) What size of plug flow reactor operating at 650°C and 11.4 atm is needed to achieve 75% conversion?

(b) What outlet composition would you expect if the plug flow reactor is replaced by the same size of mixed flow reactor and treated with a pure feed of phosphine, at the same operating conditions and space-time of part (a)?

[4+4]

PART-B

3. (a) Write the types of mechanism which can be assumed for a solid catalytic reaction, A + B→ C (Explain with drawing if required).

   (b) Write the expression of the catalyst site balance and the unit of the site concentration for solid catalyst for the above reaction.

   (c) Explain with a figure how the rate of a solid catalytic reaction is dependent on the velocity of the reactant through the catalyst bed and catalyst particle size.

   (d) Determine the rate law for the following surface reaction controlled reaction, S is vacant site of catalyst: A.S +B → C.S [5+2+5+3=15]