Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – WINTER • 2014

Subject Code: 173601 **Date: 27-11-2014**

Subject Name: Basics of Catalysis

Time: 10:30 am - 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Describe briefly about Catalyst: Promoters, Inhibitors and poisons. **07**

(b) Derive an integrated rate expression for zero order and second order irreversible reactions. **07**

Q.2 **(a)** Determination of deactivation kinetic parameters for a reaction occurs in a mixed reactor under constant flow condition. Let independent deactivation occur. Assume both the main reaction and deactivation reaction to be first order with respect to activity 'a '. **07**

(b) At certain temperature, the half-life period and initial concentration for a reaction are **07**

$t_{1/2}$ = 435 sec; C_{A0} = 0.405 mole/lit

$t_{1/2}$ = 275 sec; C_{A0} = 0.640 mole/lit

Calculate the order of reaction and rate constant of the reaction

OR

(b) 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 **07**

Adsorption: $A_{(g)} + S = A \cdot S$

Surface reaction: $B_{(g)} + A \cdot S = C \cdot S + D_{(g)}$

Desorption: $C \cdot S = C_{(g)} + S$

Overall reaction is

$A_{(g)} + B_{(g)} = C_{(g)} + D_{(g)}$

Derive a rate expression when surface reaction is rate controlling step.

Q.3 **(a)** Discuss mechanism of catalyst deactivation. **07**

(b) For kinetics of fluid-solid catalyzed reaction, write about "Adsorption isotherm". **07**

OR

Q.3 **(a)** What is catalyst deactivation? Explain deactivation kinetics of poisoning. **07**

(b) Explain mechanism of solid catalyzed reaction in details. **07**

Q.4 **(a)** Derive a performance equation for plug flow reactor (PFR) containing solid catalyst with neat and clean diagram and shows how it's different from simple performance equation **07**

(b) Write a short note on heat effects encountered in fluid- solid catalysed reaction. **07**

OR

Q.4 **(a)** Discuss Michaelis – Menten kinetics (M-M kinetics) in details. **07**

(b) Explain Temperature-Time Trajectories. **07**

Q.5 **(a)** An aqueous feed A and B (400 lit/min, 100 mmol A/lit, 200 mmol B/lit) is to be converted to product in a PFR. The kinetics of the reaction is represented by **07**

$A+B \rightarrow R$, $-r_A = 200\ C_A C_B$ mol/lit.min. Find the volume of the reactor needed to achieve 99.9% conversion of A to Product.

(b) The rate constant of a reaction measured at different temperatures is reported below. Calculate the activation energy and frequency factor for this reaction. **07**

Temp, K	293	298	303	308
K, min^{-1}	1.5×10^{-3}	2.67×10^{-3}	4.64×10^{-3}	7.93×10^{-3}

OR

Q.5 **(a)** Derive an expression for the effectiveness factor of a rectangular slab (flat plate) of porous catalyst. (Assume edges are sealed so that diffusion occurs in one direction only). **07**

(b) The isomerization of A to R (rearrangement of atoms in the molecule) proceeds at 730^0K on a slowly deactivating catalyst by second order rate and given by **07**

$$-r_A = 200\ C_A^2\ a,\ \text{mole/ (g cat}\cdot\ \text{h)}$$

As reactant and product molecules are similar in structure, deactivation is caused by both A and R. The rate of deactivation, with no diffusion effects, is found to be

$$-\frac{da}{dt} = k_d (C_A + C_R) = 10\ (C_A + C_R)\ a, \quad \text{day}^{-1}$$

It is desired to operate a packed bed reactor containing 1000 kg of catalyst for 12 days using steady feed of pure A (F_{A0} = 5 kmol/h at 730^0K and 3atm). Calculate the conversion at the start of the run and at the end of run.

****