

**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**

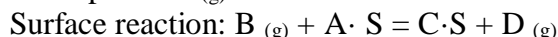
$$t_{1/2} = 435 \text{ sec}; C_{A0} = 0.405 \text{ mole/lit}$$

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

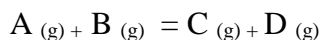
Calculate the order of reaction and rate constant of the reaction

**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**



Overall reaction is



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**
- $$A+B \rightarrow R, -r_A = 200 C_A C_B \text{ mol/lit.min.}$$
- 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 <sup>-1</sup>	$1.5 \times 10^{-3}$	$2.67 \times 10^{-3}$	$4.64 \times 10^{-3}$	$7.93 \times 10^{-3}$

**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<sup>0</sup>K 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

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

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

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