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ECH-502

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 151503

Roll No.

B. Tech.

(SEM. V) (ODD SEM.) THEORY EXAMINATION, 2014-15

CHEMICAL REACTION ENGINEERING - II

Time : **3** Hours] [Total Marks : **100**

1 Attempt any FOUR parts : **5x4=20**

(a) Derive design equation for semi batch reactor.

(b) Elucidate the rate equation for heterogeneous reactions.

(c) Discuss about selectivity and yield.

(d) Explain the process of catalysis and mention its advantages.

(e) A solid catalysed first order reaction $A \rightarrow R$ takes place with 55% conversion in a basket type mixed reactor. What would be the conversion if the reactor size is three times the original reactor keeping all else unchanged?

(f) The results of the kinetic runs on the reaction $A \rightarrow R$ made in an experimental packed bed reactor using a fixed feed rate F_{A0} = 10 kmol/h are as follows. Determine the reaction rate at 40% conversion.

W, kg catalyst	1	2	3	4	5	6	7
X_A	0.12	0.21	0.27	0.33	0.37	0.41	0.44

2 Attempt any TWO parts : **10x2=20**

(a) Elaborate the mechanism of catalytic reactions.

(b) Describe the methods of testing and characterising solid catalysts.

(c) The mechanism of decomposition of cumene on the catalyst surface is given by

Reaction :

$C_6H_5CH(CH_3)_2 \rightarrow C_6H_6 + C_3H_6$, $C(g) \rightarrow B(g) + P(g)$

Mechanism :

$C + S \leftrightarrow C.S$ .....(adsorption)

$C.S \leftrightarrow B.S + P$ .....(Surface reaction)

$B.S \leftrightarrow B + S$ .....(desorption)

Derive the rate expression if surface reaction controls.

3 Attempt any TWO parts : **10x2=20**

(a) What is effective diffusivity and thermal conductivity? Explain and discuss.

(b) An ore of uniform size particles is to be roasted in a fluidized bed reactor. The time required for complete conversion of solid particles is 20 min and the mean residence time of particles in the bed is 48 min. The solids remain unchanged in size during reaction. Calculate the fraction of the original ore remaining unconverted assuming :

(i) Chemical reaction step as rate controlling.

(ii) Ash diffusion step as rate controlling.

(c) Discuss the factors to be considered for selecting recycle reactor.

4 Attempt any TWO parts : **10x2=20**

(a) Explain unreacted core model.

(b) In a uniform gas environment, 4 mm solid particles are 87.5% converted to product in 5 min, according to Shrinking core model 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 fluidised bed reactor operating with the same environment as before, using a feed consisting of equal amounts of 2 mm and 1 mm particles. The mean residence time of solids in a fluidised bed reactor is 30 min.

(c) A reaction $A \rightarrow 3R$ is carried at 800° C in a catalytic tubular reactor packed with 30% active catalyst pellets and 70% inerts to maintain isothermal conditions. The rate equation is:
$-r_A^I = -(1/W)(dN_A/dt) = (10 \text{ lit/hr.g cat}) C_A$, mol/hr. g cat

For 500 mol/hr of feed consisting 60% A and 40% inert gas at 8.5 atm and 800° C what must be the length of reactor so that $p_{Aout}/p_{Ain} = 0.15$.

Data : Catalytic and inert pellets are porous (d_p = 3 mm), Particle density ρ_s = 2 g/cm^3, Bulk voidage of packed bed, ε = 50%, Internal diameter of tubular reactor = 2 cm

5 Attempt any TWO parts : **10x2=20**

(a) The following data (the rate of reaction as a function of urea concentration) is available for the reaction

k1 k3

k2 $-H_2O$

urea + urease $\leftrightarrow$ urea. Urease $\rightarrow$ $2NH_3$ + CO_2 + urease.

Determine Michales-Menten parameters for this reaction

C_{urea}, kmol/m^3	0.2	0.02	0.01	0.005	0.002
$-r_{urea}$, kmol/m^3.s	1.08	0.55	0.38	0.2	0.09

(b) Explain biochemical reaction system.

(c) Elaborate microbial fermentation.