Total No. of Questions : 8]

SEAT No. :

P1185

[Total No. of Pages : 3

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B.E. (Petrochemical) (Semester - I)

REACTION ENGINEERING - II

(2008 Pattern)

Time :3 Hours] *[Max. Marks :100*

Instructions to the candidates :

1) ***Attempt any three questions from each section.***
2) ***Answer to the two sections should be written in two separate answerbooks.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data if necessary.***
5) ***Use of steam tables and electronic calculator is allowed.***

SECTION - I

Q1) For the gas phase catalytic reaction, $A + 2B \rightarrow R$, derive any two rate laws based on Langmuir-Hinshelwood theory. **[16]**

Q2) A laboratory well-mixed reactor, housing 1 Kg catalyst, yields following data. Concentration of A in feed is 10 mol/m^3. **[18]**

C_A mol/m^3	1	2	3	6	9
V_0 lit/hr	5	20	65	133	540

Reaction is $A \rightarrow R$. Find the amount of catalyst needed for 92% conversion for a flow rate of 10 kmol/hr feed stream having concentration of A as 20 mol/m^3 assuming the reactor to be:

a) Fixed Bed Reactor with no recycle stream.

b) Fixed Bed Reactor with very large recycle.

Q3) True kinetics of a gas phase catalytic reaction $A \rightarrow 2R$ is given as $-r_A = 0.15\ C_A^2$ mol/m^3 cat.s. Calculate the catalyst volume needed to achieve 75% conversion of 95% pure A fed at the rate of 100Kmol/hr assuming strong pore diffusion resistance regime. Catalyst pellet diameter is 12 mm and effective pore diffusivity is 1×10^{-6} m^3/m cat.s **[16]**

P.T.O.

Q4) Discuss in brief **[16]**

a) BET Method

b) Thiele Modulus in Fixed Bed Reactor Design

c) Catalyst additives

d) Mechanisms of catalyst poisoning

SECTION - II

Q5) Derive expressions for rate of absorption needed for absorption tower design in the following cases. **[16]**

a) Reaction is infinitely rapid.

b) Reaction is very slow.

Q6) An acid gas A in a gaseous stream is to be removed so as to reduce its ppm from 5000 to 50 (total pressure is 200 KPa) by reacting it with an aqueous solution of base B in a packed tower operated in a counter-current manner. Overall gas side mass transfer coefficient is 0.009 mol/hr.m^3.Pa. Henry's constant is 15 Pa.m^3/mol. L/G ratio is 5 Kmol/Kmol Inert. Calculate minimum concentration of B needed at the top of the tower to ensure minimum height of the tower. Also calculate the height of the tower if the concentration is 70% of the minimum value. **[18]**

Q7) a) Derive expression for calculating time required for a batch of spherical particles reacting with a gas in a uniform atmosphere to a predecided level of conversion. Assume diffusion through the ash layer controlling the overall rate. State the assumptions made. **[10]**

b) Spherical particle of ZnS with initial diameter of 5 cm is subjected to oxidation in presence of pure oxygen at 2 bar and 700 C. Roasting reaction yields SO_2 as also the layer of ZnO. Molar density of solid may be assumed to be 0.08 mol/cm^3. Diffusivity of gas through the product layer is 0.02 cm^2/s. Calculate the time required for 80% reduction in the size of the particle. **[6]**

Q8) Give a brief account of pertinent reactions, catalysts used, operating conditions and reactors employed in **[16]**

a) Hydroprocessing

b) Hydrogen Production