

Chemical Reaction Engineering - II

23

Q.P. Code : 6408

(3 Hours)

[Total Marks : 80]

- N. B. (i) Question number one is compulsory.
 (ii) Answer any three questions from the rest.
 (iii) Assume suitable data wherever necessary.

- Q.1.a) Differentiate between Physical adsorption and Chemical adsorption. (05)
- b) Differentiate between true density, apparent density and bulk density of catalyst particles. (05)
- c) What are different controlling mechanisms in non catalytic heterogeneous reaction? (05)
- d) What is the significance of Hatta number in fluid-fluid reactions? (05)
- Q.2.a) Estimate the surface area (m²/gm) of 8.01 gm of glaucosil sample. Nitrogen at -195.8 deg C is used for adsorption studies. The adsorption data obtained are given below. (10)

Pressure (mm Hg)	6	25	140	230	285	320	430.	605
Vol. adsorbed (cc) at STP	61	127	170	197	215	230	277	335

The vapour pressure of nitrogen at -195.8 deg C is 1 atm and the density of nitrogen is 0.808 gm/cc.

- b) Develop Langmuir-Hinshelwood type of rate equation for $A+B \rightleftharpoons C+D$ (10)
 When the rate of adsorption of A is rate controlling step.

- Q.3) For the gas-liquid reaction of the type $A_{(gvl)} + bB_{(l)} \rightarrow R$ (20)
 $-r_A = kC_A C_B$

Discuss the possibilities of various types of reaction regime and give their rate

expressions with proper diagrams.

Q.4.a) Calculate the time needed to burn to completion particles of graphite ($R_o = 5$ mm, (08)
density of solid = 2.2 gm/cm^3 , $k'' = 20 \text{ cm/sec}$) in an 8% oxygen stream. For the high gas
velocity used assume that film resistance does not offer any resistance to transfer and
reaction. Reaction temperature = 900 deg C

b) A solid feed consisting of (12)

20 wt% of 1-mm particles and smaller

30 wt% of 2-mm particles

50 wt% of 4-mm particles

passes through a rotating tubular reactor somewhat like a cement kiln where it reacts
with gas to give a hard nonfriable solid product (SCMI reaction control,
 $\tau = 4$ h for 4-mm particles).

1. Find the residence time needed for 100% conversion of solids.
2. Find the mean conversion of the solids for a residence time of 15 min.

Q.5) The RTD analysis was carried out in a liquid phase reactor as follows:- (20)

t, min	0	2.5	2.9	3.3	3.75	4.0	4.16	4.33	4.58	5	5.41	6.25	7.5
Conc gm/cc 1×10^3	0	0	1	3	7.4	9.4	9.7	9.4	8.2	5.0	2.5	0.5	0

1. What is the mean residence time?
2. What fraction of material spends between 4 & 5 min in the reactor?
3. What conversion can be expected for the reaction carried out in this reactor
with a rate constant of 0.7 min^{-1} using segregation model.
4. Calculate Variance?
5. Calculate conversion using tank in series model.

Q.6) Write short note on any two: (20)

- a) Bubble Column Reactor
- b) Reactors for Solid Fluid Noncatalytic Reactions
- c) Two Parameter Model for Nonideal reactors