B.Tech. SEM -VI (Chemical 2014 Course (CBCS) : WINTER - 2017

SUBJECT: CHEMICAL REACTION ENGINEERING - II

Day: **Wednesday** Time: **10.00 AM TO 01.00 PM**

Date: **22/11/2017** **W-2017-2175** Max. Marks: 60

N.B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.

Q.1 A fluidized bed reactor of size 20cm, 2m long operates at steady state with a solid feed consisting of 30% of 50 μ m radius particles **(10)**

40% of 100 μ m radius particles

30% of 200 μ m radius particles

The fluidization gas is in the gas phase reactant and has uniform composition. The time required for complete conversion is 5, 10 and 20 minutes for the three sized of feed under planned operating conditions. Find the conversion of solids in the reactors for a feed rate of 1kg solids/ min to the reactor and fluidized bed contains 10kg of solids.

OR

Q.1 In roasting operation of iron sulfide particles dispensed in asbestos fibres found that the time required for complete conversion was found to be related to particle size as $\tau \alpha R^{1.5}$ particles remained as hard solid during reaction. A fluidized bed reactor is planned to convert iron sulfide are to the corresponding oxide. The feed is to be uniform in size $\tau = 20\,\text{min}$, with mean, residence time $\bar{t} = 60\,\text{min}$ in the reactor. What fraction of original sulfide are remains unconverted? **(10)**

Q.2 CO_2 is to be removed from air. We plan to use NaOH solution to hasten the removal of CO_2 from air at 25^0C. The reaction between CO_2 and NaOH is instantaneous. **(10)**

$CO_2 + 2NaOH = Na_2CO_3 + H_2O$.

i) Suggest a form of rate equation that we would use when $P_{CO_2} = 1000\,P_a$ and the solution is 2N.

ii) How much can absorption be speeded compared to physical absorption using water?

Data=

K_{Aga}= 0.01 mol/ hr.m^3 pa.

$K_{Ala} = 20hr^{-1}$

$H_A = 10^5$pa. m^3 /mol.

OR

Q.2 We plan to remove 90% of the reactant present in gas stream by absorption in water. Find the height of tower required for countercurrent operation. **(10)**

F_g = 90,000 mol /hr at $\pi = 10^5$ pa.

P_{Ain} = 1000pa, P_{Aout} = 100pa.

For the packed bed.

F_l = 900000 mol/h; K_{Aga} = 0.36 mol/ (h. m^3.pa)

$K_{Ala} = 72h^{-1}$

Molar density of liquid under all conditions is

C_T = 55556 mol/ m^3

H_A = 18 (pa. m^3/mol)

K= 0 m^3/(mol.h)

P. T. O.

Q.3 **a)** Elaborate in detail poisoning of catalyst. **(05)**

b) Write a detail note on Langmuir adsorption.

OR

Q.3 The reaction sequence for decomposition of cumene is as follows: **(10)**

$$C + S \underset{k_{-A}}{\overset{k_A}{\rightleftharpoons}} C.S$$

$$C.S \underset{k_{-S}}{\overset{k_S}{\rightleftharpoons}} B.S + P$$

$$B.S \underset{k_{-D}}{\overset{k_D}{\rightleftharpoons}} B + S$$

Find the rate expression when adsorption is rate limiting.

Q.4 The catalytic reaction $A \rightarrow 4R$ is run at 3.2 atm and 117^{0}C in a plug flow reactor which contains 0.01kg of catalyst and uses a feed consisting of the partially converted product of 20 lit/ hr of pure unreacted A. The results are as follows: **(10)**

Run	1	2	3	4
C_{Ain} mol/lit	0.100	0.080	0.060	0.040
C_{Aout} mol /lit	0.084	0.070	0.055	0.038

Find the rate equation to represent this reaction.

OR

Q.4 The catalytic reaction $A \rightarrow 4R$ is studied in a plug flow reactor using various amounts of catalyst and 20liters/hr of pure A feed at 3.2 atm and 117^{0}C. the concentration of A in the efficient stream is recorded for the various runs as follows: **(10)**

Run	1	2	3	4
C_{Ain} mol/lit	0.020	0.040	0.080	0.160
C_{Aout} mol /lit	0.074	0.060	0.044	0.029

Find the rate equation for this reaction.

Q.5 Derive the relation for internal effectiveness factor for spherical particles. **(10)**

OR

Q.5 Write notes on: **(10)**

a) CVD reactors

b) Mass transfer and reaction in packed –bed

c) Overall effectiveness factor

Q.6 **a)** What is the role of RTD in determining reactor behavior? **(05)**

b) Explain step and pulse experiment. **(05)**

OR

Q.6 Elaborate relationship between E.F and C curve. **(05)**

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