B.Tech. SEM -VI (Chemical 2014 Course (CBCS) : WINTER - 2018

SUBJECT : CHEMICAL REACTION ENGINEERING – II

Day : Thursday
Date : 15/11/2018

W-2018-2442

Time : 10.00 AM TO 01.00 PM
Max. Marks : 60

N. B. :

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labeled diagram **WHEREVER** necessary.
4) Assume suitable data, if necessary.

Q. 1 Uniform sized spherical particles UO_3 are reduced to UO_2 in a uniform environment with the following results: **(10)**

t, hr	0.180	0.347	0.453	0.567	0.733
X_B	0.45	0.68	0.80	0.95	0.98

If the reaction follows the SCM, find the controlling mechanism and a rate equation to represent this reduction.

OR

a) Illustrate about linearzing a non-linear rate equation. **(05)**

b) Derive the relation for spherical particles when chemical reaction is rate controlling. **(05)**

Q. 2 An undesirable impurity in air (A) is to be removed from air by absorption in water which contains reactant B, Chemicals A and B react in the liquid as follows: **(10)**

$A(g) + B(l) \rightarrow R(l)$

The reaction is extremely rapid 50 K = ∞
A in air entering the tower = 0.6 % (600Pa)
A in air leaving the tower = 0.1 % (100Pa)
The air flows through the tower at $\pi = 10^5 Pa.$
Data is as follows:

$Data \;\; K_{A_g} a = 0.20 \; mol/(hr.\, m^3 \; Pa)$

$K_{A_l} a = 0.5/hr$

$H_A = 15 \; (Pa.\, m^3)/\text{mol}$

$C_T = 56000 \; mol/m^3$

The flow rate per m^2 of tower cross section are :

$Fg/Acs = 1 \times 10^5 \; mol/(h.m^2)$

$Fl/Acs = 8.7 \times 10^5 \; mol/(h.m^2)$

The concentration of B in water entering the tower $C_B = 400 \; mol/m^3$.
Assume that the diffusivities of A and B in water are the same. Calculate the height of tower required for counter current operation.

P. T. O.

OR

An undesirable impurity in air (A) is to be removed from air by absorption in water which contains reactant B, Chemicals A and B react in the liquid as follows: **(10)**

$A(g) + B(l) \rightarrow R(l)$

The reaction is extremely rapid 50 K = ∞
A in air entering the tower = 0.8 % (800Pa)
A in air leaving the tower = 0.2 % (200Pa)
The air flows through the tower at $\pi = 10^5 Pa.$
Data is as follows:

$Data \quad K_{A_g} a = 0.20 \; mol/(hr.\, m^3 \; Pa)$

$K_{A_l} a = 0.5/hr$

$H_A = 15 \; (Pa.\, m^3)/\text{mol}$

$C_T = 56000 \; mol/m^3$

The flow rate per m^2 of tower cross section are :

$Fg/Acs = 2\times 10^5 \; mol/(h.m^2)$

$Fl/Acs = 8.7 \times 10^5 \; mol/(h.m^2)$

The concentration of B in water entering the tower
$C_B = 50 \; mol/m^3$. Assume that the diffusivities of A and B in water are the same. Calculate the height of tower required for counter current operation.

Q. 3 **a)** Discuss adsorption isotherm in detail. **(06)**

b) Explain catalyst deactivation with example. **(04)**

OR

a) Discuss catalyst preparation methods in detail. **(05)**

b) Show with example that promoters are helpful for catalytic reactions. **(05)**

Q. 4 The catalytic reaction $A \rightarrow 4R$ **(10)**

is run at 3.2 atm and 117^{0}C in a plug how reactor which contains 0.01 kg of catalyst and uses a feed consisting of the partially converted product of 20 liters/hr. of pure unreacted A. The results are as follows:

Run	1	2	3	4
$C_{A\ in}$ mol/lit	0.100	0.080	0.060	0.040
$C_{A\ out}$ mol/lit	0.084	0.070	0.055	0.038

Find a rate equation to represent this reaction.

OR

Catalytic $A \rightarrow 4R$ is studied in a plug flow reactor using various amounts of catalyst and 20 liters/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
Catalyst used,kg	0.020	0.040	0.080	0.1600
$C_{A\ out}$ mol/lit	0.074	0.060	0.044	0.029

Find the rate equation for this reaction.

Q. 5 Discuss the following terms: **(10)**

i) Internal effectiveness factor

ii) Overall effectiveness factor

iii) Chemical vapor diffusion reactors

OR

Derive the relation for single cylindrical pore for pore diffusion resistance combined with surface kinetics when reaction is of first order. **(10)**

Q. 6 Explain the following: **(10)**

i) The pulse experiment

ii) The step experiment

OR

The concentration readings in table represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel t, and tabulate and plot the exit age distribution E. **(10)**

Time t, min	0	5	10	15	20	25	30	35
Tracer O/P Concentration, C_{pulse} gm/liters fluid	0	3	5	5	4	2	1	0

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