Department of Chemical Engineering

Major Test in CHL221

Answer all Questions:

1. The reaction $2A \rightleftharpoons B + C$ is occurring on a catalyst. The initial rates were measured by conducting the experiments at different pressures. Test whether the data satisfies the surface chemical reaction as the rate controlling step or not.

π	$\Rightarrow$	1	1.8	2.5	4.0	7.0	10.0
$(-\gamma_A)$	$\Rightarrow$	1	1.65	2.07	2.56	3.06	3.30

(6)

2. The gas phase reaction $A \rightarrow 4R$ is conducted in a packed bed catalytic reactor. Experiments are conducted with pure A at 25 lit/hr. 3 atm pressure, 120°C with varying amounts of catalyst. From the results given below determine the rate equation. Assume the reaction to be first order. (8)

Expt. No.	-	1	2	3	4	5
Cat. Wt (Kg)	-	0.025	0.05	0.1	0.15	0.2
C_A(exit) (mol/lit)	-	0.075	0.06	0.045	0.035	0.03

3. Fe_3O_4 is reduced to metallic iron by heating with pure H_2 at 600°C and 1 atm pressure. The particle dia is 1 cm. Assuming shrinking core model with chemical reaction as rate controlling step determine the time required for 50% conversion of the solid and 50% penetration of the unreacted core.

Data:
Density of the solid reactant is 4.6gm/cc and molecular weight of Iron is 56.
Frequency factor is 1.95×10^5 cm/s
Activation energy is 24000 cal/mole. (6)

4. $CaCO_3$ decomposition is conducted in a TGA and due to power failure only two data points could be obtained. Determine the reaction rate constant from the data given.

dp = 0.74 cm, wt = 0.384 gm
Heating medium CO_2 + N_2 mixture having 5% CO_2 . T = 760°C , P = 1 atm
Eq. Partial pressure of CO_2 is given by
$\text{Log}_{10} p_e = (-8792.3/T) + 10.4022$
p_e = mmHg, T = °K
t (Sec) ⟶ 100 - 240
wt of pellet (gm) ⟶ 0.3714 – 0.3515 (6)

5. Lime stone is calcined in a vertical moving bed reactor. The residence time of the solids is 8 min. The particle size distribution in the feed and the time for complete conversion of the particles are,

$dp(\mu)$ →	100	200	400
$wt(\%)$ →	40	30	30
$t(\min)$ →	5	10	20

Determine the conversion of the feed at the exit of the reactor. (6)

6. The following date is obtained from the wicke – kallen bach apparatus.

ZnO pellet weight = 0.75 gm
Pellet Dia = 0.78 cm
Pellet Thickness = 0.74 cm
Density of pure ZnO = 5.42 gm/c.c.
Exit flow rate of gas mixture on H_2 gas side = 10.65cc/s
Exit flow rate of gas mixture on N_2 gas side = 5.2 c.c./s
Partial pressure of H_2 gas on N_2 gas side = 27 mm Hg
Partial pressure of H_2 gas on H_2 gas side = 755 mm Hg

Total pressure = 1 atm, Temperature = 25°C
$D_{H2\text{-}N2}$ = 0.76 cm^2/s

(i) Determine tortuosity factor (ii) What is the value of the tortuosity factor if equimotal counter current diffusion in the pellet is assumed.

Derive the relevant equations separately. (8)