Major Test in CHL604

Answer all questions:-

1. Determine the initial and final porosities of the $CaCO_3$ pellet and the CaO pellet formed after decomposition.
The diameter, length and weight of $CaCO_3$ pellet are 0.64 cm, 0.665 cm and 0.37 gm respectively. The true densities of $CaCO_3$ and CaO are 2.7 gm/cc and 3.3 gm/cc respectively.

2. Determine the time required for 50% conversion and 50% penetration of the reaction front in the solid. Data :
$4\ H_2 + Fe_3O_4 \longrightarrow 4H_2O+3Fe$
$\rho_{Fe_3O_4} = 4.6\,gm/cc, \quad R = 5mm$
Mol.wt of Iron is 56
$K_r = 1.93 \times 10^5 \exp(-24000/RT)$cm/sec
P = 1 atm, T = 600°C

3. From laboratory experiments, the time for complete conversion of 50μ, 100 μ and 200μ sized particles are 5, 10 and 20 minutes respectively. A feed consisting of 40% of 50μ, 30% of 100 μ and 30% of 200 μ particles are fed to a tubular reactor. If the residence of the solids is 8 min. in the reactor, determine the average conversion of the solids in the exit of the reactor.

4. The following data is obtained from Wicke-Kallenbach diffusion cell.
ZnO pellet wt = 0.75 gm
ZnO pellet dia = 0.78 cm
ZnO pellet thickness = 0.74 cm
ZnO density = 5.42 gm/c.c

Exit flow rate of gas mixture on H_2 side = 10.65 cc/sec
Exit flow rage of gas mixture on N_2 side = 5.2 cc/sec
Partial pressure of H_2 on N_2 gas side = 27 mmHg
Partial pressure of H_2 on H_2 gas side = 755 mmHg
Total Pressure = 1 atm Temperature = 25°C
$D(H_2\text{-}N_2)$ = 0.76 cm^2/sec

Determine the Tortuosity if equimolar counter current diffusion occurs in the pellet with the diffusing gases.

5. The following data was obtained for the reaction A⟶R in an experimental packed bed catalytic reactor.

Wt of catalyst (kg) ⟶	0.85	1.62	3.0	4.4	6.3	9.0	11.5	15
Feed rate of A (K.mol/hr) ⟶	10	12	15	16	18	20	20	20
X_A ⟶	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45

(i) Find the reaction rate at 42.5% conversion of the feed.
(ii) Find the amount of catalyst required to process a feed rate of 1000 K.mol/hr at 42.5% conversion level.

6.(i) Derive the equation for temperature variation with respect to concentration in the catalyst spherical solid for an exothermic reaction.
(ii) Derive an equation for catalyst activity according to concentration independent deactivation.