Q. P. Code: 27312

Duration :3 hours **Total Marks:80**

N.B. (1) Question No.1 is compulsory.
(2) Attempt any **three** questions from remaining.
(3) Assume suitable data wherever necessary with proper justification

Q.1 a) Explain the different sorts of behaviors of reacting solid particles in heterogeneous fluid-solid noncatalytic reactions. (05)

b) Write short note on Tanks in Series Model (05)

c) Differentiate between Physical adsorption and Chemical adsorption (05)

d) Draw kinetic regime for i) slow reactions, no mass transfer resistance. (05)
ii) instantaneous reaction with low C_B

Q.2 a) Derive the conversion time expression for the case of chemical reaction controlling in a gas solid noncatalytic reaction? Assume Shrinking core model with unchanging particle size. (10)

Q.2 b) In a uniform gas environment, 4 mm solid particles are 87.5 % converted to product in 5 min according to shrinking core model with chemical reaction step as rate controlling. The solids remain unchanged in size during reaction. Find the mean residence time of solids needed to achieve same mean conversion of solids in a fluidized bed reactor operating with same gas environment using 1000 kg/hr of feed consisting of equal quantities of 2 mm and 1 mm particles. Also find solid hold-up (Weight of solids) in the bed. (10)

Q.3.a) The methane is produced by catalytic reaction, at 30 atm and 340^0c, between carbon dioxide and hydrogen (14)

$CO + 4H_2 \leftrightarrow CH_4 + 2H_2O$

The rate is given as

$$-r' = \frac{kP_{CO_2}P_{H_2}^4}{[1 + k_1P_{H_2} + k_2P_{CO_2}]^5},$$

k_1=1.73 atm^{-1}, k_2=0.3 atm^{-1} and k= 7 kmol CH_4/(kg cat.h.atm^{-5})

Carbon monoxide and hydrogen are fed to a plug flow reactor in the stoichiometric proportion. The feed rate to the reactor is 100 kmol/h. Calculate the amount of catalyst needed to effect 20% conversion of CO.

Q.3b) Define the following terms(i)True density (ii) Apparent density (iii) Bulk density (06)

Q.4) Gaseous A absorbs and reacts with B in liquid according to (20)

A(g→l) +B (l) → R(l), $-r_{Al} = kC_AC_B$

In a packed bed.

a) Calculate the rate of reaction

b) Determine the location of the major resistance (gas film, liquid film and bulk liquid) and behavior in the liquid film at a point in the reactor where p_A= 100 Pa and C_B =100 mol/m^3 liquid
k= 10^8 m^3 liquid/mol.h
H_A= 1.0 Pa m^3liquid/mol

$k_{Ag}a$ =0.1 mol/(h.m^3reactor.Pa)

$k_{Al}a$ = 100 m^3liquid/(m^3reactor.h)

a=100 m^2/m^3 reactor

f_l= 0.01 m^3 liquid/m^3 reactor

$D_{Al} = D_{Bl}$= 10^{-6} m^2/h

For Ei<M_H/5, consider instantaneous reaction and E≈Ei

Q.5) The following data have been reported as a result of our effort to determine the distribution of residence time in packed bed reactor. (20)

Time *t*, min	0	5	10	15	20	25	30	35
Tracer output concentration, C_{pulse} (gm / liter fluid)	0	3	5	5	4	2	1	0

a) Use this data to generate C(t), E(t) and F(t) curve and determine the average residence time and variance in the reactor.

b) If one desires to utilize this reactor to carry out a first order isomerization reaction of type A→B and if the rate constant for the reaction is 0.307 min^{-1}. Determine the average conversion that one expects in the reactor.

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

a) Brunauer-Emmett-Teller (BET) method for determination of surface area

b) Shrinking Core model for Noncatalytic reactions

c) Fixed bed Vs Fluidized Bed reactor

****