1T00536 - T.E.(Chemical Engineering)(SEM-VI)(Choice Base Credit Grading System) (R- 19) (C Scheme) / 89242 - Chemical Reaction Engineering-II
QP CODE: 10042063 DATE: 13/12/2023

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

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

Q.1 a) Differentiate true density, apparent density and bulk density (05)

b) Explain the step input experiment for the determination of RTD of the reactor (05)

c) Draw the concentration profiles with all nomenclature for fast gas-liquid reaction with low and high concentrations of liquid reactant. (05)

d) Differentiate the shrinking core model and progressive conversion model (05)

Q.2 a) Develop conversion time relationship for spherical particles of unchanging size using the Shrinking core model for the case when the chemical reaction is controlling resistance. (10)

Q.2. b) Develop a Langmuir-Hinshelwood type of rate equation for (10)

$$A + B \rightleftarrows R + S$$

When the adsorption of B is rate controlling step.

Q3. A reactor with a number of dividing baffles is to be used to carry out the reaction (20)

$A \rightarrow R$, $-r_A = 0.05\ C_A$ mol/(l.min)

The results of a pulse tracer test are given below:

t, min	0	10	20	30	40	50	60	70
C	35	38	40	40	39	37	36	35

i) Calculate mean residence time
ii) Find the conversion expected: (a) assuming plug flow, (b) assuming the tanks-in series model and (c) assuming mixed flow.

Q.4.a) Gaseous A absorbs and reacts with B in liquid according to (14)

$A(g \rightarrow l) + B(l) \rightarrow R(l)$, $-rA_l = kC_AC_B$

in a packed bed.

(i) Calculate the rate of reaction.

(ii) Determine resistance offered by the main body of liquid at a point in the reactor where P_A = 100 Pa and C_B = 1 mol/m³ liquid.

Data : k= 10 m^3 liquid/(mol.h)

$H_A = 10^5$ (Pa.m^3 liquid)/mol

k_{Ag} a = 0.10 mol/ (h.m^3 of reactor. Pa)

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

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

a = 100 m^2/m^3 reactor

$Ɗ_{Al} = Ɗ_{Bl} = 10^{-6}$ m^2/h

For M_H< 0.02, we have an infinitely slow reaction.

b) Calculate the time required to burn to completion spherical particles of graphite (*radius 5 mm*, *bulk density 2.2 g/cc*) in an 8% oxygen stream at 900°C and 1 atm. Assume gas film resistance to be negligible. Surface reaction rate constant = k'' = 20 cm/s (06)

Q.5 An active carbon catalyses the oxidation of NO according to the following rate. (20)

$$-r' = \frac{p_{NO2}.p_{O2}}{[k + k_1 p_{NO2} + k_2 p_{NO}^2]}, \frac{mol}{gm\ catalyst.h}$$

Pressure is in atm, k_1 – 0.001352 , k_2 – 4.812, k – 0.0001619

Find the volume of a reactor for converting 50 MT /day of NO to NO2 when using an air -NO mixture containing 15 mole% of NO. The conversion of NO is 90%. The bulk specific gravity of the catalyst is 0.48, and the total pressure is 3 atm.

Q6. a) In a uniform gas environment, 4 mm solid particles are 87.5% converted to the product in 5 min according to the SCM with the chemical reaction step as rate controlling. The solids remain unchanged in size during the reaction. Find the mean residence time of solids needed to achieve the same mean conversion of solids in a fluidised bed reactor operating with the same environment as before, using a 1000 kg/h feed consisting of equal amounts of 2 mm and 1 mm particles. Also find out solid hold up in the bed. (10)

Q6.b) Discuss the reactors used for carrying out Solid Fluid Noncatalytic reactions . (10)

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