Total No. of Questions :10]

SEAT No. :

P3924

[Total No. of Pages :4

[4958]-1097
T.E. (Chemical)
CHEMICAL REACTION ENGINEERING -I
(2012 Pattern)

Time : 2½ Hours] ***[Max. Marks :70***

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6,Q.7 or Q.8, Q.9 or Q.10.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data, if necessary.***

Q1) a) The decomposition of nitrous oxide is found to proceed as follows: **[6]**

$$N_2O \rightarrow N_2 + \frac{1}{2}O_2, \; -r_{N_2O} = \frac{k_{1[N_2O]^2}}{1+k_{2[N_2O]}}$$

What is the order of this reaction with respect to N_2O, and overall?

b) Differential between single and multiple reactions with suitable example. **[4]**

OR

Q2) a) At certain temperature, the half-life period and initial concentration for a reaction are, **[6]**

$$t\,{}^{1}\!/_{2} = 420\,\text{sec}, C_{A0} = 0.405 \text{ mol/lit}$$

$$t\,{}^{1}\!/_{2} = 275\,\text{sec}, C_{A0} = 0.64 \text{ mol/lit}$$

Find the rate constant of reaction.

b) Derive and explain pseudo first-order reaction. **[4]**

P.T.O.

Q3) a) Deduce the performance equation for recycle reactor. **[6]**

b) In an isothermal batch reactor 70% of a liquid reactant is converted in 13 min. What space- time and space-velocity are needed to effect this conversion in a plug flow reactor and in a mixed flow reactor? **[4]**

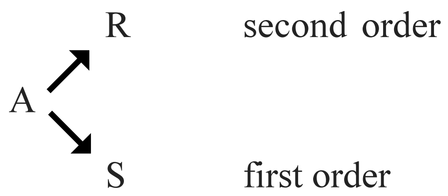
OR

Q4) A homogeneous gas reaction $A \rightarrow 3R$ has reported rate at 215°C **[10]**

$-r_A = 10^{-2} C_A^{1/2}$ [mol/lit. sec].

Find the space time needed for 80% conversion of 50% A and 50% inert feed to a Plug flow reactor operating at 215°C and 5 atm ($C_{A0} = 0.0625$ mol/lit)

Q5) a) Substance A in a liquid reacts to product R and S as follows: **[8]**



A feed ($C_{A0} = 1$, $C_{R0} = 0$, $C_{S0} = 0.3$) enters two mixed flow reactors in series, ($\tau_1 = 2.5$ min, $\tau_2 = 10$ min). Knowing the composition in the first reactor ($C_{A1} = 0.4$, $C_{R1} = 0.2$, $C_{S1} = 0.7$), find the composition leaving the second reactor.

b) Explain in detail **[8]**

i) Instantaneous yield (ψ)

ii) Overall yield (φ)

OR

Q6) a) Liquid reactant A decomposes as follows: **[12]**

$$A \nearrow R, \quad r_R = k_1 C_A^2, \quad k_1 = 0.4 m^3/\text{mol.min}$$

$$A \searrow S, \quad r_S = k_2 C_A, \quad k_2 = 2\,\text{min}^{-1}$$

A feed of aqueous A (C_{A0} = 40 mol / m^3) enters a reactor, decomposes, and a mixture of A, R, and S leaves. Find C_R, C_S, τ for $X_A = 0.9$ in;

i) Mixed flow reactor

ii) Plug flow reactor

b) Explain qualitative discussion about product distribution. **[4]**

Q7) a) Find out instantaneous fractional yield of reaction (ψ) **[4]**

$$A + B \xrightarrow{k_1} R \qquad \frac{dC_R}{dt} = 2.0 C_A^{1.2} C_B^{1.4}$$

$$A + B \xrightarrow{k_2} S \qquad \frac{dC_S}{dt} = 3.0 C_A^{0.6} C_B^{2.0}$$

b) Under the ultraviolet radiation, reactant of A of C_{AO} = 10 kmol/m^3 in a process stream (ν = 1 m^3/min) decomposes as follows. **[12]**

$$A \nearrow R \qquad r_R = 16\, C_A^{0.5} \text{ kmol / } m^3 \text{ .min}$$

$$A \rightarrow S \qquad r_S = 12\, C_A \text{ kmol / } m^3 \text{ .min}$$

$$A \searrow T \qquad r_T = C_A^2 \text{ kmol / } m^3 \text{ .min}$$

We wish to setup a reactor for a specific duty. Sketch the scheme selected, and calculate the fraction of feed transformed into desired product as well as the volume of reactor needed when product R is the desired material.

OR

Q8) a) Compare and explain Arrhenius and transition-state theories. **[4]**

b) A first order liquid phase reaction is carried out in mixed flow reactor. The concentration of reactant in feed is 3 kmol/m^3 and volumetric flow rate is 60×10^{-6} m^3/s. The density and specific heat of reaction mixture are constant at 103 kg/m^3 and 4.19×103 J/(kg.K). The volume of the reactor is 18×10^{-3} m^3. The reactor operates adiabatically. If feed enters at 298 K, what are steady state conversions and temperatures in the product stream?

Data: $\Delta H_R = -2.09\times10^8$ J/kmol

Rate = 4.48×10^6 exp(-62800/RT) C, kmol/(m^3/s) **[12]**

Q9) Write short notes: **[18]**

a) Dispersion model

b) E,F curves

c) Seggregation model

d) Micro and macro mixing of fluids

e) Early and late mixing

f) Examples of non-ideality in reactors

OR

Q10) a) Derive and discuss tank in series model. **[8]**

b) A sample of the tracer hytane at 320 K was injected as a pulse to a reactor and the effluent concentration measured as a function of time resulting in the following data: **[10]**

t (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C (g/m^3)	0	1.5	5.5	8.6	10	8.6	6	4.5	3.5	2.2	1.5	0.6	0

i) Construct figures showing C(t) and E(t) as function of time.

ii) Determine fraction of material leaving the reactor that has spent between 4 and 9 min in the reactor.

iii) Determine fraction of material that has spent 2 min or less in the reactor.

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