Sardar Beant Singh State University, Gurdaspur
Department of Chemical Engineering & Bio Technology

Assignment No.5

Subject: Chemical Reaction Engineering-I

Topic: Temperature & Pressure Effect & Non Ideal Flow

Q1. The acid-catalyzed irreversible (second order reaction) liquid-phase reaction A→ R is carried out adiabatically in a CSTR. The reaction is second order in A. The feed, which is equimolar in a solvent (which contains the catalyst) and A, enters the reactor at a total volumetric flow rate of 10 dm^3 /min with the concentration of A being 4 mol/dm^3. The entering temperature is 300 K.

(a) What CSTR reactor volume is necessary to achieve 80% conversion?

(b) What conversion can be achieved in a 1000 dm^3 CSTR? What is the new exit temperature?

(c) How would your answers to part (b) change, if the entering temperature of the feed were 280 K? ***Additional Information***: ΔH_{RX}(300K)= -3300cal/mol.^{0}C, $C_{PA}=C_{PB}$=15cal/mol.^{0}C, C_{PS}=18cal/mol.^{0}C, K(300K)=0.0005dm^3/mol.min, E=15,000cal/mol

Q2. Determine the equilibrium conversion for the elementary reaction (A↔R) between 0^0C and 100^0C. (a) Construct a plot of temperature v/s conversion (b) What restriction should be placed on the reactor operating isothermally if conversion of 75% or highest is desired?

Additional Information at 298^{0}K: ΔH_{RX}= -75300 J/mol, $C_{PA}=C_{PR}$=constant, ΔG^0=-14130J/mol

Q3. For a reversible first-order liquid-phase reaction (A↔R) with $-r_A= k_1 * C_A - k_2 * C_R$ is to be carried in plug flow reactor. For maximum permissible feed temperature of 95^0C (maximum permissible operating temperature of 95^0C) and the feed rate 1000mol/min of reactant A, what is the optimum temperature progression in a plug flow reactor? A conversion of 80% is required and feed concentration of A is C_{A0}=4 mol/l and C_{R0}=0.

Also calculate the space time and volume needed for 80% conversion of a feed of F_{A0}=1000 mol/min with C_{A0}=4 mol/l and C_{R0}=0

Additional Information: $k_1=34*10^6$ exp(-48900/RT), min^{-1} and $k_2=1.57*10^{18}$ exp(-123800/RT), min-1 and E is in J/mol

Q4. A first order liquid-phase reaction (A→R) is to be carried in mixed flow reactor. The density of reaction mixture is 1.2 g/cm^3 and specific heat is 0.9 cal/ (g. ^{0}C). The volumetric flow rate is 200 cm^3/s and reactor volume is 10 liters. If the heat of reaction is -46000cal/mol and feed temperature is 20^0C, what are possible temperatures and conversions for stable, adiabatic operation for feed concentration of 4mol/L?

Additional Information: $k=1.8*10^5$ exp(-12000/RT), sec^{-1}

Q5. Dispersed non-coalescing droplets (C_{A0} = 2 mol/liter) react (A →R, $-r_A$,= $k*C_A^2$, k = 0.5 liter/mol.min) as they pass through a contactor. Find the average concentration of A remaining in the droplets leaving the contactor if their RTD is given by the curve in Fig 1.

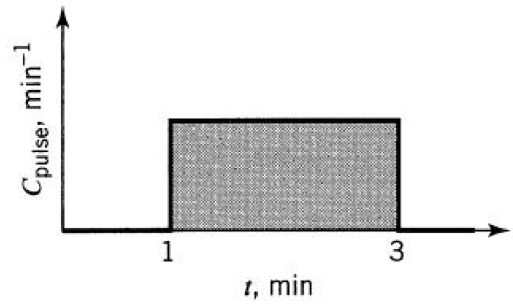

Figure 1. Concentration v/s time profile of macro fluid

Q6. The following data were obtained from a tracer test to a reactor.

t(s):	0	5	10	15	20	25	30	35
C_t(mg/dm^3):	0	0	0	5	10	5	0	0

1) Plot Ct (t).
2) Find E (t).
3) Find the fraction of material that spends between 15 and 20 seconds in the reactor.
4) Find F (t) and, the fraction of material that spends 25 seconds or less in the reactor.
5) Evaluate mean residence time.
6) Evaluate the variance.

Q7. The concentration data were observed a continuous response to a pulse input into a closed vessel. This vessel is to be used as reactor for decomposition of liquid A ($A \rightarrow R$, $-r_A = k*C_A$ & $k = 0.10 min^{-1}$)

t (min)	C_{pulse} (g/cm^3)	t (min)	C_{pulse} (g/cm^3)
0	0	7	4
1	1	8	3
2	5	9	2.2
3	8	10	1.5
4	10	12	0.6
5	8	13	0.2
6	6	14	0

Calculate the conversion of reactant v/s t determine E.