1. The elementary reversible gas phase reaction

$$2A \leftrightarrow C$$

is performed in a packed bed reactor with pressure drop. Pure A enters the reactor at 450 K with a flow rate of 8 mol/s and a concentration of $.8\ mol/dm^3$. The PBR contains 35 kg of catalyst and is surrounded by a heat exchanger with a cooling fluid at 525 K.

Data: $\alpha = .018\ \frac{1}{kg*cat}$; $\frac{Ua}{\rho} = 100\ \frac{J}{kg*cat*s*K}$; $\Delta H^o{}_{rxn} = -21000\ \frac{J}{mol*K}$ @ 450 ; $C_{P_A} = 20\ \frac{J}{mol*K}$

$C_{P_C} = 40\ \frac{J}{mol*K}$; $C_{P_{Coolant}} = 20\ \frac{J}{mol*K}$; $m_{coolant} = 90\ \frac{mol}{s}$

$k = .6$ @ $450\ K$; $E = 7500\ \frac{J}{mol*K}$; $Kc = 95@450K$

Plot the conversion, pressure ratio and temperatures as a function of catalyst weight for counter-current flow of the cooling fluid.

2. The elementary irreversible liquid-phase reaction

$$A + 2B \rightarrow 3C$$

Is performed adiabatically in a 25 L CSTR. The feed enters at 40^oC, with a volumetric flow rate of $2\ \frac{dm^3}{s}$. $C_{A_o} = .5\ \frac{kmol}{m^3}$ $\quad C_{B_o} = 2\ \frac{kmol}{m^3}$

Additional Information:

$H_A(273K) = -20\frac{kcal}{mol}$; $H_B(273K) = -15\frac{kcal}{mol}$; $H_C(273K) = -21\frac{kcal}{mol}$

$C_{P_A} = C_{P_B} = 15\ \frac{cal}{mol*K}$; $C_{P_C} = 30\ \frac{cal}{mol*K}$; $k = .01\ \frac{dm^3}{mol*s}$ @ $300K$; $E = 10{,}000\ \frac{cal}{mol}$

Determine the temperature and conversion in the reactor.

3. Consider the following gas-phase reactions taking place in a plug flow reactor. The gas stream entering the reactor is equimolar in A and B, and is at 16.4 atm and 500 K, with a volumetric flow rate of 20 $\frac{dm^3}{min}$

$$A + 2B \rightarrow C + D; \quad r_{1D} = k_{1D} C_A C_B{}^2$$

$$2D + 3A \rightarrow C + E; \; r_{2E} = k_{2E} C_A C_D$$

$$B + 2C \rightarrow D + E; \; r_{3E} = k_{3E} C_B C_c{}^2$$

$$k_{1D} = 1.4 \; \frac{dm^6}{mol^2 * min}$$
$$k_{2E} = .18 \; \frac{dm^3}{mol * min}$$
$$k_{3E} = 1.2 \; \frac{dm^6}{mol^2 * min}$$

Plot the conversion of A, the molar flow rates of each species as a function of reactor volume and determine the reactor volume required to achieve a conversion of 80%.

4. The elementary liquid phase reaction

$$A + B \leftrightarrow C$$

Takes place in a 30 dm^3 adiabatic plug flow reactor. The molar flow rate of the feed is 4 mol/s, with a composition 25% A and 75% B and a volumetric flow rate of 2.3 $\frac{dm^3}{s}$. The inlet is fed at 350K. The heat of reaction at 298K is $-20000 \; \frac{cal}{mol}$. The reaction constant is $k = \; .0005 \; \frac{1}{s}$ at 298K with $E = 12500 \; \frac{cal}{mol} \;\; Kc = 645 \; @ \; 315K$. The heat capacities are: $C_{P_A} = 15 \;\; C_{P_B} = 25 \; C_C = 35$

Determine the adiabatic equilibrium conversion and plot conversion and equilibrium conversion as a function of reactor volume. Plot the temperature with respect to reactor volume.