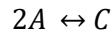


1. The elementary reversible gas phase reaction



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 $.8 \text{ mol/dm}^3$. The PBR contains 35 kg of catalyst and is surrounded by a heat exchanger with a cooling fluid at 525 K.

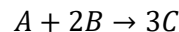
$$\text{Data: } \alpha = .018 \frac{1}{\text{kg*cat}}; \frac{Ua}{\rho} = 100 \frac{\text{J}}{\text{kg*cat*s*K}}; \Delta H^{\circ}_{rxn} = -21000 \frac{\text{J}}{\text{mol*K}} @ 450; C_{P_A} = 20 \frac{\text{J}}{\text{mol*K}}$$

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

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

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



Is performed adiabatically in a 25 L CSTR. The feed enters at 40°C , with a volumetric flow rate of $2 \frac{\text{dm}^3}{\text{s}}$. $C_{A_0} = .5 \frac{\text{kmol}}{\text{m}^3}$ $C_{B_0} = 2 \frac{\text{kmol}}{\text{m}^3}$

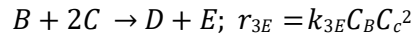
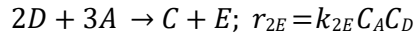
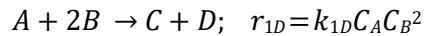
Additional Information:

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

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

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 $20 \frac{dm^3}{min}$



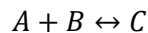
$$k_{1D} = 1.4 \frac{dm^6}{mol^2 * min}$$

$$k_{2E} = .18 \frac{dm^3}{mol * min}$$

$$k_{3E} = 1.2 \frac{dm^6}{mol^2 * min}$$

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



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

$$E = 12500 \frac{cal}{mol} \quad Kc = 645 @ 315K. \text{ The heat capacities are: } C_{p_A} = 15 \quad C_{p_B} = 25 \quad C_C = 35$$

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.