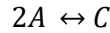


1. The elementary reversible gas phase reaction



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.

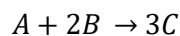
$$\text{Data: } \alpha = .018 \frac{1}{\text{kg} \cdot \text{cat} \cdot \rho}; \frac{U_a}{\rho} = 100 \frac{\text{J}}{\text{kg} \cdot \text{cat} \cdot \text{s} \cdot \text{K}}; \Delta H_{\text{rxn}}^\circ = -21000 \frac{\text{J}}{\text{mol} \cdot \text{K}}; C_{pA} = 20 \frac{\text{J}}{\text{mol} \cdot \text{K}}; C_{pC} = 40 \frac{\text{J}}{\text{mol} \cdot \text{K}};$$

$$C_{p_{\text{coolant}}} = 20 \frac{\text{J}}{\text{mol} \cdot \text{K}}; m_{\text{coolant}} = 90 \frac{\text{mol}}{\text{s}}$$

$$k = 0.6 @ 450 \text{ K}; E = 7500 \frac{\text{J}}{\text{mol} \cdot \text{K}}; K_c = 95 @ 450 \text{ K}$$

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  $40^\circ\text{C}$ , with volumetric flow rate of  $2 \frac{\text{dm}^3}{\text{s}}$  with

$$C_{A0} = 0.5 \frac{\text{kmol}}{\text{m}^3} \text{ and } C_{B0} = 2.0 \frac{\text{kmol}}{\text{m}^3}$$

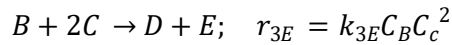
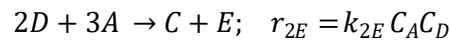
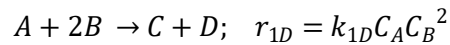
Additional information:

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

$$C_{pA} = C_{pB} = 15 \frac{\text{cal}}{\text{mol} \cdot \text{K}}; C_{pC} = 30 \frac{\text{cal}}{\text{mol} \cdot \text{K}}; k = .01 \frac{\text{dm}^3}{\text{mol} \cdot \text{s}} @ 300 \text{ K}; E = 10,000 \frac{\text{cal}}{\text{mol}}$$

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 -20,000 cal/mol. The reaction constant is  $k = .0005 \text{ 1/s}$  at 298 K with  $E = 12500 \frac{cal}{mol}$   $K_c = 645 @ 315 K$ . The heat capacities are:  $C_{pA} = 15$ ,  $C_{pB} = 25$ ,  $C_{pC} = 35$ .

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.