AFCoKaRE Practice Problem 19.2

Purpose: This problem will allow you to practice the quantitative analysis of a batch reactor.

Problem Statement: An adiabatic batch reactor with a volume of 15 ft^3 is initially charged with a 650 ºR solution containing A at a concentration of 0.125 lbmol ft^{-3} and B at a concentration of 3 lbmol ft^{-3}. Reaction (1) occurs with a rate given by equation (2) wherein k_0 = 1.2 × 10^{14} ft^3 $lbmol^{-1}$ min^{-1}, E/R = 23000 ºR, K_0 = 6.5 × 10^{-13} ft^3 $lbmol^{-1}$ and $\Delta H/R$ = -20000 ºR. The heat of reaction (1) is constant and equal to -170,000 BTU $lbmol^{-1}$. The heat capacity of the solution may be taken to equal 135 BTU $ºR^{-1}$ ft^{-3}, independent of temperature. The density of the liquid may be assumed to be constant. Calculate the concentration of Z and the temperature after 2 h of operation.

$$A + B \rightleftarrows Z \tag{1}$$

$$r_1 = k_0 \exp\left\{\frac{-E}{RT}\right\} C_A C_B \left(1 - \frac{C_Z}{K_0 \exp\left\{\frac{-\Delta H}{RT}\right\} C_A C_B}\right) \tag{2}$$