Problem 2: solution

By combining the molar balance for the key component (A) and the rate law in terms of the conversion, we obtain the first differential equation:

$$\frac{dt}{d\xi_A} = \frac{\frac{N_{t0}RT}{p}\left(1+\varepsilon\xi_A\right)}{N_{A0}\left(1-\xi_A\right)^2 k(T)}$$

The second differential equation is obtained from the steady state enthalpy (energy) balance assuming adiabatic conditions:

$$\frac{dT}{d\xi_A} = \frac{N_{A0}\left(-\Delta H(T)\right)}{\sum_j^S N_{j0}Cp_j + N_{A0}\Delta Cp\xi_A}$$

a) $Cp_j = constant \equiv Cp_{mj}$

Reaction time = 2.254 h

Final temperature = 787.6 K

b) $Cp_j = g_j(T)$

Reaction time = 2.250 h.

Final temperature = 786.1 K