AFCoKaRE Practice Problem 23.1

Purpose: This problem will allow you to practice the quantitative analysis of a transient CSTR.

Problem Statement: A 150 ºC solution containing 2 mol L^{-1} of A is being to a 500 L CSTR at a rate of 250 L h^{-1}. A jacket surrounding the CSTR contains a fluid at a constant temperature of 180 ºC. The contact area between the CSTR contents and the jacket is 2 m^2 and the overall heat transfer coefficient is equal to 500 kcal m^{-2} h^{-1} K^{-1}. Within the reactor reaction (1) occurs at a rate given by equation (2). The pre-exponential factor for the rate coefficient in equation (2) is 1.14×10^9 L mol^{-1} h^{-1} and the activation energy is 16.2 kcal mol^{-1}. The reacting solution has a constant density and a constant heat capacity of 1.17 cal mL^{-1} K^{-1}. The heat of reaction is 18.2 kcal mol^{-1} and is independent of temperature. At steady state at these conditions, the outlet temperature is 167 ºC and the conversion of A is 86%. Suppose that the temperature of the fluid in the jacket suddenly dropped to 160 ºC. Calculate the temperature and conversion versus time until a new steady state is attained.

$$A \rightarrow B \tag{1}$$

$$r_1 = k_1 C_A^2 \tag{2}$$