AFCoKaRE Practice Problem 26.2 Solution

Purpose: This problem will allow you to practice the quantitative analysis of a steady state PFR.

Problem Statement: The heat of reaction (1) is 44.8 kJ mol^{-1}, and it is irreversible. The rate expression is equation (2) where the pre-exponential factor is 7.22 x 10^6 mol atm^{-2} cm^{-3} s^{-1} and the activation energy is 84.1 kJ mol^{-1}. A 10 foot long tubular reactor with a diameter of 1 inch is heated by a fluid at 200 ºC that is in contact with the outside of the tube wall. The overall heat transfer coefficient is 7.48 x 10^4 J h^{-1} ft^{-2} K^{-1}. Pressure drop through the reactor is negligible. If a gas phase mixture of 60% A and 40% B enters the reactor at 282 L min^{-1}, 2.5 atm and 175 ºC and if the heat capacities of A, B and Z are equal to 18.0, 12.25 and 21.2 cal mol^{-1} K^{-1}, what steady state outlet temperature and conversion of B will result?

$$A + B \rightarrow Z \quad (1)$$

$$r_1 = k_1 P_A P_B \quad (2)$$