**Practice Problem 28.1**

*Purpose*: This problem will allow you to practice both the qualitative and quantitative analysis PFRs and CSTRs.

*Problem Statement*: Consider the irreversible, liquid phase reaction $A \rightarrow Z$, equation (1) which occurs at constant density. Reactant A is supplied at a rate of 4 L min$^{-1}$ in a concentration of 2 mol L$^{-1}$ and at a temperature of 43 °C. The heat capacity of the fluid is 0.87 cal mL$^{-1}$ K$^{-1}$ and the heat of reaction is -27.2 kcal mol$^{-1}$. The reaction is second order in the concentration of A, equation (2), and the rate coefficient obeys Arrhenius’ law with a pre-exponential factor of $6.37 \times 10^9$ L mol$^{-1}$ min$^{-1}$ and an activation energy of 14.3 kcal mol$^{-1}$. (a) Using a qualitative analysis, predict whether the required reactor volume of an adiabatic PFR or of an adiabatic CSTR would be larger assuming the conversion to be 50%, then perform a quantitative analysis to check your prediction. (b) Repeat part (a) assuming the conversion to be 95%.

$$A \rightarrow Z \quad \text{(1)}$$

$$r = kC_A^2 \quad \text{(2)}$$