AFCoKaRE Practice Problem 32.1

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

Problem Statement: Acid A is to be neutralized using base B by slowly adding a 2 M solution of the base to a 10 M solution of the acid. The neutralization reaction is irreversible with a heat of reaction equal to -44 kcal mol^{-1}. The reaction is first order in both acid and base with a pre-exponential factor of 8.11 x 10^{12} L mol^{-1} s^{-1} and an activation energy of 17.7 kcal mol^{-1}. A jacketed, perfectly mixed, 25 L batch reactor will be charged with 4 L of the 10 M solution of A at 20 ºC, while cooling water at 20 ºC flows at 0.1 kg min^{-1} to the perfectly mixed, 0.5 L jacket. The heat transfer area is 0.6 ft^2 and the heat transfer coefficient is 1.13 x 10^4 cal ft^{-2} h^{-1} K^{-1}. The cooling water and the solutions of A and B may be taken to have a constant density of 1 g cm^{-3} and a constant heat capacity of 1 cal g^{-1} K^{-1}. The pressure in the reactor will be constant and equal to 1 atm. Plot the acid concentration and the reactor temperature as a function of time during which the base solution at 20 ºC is being added at a rate of 1.0 L min^{-1}.