

A First Course on Kinetics and Reaction Engineering

Example 24.2

Problem Purpose

This problem illustrates the effect of the start-up procedure upon the final steady state of a CSTR that can display multiple steady states.

Problem Statement

Example 2 from Unit 23 described a start-up procedure for the same reactor/reaction combination that was considered in Example 1 of this Unit. The start up procedure involved filling the reactor with pure solvent at 190 °C and then admitting the feed. On the basis of Example 1 of this Unit, we now know that this system can display multiple steady states. Determine what would happen if pure solvent in the reactor was at 180 °C when the feed was admitted.

Problem Analysis

The only difference between this problem and Example 2 from Unit 23 is that the initial temperature of the fluid is 180 °C instead of 190 °C. Thus, it is solved in the exact same manner as that example, and the same computer code can be used as long as that one temperature is changed.

Problem Solution

Since the solution using the 180 °C initial temperature is essentially the same as that presented in Unit 23, the description of the solution procedure won't be repeated here. Instead, we will move directly to the results. Figures 1 and 2 below show the conversion of A during the first 3000 s of the startup procedure. Comparing those results to the results from Example 2 of Unit 23 shows that a mere 10 °C difference in the initial temperature of the fluid in the reactor causes the system to attain a different steady state. The lower initial temperature led to the steady state with a conversion of 0.03 %, while the higher initial temperature led to the steady state with a conversion of 97.6%. (These steady states were identified in Example 1 of this Unit.)

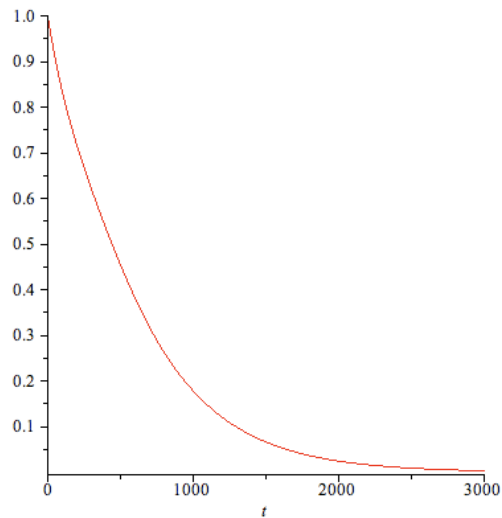


Figure 1. Initial temperature of 180 °C

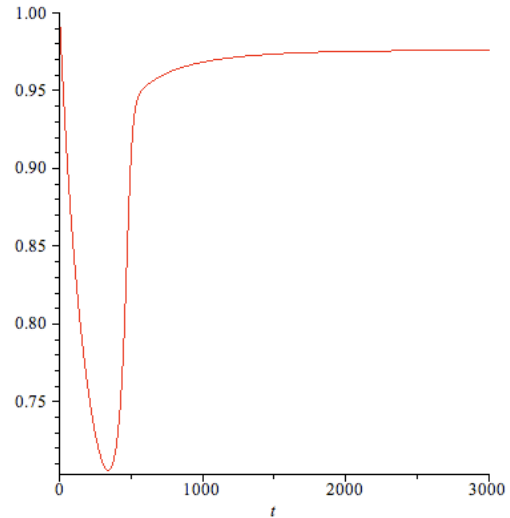


Figure 2 Initial temperature of 190 °C

Calculation Details Using MATLAB

The modified MATLAB template file, Example_23_2 provided with Example 2 of Unit 23 can be used to solve this problem. It is only necessary to change the initial outlet temperature from 190 °C to 180 °C.