A First Course on Kinetics and Reaction Engineering

Activity 33.1

Problem Purpose

This problem will allow you to practice the analysis of an axially dispersed tubular reactor. It will also demonstrate how increasing the dispersion number causes the reactor to become less like a PFR and more like a CSTR.

Problem Statement

Suppose liquid phase reaction (1) is second order in the concentration of A. The reaction proceeds isothermally with a rate coefficient equal to 0.05 $dm^3\ mol^{-1}\ min^{-1}$. The liquid density is constant. The feed to the process is taken from a tank containing A at a concentration of 1 M and enters the reactor with a superficial velocity of 6.0 dm min^{-1}. Plot the concentration of A versus axial position within the reactor for axial dispersion coefficients of 0.1, 1, 10, 100 and 1000 $dm^2\ min^{-1}$.

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

Worksheet

1. Read through the problem statement. Each time you encounter a quantity, write it down and equate it to the appropriate variable. When you have completed doing so, if there are any additional constant quantities that you know will be needed and that can be calculated from the values you found, write the equations needed for doing so.

2. Generate the mole balance design equations needed to model the axially-dispersed tubular reactor by simplification of the general design equations found in Unit 33 or on the AFCoKaRE Exam Handout.

3. Identify the independent and dependent variables, if appropriate, and the unknown quantities to be found by solving the equations.

4. Assuming that the equations will be solved numerically, specify the information that must be provided and show how to calculate any unknown values.

5. Identify what variables will become known upon solving the design equations and show how those variables can be used to answer the questions that were asked in the problem.

6. Write a half-page memo that describes how the performance of an axially dispersed tubular reactor varies as the dispersion number changes. Refer to the plot shown in class and be sure to state what the plot would look like (and explain why) if the axial dispersion number was infinite. If you know of another reactor system where the performance can be varied in a similar manner, be sure to mention it.