A First Course on Kinetics and Reaction Engineering

Unit 13. Lesson Plan

Before Class

- Provide the redacted slides and the handout for Activity 13.1 to the students and tell them to bring them to class
- The activity will involve problem solving, if you want the students to perform the calculations (as opposed to just setting them up), make arrangements so the students have access to whatever software they need/use for linear least squares fitting

During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 13 (5 to 10 minutes)
  - Slides 3 and 4
- Ask whether the students have any questions from their pre-class preparation and answer them
  - Slide 5
- Learning Activity 13.1a (~20 minutes)
  - Slide 6: Tell the students to look at the handout, then go over each of the points on the slide. On the last part, note that these experiments used as little reactant as possible and a high concentration of products. If the reaction is reversible, then the reaction should take place in the reverse direction. Looking at the results, there is no change in the concentration of Y to within experimental noise, so the reaction appears to be irreversible. Note, because the apparent conversion for these points is essentially at the noise level, advise the students not to use them in their later data analysis.
  - Slide 7: Go over the points on the slide. For the first bullet item, emphasize that with a CSTR you set the inlet flow rate, but the reaction occurs at the outlet composition. Therefore if you are trying to say double a concentration holding others constant by changing the inlet composition, you need to run the reactor at low conversion. You can also tell them that these data were generated using the CSTR simulator from Unit 12.
  - Slide 8: Go over all the points on the slide, then divide the class into fifths. Tell all the students in the first fifth, working alone or in groups whichever you prefer, to test the suggested rate expression using the 305 K data; tell the students in the second fifth to do so using the 320 K data, and so on.
    - Tell them to get started, then circulate among them as they work, answer questions, make suggestions, correct an misconceptions you notice, etc.
  - Slides 9 and 10: Select a group that appears to have completed the task correctly explain how they did so, then use slide 9 to reinforce the process, then use slide 10 to show them what they should have found. Note that MATLAB code for doing the fitting will be

provided after class along with an Excel spreadsheet showing the numbering of the data used in that code and the results in the table here
- Slide 11: Note that in most textbook and homework problems, they usually would be given a set of data for experiments at a single temperature. However in a real-world problem, they would generate and use data at several temperatures. The rest of this activity shows how they might proceed in that situation.

• Learning Activity 13.1b (~20 minutes)
  - Slide 12: Go over all of the points on the slide then let them get started. (Everyone will now be working with the full data set, whether in groups or individually, not just the data for a single temperature as they did in part a). Again circulate among them answering questions, etc.
  - Slide 13: After they have worked for a while, use this slide to show them how this equation can be linearized to a form suitable for traditional linear least squares
  - Slide 14: present the results and discuss the relative merits of the two approaches
  - Slide 15: show them what's next and how it relates to what's already been covered

After Class

• Provide the complete slides to the students.
• Provide the results handout from activity 13.1 and the MATLAB code to the students.

Variations

Alternative Activity 12.1 has the students generate a set of data like the one used in this activity. You could replace one of the activities in Unit 12 with Alternative Activity 12.1. Then for this unit, they can use the data that they generated. This would give them a (simulated) feel of the whole process of generating multiple temperature data and fitting for both the composition dependence and the temperature dependence.