A First Course on Kinetics and Reaction Engineering

Unit 26. Lesson Plan

Before Class

- Provide the redacted slides to the students and tell them to bring a printed copy of the slides to class

During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 26 (5 to 10 minutes)
  - Slide 3: go over the key concepts on the slides
    - Note that these equations can also be written using the reaction volume as the independent variable
    - Note that the sensible heat term might need to be expressed in terms of an overall heat capacity instead of species' molar heat capacities
  - Slide 4: go over the key concepts on the slides
    - Note that before starting, they need to identify the type of problem; this approach applies to reaction engineering of a steady state PFR
    - Note that some people find a schematic to be helpful
    - Note that a basis can only be assumed if none of the quantities in the first step is extensive
    - Remind them that the preferred form has one derivative on the left of the equals and a function of the independent and dependent variables on the right
    - Note that the equations for step 4.3 will be used to write code that evaluates the derivatives when the ODEs are written in the preferred form
    - Note that this strategy may need to be adapted and point out that Example 26.2 shows one such situation
- Ask whether the students have any questions from their pre-class preparation and answer them
  - Slide 5
- Learning Activity 26.1 (~30 - 40 minutes)
  - Slide 6: Display the slide and read through or summarize the problem. Tell the students that they will be setting up the solution on the redacted slides they brought to class. If they forgot to print the slides and bring them, they can just use a sheet of paper. Optionally let them work in groups of two or three. Tell them that they will be following the general approach to solving PFR design equations that was presented in the reading.
  - Slides 7: Read through the instructions and then tell them to write their answers on the sheet they brought to class; give them a few minutes to do so
  - Slide 8: Go over the answers
    - On the first question, point out that it is easy now to determine that this is a steady state PFR and to pick the correct general design equations because this unit is all about PFRs.

Remind them that on an exam, the reactor could batch, CSTR or PFR and they'd need to know which design equations to use. Similarly, it's easy to know this is a reaction engineering problem because that's the section of the course we're in, but on a comprehensive exam, they need to be able to discriminate between a kinetics problem and a reaction engineering problem.

- Slide 9: Read through the instructions and then tell them to write their answers on the sheet they brought to class; give them a few minutes to do so
- Slide 10: Go over the answers. Make sure they understand why a basis can be chosen.
- Slide 11: Tell them that some people find a schematic useful. Note that some of the values shown on the schematic were calculated using the equations on the preceding slide.
- Slide 12: Read through the instructions and then tell them to write their answers on the sheet they brought to class; give them a few minutes to do so
- Slide 13: Go over the answers.
- Slide 14: Read through the instructions and then tell them to write their answers on the sheet they brought to class; give them a few minutes to do so.
- Slide 15: When most appear to be finished, or stuck, ask them what they found for initial and final values and then ask if anyone had trouble writing the equations needed to evaluate the functions. (If no one indicates any trouble, ask them what value of D should be used)
- Slide 16: Point out that the axial distance, z, and the reactor diameter, always appear in the equations in as $\pi D^2/4\ dz$, and as such, without further information, it is impossible to find values for both D and z. Point out that if the reactor was not adiabatic, or if there was a pressure drop, this would not be true and values for both could be found. Note that here, however, it will be necessary to combine those variables; go over the last points then give them a few minutes to write the new design equations and then the equations needed to evaluate those design equations. Give them a few minutes to do so
- Slide 17: Go over the answers.
- Slide 18: Read through the instructions and then tell them to write their answers on the sheet they brought to class; give them a few minutes to do so.
- Slide 19: Go over the answers.
- Slide 20: Summarize what they just did and tell them to make sure they understand the process and how to follow it, as it will help them on homework and exams

• Optional Learning Activity 26.2 (~remainder of class)
  - Put up another problem statement and tell them to follow the process on their own. Answer any questions as they arise. Tell them to complete the problem as homework.
• Slide 21: Put the material covered in this class into the overall context of the course.

After Class

- Provide the complete slides the write-up of the solution to the first problem and the code used to solve the first problem
  - Optionally, tell them to solve the equations numerically as homework
- If a second problem was used, give them the due date