

A First Course on Kinetics and Reaction Engineering

Unit 23. Lesson Plan

Before Class

- Provide the redacted slides to the students and tell them to bring them to class

During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 23 (5 to 10 minutes)
 - Slides 3 and 4: go over the key concepts on the slides
- Ask whether the students have any questions from their pre-class preparation and answer them
 - Slide 5
- Learning Activity 23.1 (~20 minutes) The objective of this activity is to help students understand which quantities are changing during a transient, to help them understand the difference between inlet and initial values and to show them a situation where they will need to either eliminate a dependent variable or add an ODE in order to solve the design equations. Have them work individually on this activity.
 - Slide 6: Show them the slide and tell them to write a sentence or phrase that describes what will be observed at points A, B and C. Give them ~5 minutes to do so, then call on volunteers to give their answers. After each answer ask if anyone disagrees and allow discussion until the proper conclusion is reached for each point
 - Slide 7: Summarize the qualitative response using this slide. Then tell them to write a mole balance on the red coloring. Tell them they also must specify the initial value needed in order to solve the equation.
 - Slide 8: Point out that even though there is no reaction, they can use the transient mole balance design equation. Give them ~5 minutes to write their answer. Ask for a volunteer to explain which terms can be dropped and why. Ask if anyone disagrees and allow discussion until the proper conclusion is reached. Ask for a volunteer to describe which variable needs to have its initial value specified. Ask if anyone disagrees and allow discussion until the proper conclusion is reached.
 - Slide 9: Summarize using this slide.
 - Slide 10: Note that the problem is the same except the fluid is a gas, and consequently it fills the entire reactor. Ask whether the qualitative behavior will be any different from the liquid, and allow for discussion, if needed.
 - Slide 11: Note that qualitatively things are the same, then ask whether there will be any differences in the mole balance. Let them discuss, then take a vote whether they feel it will be the same or different.

- Slide 12: Use this slide to show them how the equations will be different. Then note that they will consequently end up with one more dependent variable than equation and won't be able to solve in that case.
- Slide 13: Use this slide to illustrate how to either eliminate a dependent variable or add an ODE so the number of equations equals the number of dependent variables and the equations can be solved.
- Learning Activity 23.2 (~20 minutes) This is a problem solving activity; you can have them work alone, in groups, in groups at the blackboard, etc. Here I'll assume they work in small groups
 - Slide 14: Show them the problem and give them time to read through it.
 - Slide 15: Then show them this slide, which presents the steady state results that prevail prior to the change in flow rate. Ask if they all understand why the inlet molar flow rates each doubled, as well and explain if necessary, then tell them to set the problem up. Circulate among them, observing, answering questions, etc. as they work. Give them about 15 minutes.
 - Slide 16: Tell them that to solve the problem they will need mole balances and an energy balance and walk them through the simplifications shown on the slide.
 - Slide 17: Then tell them that if they are going to solve numerically, they need initial values, code to evaluate the ODEs and a final value, and quickly walk them through those items
 - Slide 18: Show them the result, and note that it is common for a transient to overshoot before settling to a new steady state.
- Slide 19: Put the material covered in this class into the overall context of the course.

After Class

- Provide the complete slides and MATLAB files (or equivalent for the math software your students use) to the students.