

# A First Course on Kinetics and Reaction Engineering

## Unit 32. Lesson Plan

### Before Class

- Provide the redacted slides to the students
- Tell the students to print the worksheet for Activity 32.1 and bring it to class
- Tell the students to print the equations from Unit 17 or, preferably, the AFCoKaRE Exam Handout and bring it to class

### During Class

- Introduce today's topic and where it fits in the course
  - Slides 1 and 2
- Review of Unit 32 (5 minutes)
  - Slides 3
    - emphasize that when species are boiling off, it is usually assumed that the liquid and vapor phases are continually in equilibrium
    - emphasize that in past units the mole balances were written on the reaction volume, but so far it really didn't matter because most systems considered were single phase or if there was a headspace, we it was ignored. Now, if a liquid phase species evaporates into the vapor phase, even though it remains in the reactor, the reactor is semi-batch
  - Slide 4
    - Point out that these are the batch design equations except for the addition of the highlighted terms
  - Slide 5: ask whether the students have any questions from their pre-class preparation and answer them
- Learning Activity 32.1 (~40 minutes)
  - Slide 6: Read through the problem statement.
  - Slides 7 and 8: Read through the items, then give them a few minutes to predict time required and selectivity. Call on a few students to share their predictions; correct any flawed reasoning and lead the discussion to the predictions on slide 8, at which time that slide can be shown.
  - Slides 9, 10 and 11: Give them a few minutes to list the unknowns, then start reading out numbers from the problem statement and have students tell you what variable each quantity should be assigned to. Each time, ask whether anyone had a different response and discuss/resolve the issue. When all the quantities have been identified, display slide 10 and ask them if they can think of any other quantities that they will need when solving the problem that they could calculate at this point. Go over any responses, then show slide 11. Before giving them time to generate the design equations, ask them what design equations will be needed. Lead the discussion to the

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realization that only mole balances will be needed, then give them time to generate the mole balances.

- Slides 12, 13 and 14: Before showing the slide, have four students go to the board and have each one write one of the mole balances on the board. Have the class correct any mistakes, discussing why it needs correction. When done, show the slide. Then point out that there may be two stages of operation. Ask whether there is more than one stage in the process and lead the discussion to the point that the first stage is the time while B is being added and the second follows immediately and is the time while reaction continues in batch mode, then show slide 13. Ask whether the same equations can be used for both stages. After someone answers, show slide 14
- Slides 15, 16, 17 and 18: Show slide 15 and ask them what kind of equations are the design equations, what are the independent and dependent variables and what quantities will be found by solving them, then show slide 16 where independent and dependent variables are explicitly identified and ask them what they will need to provide in order to solve the equations numerically. Give them time to work, then call on students for answers. After they have identified initial conditions, final conditions and code to evaluate functions, show slide 17 and lead discussion through slide 18. Give them time to work on last bullet item
- Slide 19: Ask what variables they obtain by solving the design equations, then ask how they use them to answer the question, then show slide 19 and answer any questions
- Summary
  - Slide 20: Put the material covered in this class into the overall context of the course.

### **After Class**

- Make the complete slides and the MATLAB code for Activity 32.1 available to the students