A First Course on Kinetics and Reaction Engineering

Unit 5. Lesson Plan

Before Class

- Provide the redacted slides to the students and tell them to bring them to class
- One of the activities for this class will require the students to use Excel (and perhaps PowerPoint) in class; make appropriate arrangements (i. e. tell them to bring laptops to class) and provide them a way to obtain the Excel spreadsheet handout before or in class
- Get several ping pong balls to use in class

During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 5 (5 to 10 minutes)
  - Slide 3: Go through the info on the slide, when mentioning the term for reversible reactions, note that it can be used with any rate expression that does not go to zero at equilibrium, but in order to be used, it must fit the data well
  - Slide 4: Main points to emphasize are rate expressions at the top (because used in mechanistic analysis in following units) and that it's usually OK to take pre-exponentials as constants (i. e. assume Arrhenius behavior)
- Ask whether the students have any questions from their pre-class preparation and answer them
  - Slide 5
- Learning Activity (~20 minutes)
  - Slide 6 (as groups or individually): The Excel spreadsheet provided as a handout has the plots all set up; all they need to do is to enter the expressions to calculate the concentrations and rates. Tell them to use the graphs to explain the issue with the uncorrected power law model
    - Give them some time to work; the presentations can simply be sketched out; optionally let a few of them give their presentations
  - Slides 7 through 9
    - This is one possible three slide presentation
    - Slide 7 be sure to note that equilibrium conversion is 0.8 and show that the rate does not equal zero. If they used this in a reactor design calculation, it would allow them to design a reactor that achieved 100% conversion
    - Slide 8 go through how the added term has no effect (equal to 1) far from equilibrium, but goes to zero as equilibrium is approached, exponent a affects how abruptly it goes from 1 to zero
    - Slide 9 - if they filled out the handout spreadsheet, they will have discovered the issues shown here in the data table. Note that in numerical solutions, the solution of the equations will sometime require evaluation of the rate at points beyond equilibrium

and these will likely fail if the rate becomes indefinite or if it goes to zero at equilibrium, but then increases beyond equilibrium

- Learning Activity (20 minutes)
  - Slide 10
    - Assemble the students into one or more groups sitting in a circle and go through the instructions; emphasize safety and that they should roll the balls; use the same time for each session (two balls, three balls and four balls)
  - Slide 11: Discuss as a class the questions on the slide; things that may come out include: 2-D vs. 3-D, paths are guided, not random, density of balls is low, etc.
  - Slide 12: Make the key point that most elementary reactions are bimolecular, a small number are termolecular, none involve 4 or more reactants; if time allows, open the discussion of unimolecular reactions
- Slide 13: show them what's next and how it relates to what's already been covered

After Class

- Provide the complete slides and spreadsheet to the students.