

ChE 200
Material Balances
Summer 2008

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Class time: M - F 2:10 - 4:00
Classroom Stocker 107 Weeks 1-4 Stocker 187 1st day + Week 5
office hours: M-F 12:00 - 2:00 (except T).
I will see you almost any other time I'm in. If you can't come at the posted time or reach me, call or e-mail me to set up a time.
required text: Felder, R.M. and R.W. Rousseau. Elementary Principles of Chemical Processes. 3rd ed. John Wiley and Sons, 2005. (We will cover Chapters 1-6.) (The same text is used for ChE 201.)
Other interesting or useful websites are
<http://www4.ncsu.edu/unity/lockers/users/f/felder/public/EPCP.html>
<http://webche.ent.ohiou.edu/matlab/matlab.html>

It is particularly suggested that you read "An Engineering Student Survival Guide" and the "Memo to Students Who Have Been Disappointed with Their Test Grades" that you will find linked under "Handouts for students" at the first web address.

Grade Breakdown

Exams (3?)	65%
Project	15%
Homework / In-Class / Quizzes	20%

Grading Scale

93.33 - 100	A	73.33 - 76.67	C
90 - 93.33	A-	70 - 73.33	C-
86.67 - 90	B+	66.67 - 70	D+
83.33 - 86.67	B	63.33 - 66.67	D
80 - 83.33	B-	60 - 63.33	D-
76.67 - 80	C+	0 - 60	F

I do not curve or scale individual exams and assignments. Appropriate scaling of the final course averages will be done at my discretion. Your grade will never be lower than that given on the above scale. Feel free to contact or visit me to determine your standing in the class at any time.

A grade of C or better is required in this course to continue on to ChE 201.

Course Objective

To develop your ability to set up and solve mass balance problems for both non-reactive and reactive processes.

This offering of the course will closely follow the format and objectives of the Winter offering, as those are the students you will “merge” with next year. It is important that your background and experiences match theirs.

Assignment Summary

Reading Assignments

Reading the material before it is covered in class increases your understanding. They should be completed promptly. **Students are responsible for the material in the reading assignments even if the material is not specifically covered in lecture.**

Homework

The material in this course can only be learned by working problems. Homework problems from the text will be assigned almost daily. It is important to work these problems to keep up with the material. Some of these will be graded. These problems might be supplemented with problems from me.

Quizzes

I believe that it is important to evaluate your performance frequently to catch problems as early as possible. To this end quizzes will be given often. Something on the order every other day can be expected. These will often be short answer, multiple choice, or simple problems. Typically they will be closed book and notes. Quizzes won't always be previously announced. They can be excused with an acceptable reason (as defined by me.)

Exams

Three exams are forecasted. Exams will be announced several days in advance. The Final Exam is a regular exam and will be given the last day of class. It is comprehensive, but as you will see, the whole course is essentially comprehensive. Exams may or may not be equally weighted.

Projects

As a Department we have decided to take a more consistent organized approach to the use of computers by committing ourselves to the use of MATLAB throughout your undergraduate career. Two projects will be completed. The Department of Chemical Engineering has created several tutorials covering topics commonly covered in the curriculum. They are located on the Department's homepage (<http://webche.ent.ohiou.edu/WEB-che101/index.html/>). You are free to print them.

Other notes about the course

I will use e-mail to communicate with you. You are responsible for this information. I expect that you will check your e-mail every day.

A project required to be worked in Matlab will be completed. More on this later.

Course Coverage

We will cover the first six chapters of the textbook.

- Chapter 1 You should read this chapter. While there is no material from this chapter to be tested I think it is an excellent presentation of what issues a chemical engineer could expect to encounter.
- Chapter 2 You should read, and are responsible for the material in this chapter. We will not lecture straight through this chapter, but will deal with the material as it arises. Much of the material will be review or refresher from earlier in your curriculum. Be sure you understand the material covering units and dimensions, scientific notation, significant figures, and linear regression. Some homework will be assigned from this chapter.
- Chapter 3 We will cover some of this material, and will do so quickly. We will then frequently refer to this chapter throughout the course.
- Chapter 4 This chapter is the heart of the course, and to a certain extent the heart of the profession. We will spend the bulk of our time in this chapter. We will work lots of problems from this chapter.
- Chapter 5 You will have seen much of this material in chemistry. Our approach will be how this applies to solving mass balance problems.
- Chapter 6 We will hit this chapter quickly. As with Chapter 5, our approach will be how this applies to solving mass balance problems. There will possibly be sections that we will skip.

'Secrets for Success'

- Read all reading assignments. [Read the text parts prior to the relevant lectures.]
- Attend the lectures.
- Ask questions.
- Know and be able to perform the "Instructional Objectives."
- Be an active participant in class. ['Recitation' is not a spectator sport!]
- Do the homework!! [Start early. Genuinely attempt all problems. Ask questions based on attempted/outlined problem solutions.]
- Re-do (not just review) the homework!!! [Make sure that you can both get the correct answer and understand how you got it.]
- Learn the "procedure." We are trying to learn the methodology not the just the answer.

Initial Assignments

Reading Assignment #1

Chapters 1, 2, 3, and 4 (through Section 4.3) Read by the end of this week.

Homework #1 Due at 12:10, Thursday 6/26

Chapter 3 3, 5, 16 (plus part c: What is the mole percent of methanol in the mixture?), 21, 49

Chapter 4 3, 4, 5a

Prerequisites - Mastery

All students entering ChE 200 must be able to:

Mathematics

- Find the equation of a line given two points.
- Integrate a polynomial expression.
- Rearrange an algebraic equation so it is explicit in one variable and solve.
- Solve equations by trial-and-error or successive approximation when appropriate.
- Calculate the perimeter and area of triangles, circles, and rectangles.
- Calculate the surface area and volume of spheres, cylinders, and rectangular boxes.
- Perform linear interpolation between values in a table.
- Represent a function, its integral, and its derivative on a graph.
- Correctly manipulate expressions containing logarithms, exponentials, and powers.

English

- Read, write, and speak in Standard English.
- Proofread written work.

Physics

- Define variables to represent real quantities.
- Define equations to represent real processes and relationships between quantities.
- Present problem solutions logically, with a diagram and with appropriate equations.
- Check that answers are of reasonable magnitude and that significant figures are reasonable.
- Associate appropriate units with all quantities.
- Convert between different unit systems, given conversion factors.

Chemistry

- Define variables to represent real quantities.
- Define equations to represent real processes and relationships between quantities.
- Present problem solutions logically, with a diagram (if appropriate) and with appropriate equations.
- Check that answers are of reasonable magnitude and that significant figures are reasonable.
- Associate appropriate units with all quantities.
- Convert between different unit systems, given conversion factors.
- Convert between mass and moles (and reverse), given the molecular weight of a substance.
- Calculate compositions of mixtures in weight percent, weight fraction, mole percent, mole fraction, and molarity.
- State the ideal gas law.
- Explain that intermolecular forces are neglected in an "ideal gas".
- Identify conditions under which real gases typically behave ideally.
- Define boiling point, normal boiling point, and melting point.
- State the chemical compositions/structures of common substances (water, air, table salt, methane, methanol, ethanol, acetylene, ethylene, benzene, toluene, linear alkanes, hydrochloric acid, sodium hydroxide).
- State the nitrogen and oxygen content of air.
- Explain the relationship between pH, H⁺, and OH⁻.

Computers (general)

- Use a word processor.
- Send text messages via e-mail.
- Search for information on the World Wide Web.
- Search for information in the Ohio University Libraries electronic catalog system.

Computers (Matlab)

Students should be able to accomplish the following Matlab tasks with occasional reference to the tutorials or manual:

- Write m-files and function m-files in which a series of commands in a logical order correctly complete a calculation.
- Comment m-files and format output appropriately (labels, units, etc.).
- Use "for" and "if-then" structures and counters.
- Perform calculations with scalars, vectors, and arrays.
- Properly distinguish between element-by-element and array operations.
- Make plots with labeled axes.
- Use Matlab to solve systems of linear equations.
- Use fsolve to complete a "trial-and-error"-type solution of a single equation.
- Use Matlab to solve systems of nonlinear equations.
- Use Matlab to make least squares linear regressions.

Engineering

- Define variables to represent real quantities.
- Define equations to represent real processes and relationships between quantities.
- Present problem solutions logically, with a diagram and with appropriate equations.
- Identify all assumptions in a problem solution.
- Identify the source of information used in a problem solution.
- Check that answers are of reasonable magnitude and that significant figures are reasonable.
- Associate appropriate units with all quantities.
- Recognize and work with common units in both the English and metric system.

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Course Outcomes

The Law of Conservation of Matter states that matter is neither created nor destroyed in the physical and chemical transformations that are part of a typical chemical process. However, its state and composition can change when a substance changes temperature, pressure, location, or phase, or when it reacts or forms a solution. All of the material involved in a process can be accounted for, just like balancing a bank account. This allows a chemical engineer to answer economic, safety, and environmental questions about the amount of raw materials consumed, product produced, and waste generated.

After you successfully complete this course, you will be able to:

- Analyze the steady state operation of a chemical process, using the Law of Conservation of Matter, in conjunction with process specifications, physical properties and laws, and physical constraints.
- Sketch a chemical process from a description, or describe a chemical process from a sketch.
- Explain the terms “steady state” and “accumulation”, and explain the difference between “steady state” and “equilibrium”.
- Identify parts of a chemical process that involve transformations in composition and/or state.
- Label process streams and define process variables to describe them.
- Write mathematical equations for overall and component mass balances.
- Write mathematical expressions equivalent to process specifications.
- Write mathematical expressions based on physical properties (e.g., density, molecular weight) to describe relationships among process variables.
- Write mathematical expressions based on simple equilibrium relationships (Raoult’s Law, Henry’s Law) and equations of state (Ideal Gas Law, General Compressibility Factor) to describe relationships among process variables.
- Write mathematical expressions for physical constraints (e.g., “the sum of the mole fractions is 1”).
- Convert among mass flow rate, molar flow rate, and volumetric flow rate; and between mass and mole fraction.
- State the relationship between volumetric fluid flow rate, pipe diameter, and average fluid velocity.
- Use the Ideal Gas Law appropriately to calculate gas properties.
- Use the Antoine Equation to calculate the vapor pressure of a substance given the temperature, or the temperature given the vapor pressure.
- Identify situations when vapor-liquid equilibrium (VLE) is likely to play an important role.
- Define saturated and superheated vapor, dew point, bubble point, relative humidity, and relative saturation, and use these concepts to determine the composition and phase of streams containing volatile and condensable components.
- Use ideal VLE behavior to predict condensation and vaporization in streams with condensable and non-condensable components.
- Use a T-xy diagram to find the dew point, bubble point, and amount and composition of each phase in problems involving two-phase, two-component systems.
- Complete the multistep analysis of steady state chemical processes including multiple components with chemical reactions and phase changes.
- Make appropriate assumptions and justify them.
- Write equations and identify the data required.
- Complete a degree-of-freedom analysis
- Gather the data (given, look up, estimate).
- Solve equations (linear, non-linear, simultaneous, integral).
- Evaluate calculations using engineering judgment and fundamental principles of science.

During this course, you will improve your ability to:

- Think, act, and communicate like a successful chemical engineer.
- Demonstrate professional behavior in work performance and interpersonal interactions.
- Consider and discuss ethical, economic, safety, and environmental concerns.
- Communicate technical information effectively and confidently.
- Present written information concisely, in a logical order, in an orderly format.
- Follow rules of standard English and technical writing.
- Use an engineer's vocabulary.
- Consistently provide appropriate units, significant figures, and references with information.
- Use the computer as a tool to solve problems.
- Explain the purpose of flash tanks, reactors, pumps, evaporators, distillation columns, liquid-liquid extraction columns, and crystallizers.

(Last modified on 01/05/07)