ChE 320: Phase & Chemical Equilibria

Welcome!

The aim of this course is that you will be able to solve standard problems in Phase & Chemical Equilibria, and to apply the idealized solutions to a broad variety of real problems. Equilibrium Thermodynamics theory is a broad and mathematical subject. We will focus on the important, well-studied, idealized problems listed in the Topics section of this syllabus. By the end of the course, you will be able to …

- **solve the most essential ChE thermo “standard problems”**. Vapor-liquid equilibrium, liquid-liquid equilibrium, chemical reaction equilibrium, changes to all of these with temperature or pressure, dissolution of gas in liquids.
- **thermodynamics v kinetics**. You will be able to distinguish thermodynamic problems (infinite time) from reaction kinetics or transport problems. You will know when to approximate time-dependent problems with thermodynamics, and you will be able to estimate reaction equilibria from thermodynamic data.
- **thermodynamic models**. You will be able to choose a correct thermodynamic model (ideal or nonideal) to approximate equilibrium in gases, VLE (vapor-liquid equilibrium) and LLE.
- **molecular origins**. You will understand how molecular contributions impact equilibrium. This greatly enhances your intuition into complicated problems.
- **apply techniques from the standard problems to processes and devices**. You will examine flash operations, plus everyday applications of equilibrium thermodynamics.

As with most courses, you are mostly responsible for choosing your grade. This is a 3-credit course. If you spend 9 hours extra/week (12 total), you will probably get an “A”. If you spend 6 hours extra, probably a “B”. And if you spend 3 hours extra, probably a “C”.

The grading scale is:  

- A = 90%, A- = 88%, B+ = 86%, B = 80%, B- = 78%, C+ = 76%, C = 70%, D = 60%.

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>10%</td>
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<tr>
<td>2 in-class midterm exams</td>
<td>40%</td>
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<tr>
<td>2 written exams</td>
<td>50%</td>
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Course Details

Instructor: Professor Darrell Velegol. 108 Fenske Lab, 814-865-8739, velegol@psu.edu.
TAs: Joe McDermott (jim489@psu.edu), Adam Mayernick (adm247@psu.edu).
Online: specialist Mike Sechrist (mss32@psu.edu).
Location: 111 Wartik (this location might change part way into the semester).
Time: 8:00-8:50 MWF.
Pre-requisites: ChE 220.
Book: Professor Themis Matsoukas ChE 320 notes. Very important to buy!
Homework: due Wednesday before class, either given in person or by ANGEL dropbox.
Office hours: Velegol: Monday 3-5:15, with a general review session at 4 pm in 108 Fenske.
TAs: “live” Tues 4-6, by email Tues 8-10. Also, a class message board.
Schedule of topics

Review of the first and second law of thermodynamics.
Pure fluids. PVT equations of state, vapor-liquid equilibrium (VLE), fugacity.
Mixtures of fluids. Equations of state.
Mixtures of fluids. Phase diagrams.
Phase equilibrium. Chemical potential, phase rule, VLE.
Ideal and non-Ideal Solutions. Raoult's law, activity coefficients.
Solubility of gases in liquids. Henry’s law, Lewis-Randall rule.
Chemical Equilibrium. Equilibrium constants for reactions, effect of T and p, group contribution.

Other points

CENTER. Character, Excellence, OwnNership, Tenacity, Entrepreneurship, Relationship. Some of you will ask me to write a letter one day, and I am delighted to write. Just make sure to “write your own letter” for me through your actions. See the ANGEL attachment about CENTER.
Honors options. If you’re interested, just email me and we’ll discuss possibilities.
Late homework or quizzes. Not accepted.

References (general list, not on reserve)

General references

- **P** Perry’s chemical engineers’ handbook, 7th ed. Eds. Robert H. Perry and Don W. Green [TP151.P45 1997]. This classic reference text has extensive data, formulae, and design criteria for a very wide range of chemical engineering practices. To use this book, start with the index.
- **CRC** CRC Handbook of Chemistry and Physics. [QD65.H301] This classic reference text also has extensive data and formulae, but more for chemical products than about equipment and practice.

Thermodynamics

- **S** Sandler, Stanley I. Chemical and engineering thermodynamics, 3rd ed. [QD504.S25 1999]. A classic text of thermodynamics, with many results.
- **D** Denbigh, Kenneth. The Principles of Chemical Equilibrium. 2nd ed. [QD503.D46 1981]. This text contains results found using more advanced thermodynamics.

Transport phenomena

Chemical reactions


Process Design


Other books