CM 2120
Fundamentals of Chemical Engineering 2

Curricular Designation: Required

Catalog Description:

Application of mass and energy balances to common chemical engineering operations. Mass balances, energy balances, and fundamental concepts are applied to flow in piping systems, pumps, compressors, and stagewise separations (distillation, absorption/desorption, and extraction). Advanced use of Process Flowsheet Simulations software.

Textbooks(s) and/or Other Required Materials:

Required text: Wankat, P. Separation Process Engineering, 2^{nd} Ed., Prentice Hall.

Prerequisites by Topic:

CM2110 Fundamentals of Chemical Engineering 1 - Mastery of unit conversions; mastery of principles of mass and energy balances; mastery of problem-solving skills in mass and energy balances.

Course Objectives:

- Mastery of the chemical engineering fundamentals regarding the application of the mechanical energy balance and Bernoulli equation, friction factors, pumps, compressors, and evaporators.
- Mastery of flash distillation
- Mastery of two-component column-based distillation
- Mastery of multicomponent column-based distillation using shortcut methods
- Introduction to multicomponent design using rigorous exact methods
- Familiarity with complex distillation principles
- Familiarity with batch distillation operations
- Familiarity with column design and economics
- Familiarity with absorption and stripping operations
- Familiarity with extraction operations

Topics Covered:

1. Chemical Engineering Fundamentals
   1.1 Mechanical Energy Balance / Bernoulli Equation (week 1)
   1.2 Friction Factor (week 1)
   1.3 Pumps / Compressors (week 2)
   1.4 Evaporation (week 3)
2. Separations Fundamentals
   2.1 Flash Distillation (weeks 3-4)
   2.2 Column Distillation (weeks 4-6)
   2.3 Multicomponent Distillation (week 7)
   2.4 Exact / Shortcut Methods (weeks 7-8)

2.5 Complex Distillation (weeks 9-10)
2.6 Batch Distillation (week 10)
2.7 Column Design (week 11)
2.8 Column Economics (weeks 12-13)
2.9 Absorption and Stripping (week 13)
2.10 Extraction, Washing, Leaching and Supercritical Extraction (weeks 13-14)

Grading: Eight homework assignments (25%), four midterm examinations (40%), one semester project (10%), class attendance and participation (5%), and one cumulative final exam (20%).

Class/Laboratory Schedule (note: 1 hour = 50 minutes)**:**

Lecture: 14 hours = 3 hour / week for 14 weeks

Contribution of Course to Meeting the Professional Component:

"Engineering Topics"

Relationship of Course to Program Outcomes:

The Accreditation Board for Engineering and Technology (ABET) is a non-profit organization that certifies the quality of U.S. undergraduate degree programs in applied science, computing, engineering, and technology.

AY 2009-10 is Michigan Tech's "Year of Record" for ABET accreditation renewal.

Outcomes: Skills, knowledge students must have when they graduate

Outcome	Topics and Level of Coverage			Comments/Examples
	Important	***Moderately important***	***Not covered***	
a) Apply knowledge of mathematics, science, and engineering	1-2			Core course topics are all math, science, and engineering.
b) Design and conduct experiments, analyze and interpret data		1-2		Data analysis on piping and separation systems.
c) Design a system, component, or process to meet desired needs		1-2		Introduction to column design to prepare for senior design course.
d) Function on a multi-disciplinary team		x		Semester team project
e) Identify, formulate, and solve engineering problems	1-2			All core topics require engineering problem solving.
f) Understand professional and ethical responsibility		2		Brief discussions of ethics and safety in chemical engineering plants.
g) Communicate effectively		x		Semester team project
h) Understand global and social impact of engineering solutions		2		Discuss relationships of separations to solve energy and air/water quality challenges.
i) Recognize the need for life-long learning		1-2		Introduction of fuel cell problems and relation to compression / separations to show scope of course is beyond what is in the text.
j) Demonstrate knowledge of contemporary issues		2		Discuss relationships of separations to solve energy and air/water quality challenges.
k) Use the techniques and tools of modern engineering practice		2		HW problem using UniSim process simulation software; reinforced with semester team project.

Relationship of Course to AIChE Program Criteria:

Outcome	Topics and Level of Coverage			Comments/Examples
	Important	***Moderately important***	***Not covered***	
A-1) Thorough grounding in chemistry and a working knowledge of advanced chemistry such as organic, inorganic, physical, analytical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program	1-2			Basic chemical properties as it relates to course content; chemical reaction byproduct separation, etc.
A-2) Working knowledge, including safety and environmental aspects of material and energy balances applied to chemical processes		1-2		Material and energy balance on chemical plants; safety and environmental issues with solvent use.
A-3) Thermodynamics of physical and chemical equilibria		2		Equilibrium and its use in separations; obtaining VLE data from the literature and process simulators.
A-4) Heat, mass, and momentum transfer			x	
A-5) Chemical reaction engineering			x	
A-6) Continuous and stage-wise operations	2			Separation principles is a significant component of this course.
A-7) Process dynamics and control			x	Mention column startup issues during class.
A-8) Process design		2		Introduction to distillation column design and economics.
A-9) Modern experimental and computing techniques		2		HW & semester project using UniSim.

Prepared by:

Jason M. Keith, Associate Professor, December 4, 2009