Transport/Unit Operations

Professor Faith A. Morrison
Department of Chemical Engineering
Michigan Technological University

CM2120—Fundamentals of ChemE 2 (Steady Unit Operations Introduction)
CM3110—Transport/Unit Ops 1 (Momentum & Steady Heat Transport, Unit Operations)
CM3120—Transport/Unit Ops 2 (Unsteady Heat Transport, Mass Transport, Unit Operations

www.chem.mtu.edu/~fmorriso/cm3210/cm3210.html

CM3120 Transport/Unit Operations 2

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Primary Text:
Christie J. Geankoplis, Transport Processes and Unit Operations, 4th Edition, Prentice Hall, New York (2003).

*Free electronically!

www.chem.mtu.edu/~fmorriso/cm3120/cm3120.html

9AM Section

EMERGENCY EVACUATION PROCEDURES

Important: The Michigan Bureau of Fire Services has adopted new rules for colleges and universities effective 2015

1. Only residence halls are required to hold fire and tornado drills.
2. In lieu of fire drills in other university buildings all faculty and instructional staff are required to do the following on the first day of class:
   - Explain the university fire evacuation procedures to the class (see below).
   - Explain the locations of the primary and secondary exit routes for your class location.
   - Explain your designated safe location where the class will meet after evacuating the building.
3. The class instructor is responsible for directing the class during a building evacuation.

General evacuation procedure:

- Use the nearest safe exit route to exit the building. **The nearest safe exit from room 19-102 is the front (south) entrance that is close to highway 41. The secondary exit is the campus (east) exit, that connects to the path between Chem Sci and EERC.**
- Close all doors on the way out to prevent the spread of smoke and fire.
- After exiting, immediately proceed to a safe location at least 100 feet from the building. **Our designated safe location is south of Chem Sci, in the parking lot in front of the MUB.**
- Do not re-enter the building until the all-clear is given by Public Safety or the fire department.

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11AM Section

EMERGENCY EVACUATION PROCEDURES

Important: The Michigan Bureau of Fire Services has adopted new rules for colleges and universities effective 2015

1. Only residence halls are required to hold fire and tornado drills.
2. In lieu of fire drills in other university buildings all faculty and instructional staff are required to do the following on the first day of class:
   - Explain the university fire evacuation procedures to the class (see below).
   - Explain the locations of the primary and secondary exit routes for your class location.
   - Explain your designated safe location where the class will meet after evacuating the building.
3. The class instructor is responsible for directing the class during a building evacuation.

General evacuation procedure:

- Use the nearest safe exit route to exit the building. **The nearest safe exit from room 15-139 is the front (south) entrance that is close to highway 41. The secondary exit is the campus (north) exit, that connects to the main path through campus.**
- Close all doors on the way out to prevent the spread of smoke and fire.
- After exiting, immediately proceed to a safe location at least 100 feet from the building. **Our designated safe location is east of Fisher, in the parking lot of the Center for Diversity and Inclusion.**
- Do not re-enter the building until the all-clear is given by Public Safety or the fire department.

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Why study transport/unit ops?

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Why study transport/unit ops?

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- Modern engineering systems are complex and often cannot be operated and maintained without analytical understanding
- Design of new systems will come from high-tech innovation, which can only come from detailed, analytical understanding of how physics/nature works

Image: wikipedia.org

Image: planetforward.ca

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Where are we now?

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Where are we now?

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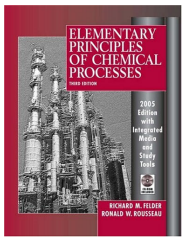
CM2110

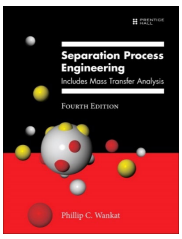


Summary

CM2110

1. Steady mass balances
2. Steady energy balances (how to calc. energy)
3. MEB-Mechanical Energy Balance (no friction)

CM2120



CM2120/CM3215

1. MEB-Mechanical Energy Balance (with friction)
2. Pumps
3. Introduction to Unit Operations
4. *Staged* Unit Operations (distillation, absorption)

Where are we now?

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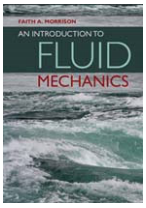
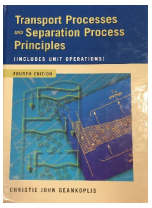
CM3110



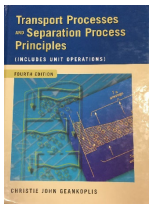


Summary

CM3110

1. Steady *momentum* balances (macro and micro)
2. *Rate-based* heat transfer processes (Fourier's law, heat transfer coefficients, radiation)
3. Unit Operations involving heat transfer (Heat Exchangers)

CM3120



CM3120

1. Unsteady energy balances
2. *Rate-based* mass-transfer processes (Fick's law, mass transfer coefficients)
3. Unit Operations involving mass transfer (separators)

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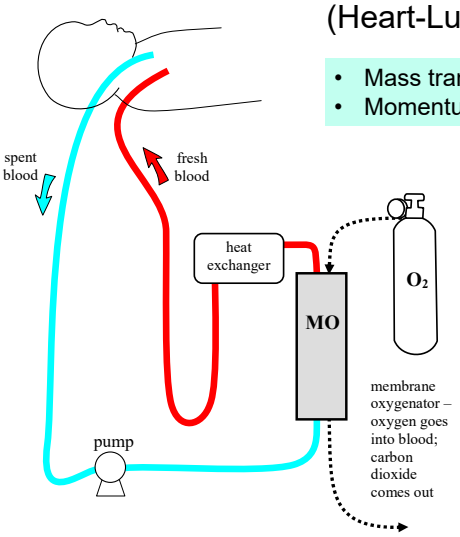
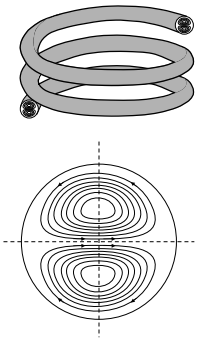
Membrane Oxygenator, MO
(Heart-Lung Machine)

- Mass transfer
- Momentum transfer





Secondary flow drives the O_2 mass transfer

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Where are we going?

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+CM3510—Chemical Reaction Engineering

- Performance of chemical reactors
- Advanced chemical kinetics

+CM3120—Thermodynamics for Chemical Engineers

- Non-ideal solutions
- Mixtures
- More complex chemical behavior

CM4110/20—Unit Operations/Chemical Plant Operations Lab

- Capstone, hands-on study of the operation of units that produce chemical transformations

CM4855/4860/1—Chemical Engineering Process Analysis & Design

- Capstone, applied engineering of processes that produce chemical transformations

CM4310—Safety/Environment

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Where to start?

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We've already started.

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We need to bring what we've learned so far to advance along the path to becoming a chemical engineer.

1. Mathematics background
2. Macroscopic Mass Balances (steady)
3. Macroscopic Energy Balances (including Mechanical Energy balance)
4. Staged Operations
5. Momentum transfer (Newton's law, Newtonian fluid mechanics)
6. Steady Heat transfer (Fourier's law, Steady microscopic energy balances)
7. Dimensional analysis and use of data correlations for real systems

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For more examples: see textbooks from prerequisite courses, CM2110/20 notes; HW1

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- **Homework 1, with answers, posted; TA has solutions**
- **TA help sessions: Sundays 6:30-7:30pm, room 19-211, weeks: 2, 5, 9, 15**
- **Website: http://pages.mtu.edu/~fmorriso/cm3120/cm3120.html**
- **Links to website in Canvas**

Prerequisite material

Resources:

- Richard Felder and Ronald Rouseau, *Elementary Principles of Chemical Processes*, 3rd Edition, Wiley, 2005.
- FAM summary notes on the energy balance information from CM2110/CM2120 (*http://www.chem.mtu.edu/~fmorriso/cm310/Energy_Balance_Notes_2008.pdf*).
- Christie J. Geankoplis, Transport Processes and Unit Operations, 4th Edition, Prentice Hall, New York (2003). *(two copies on library reserve)*
- Faith A. Morrison, *An Introduction to Fluid Mechanics*, Cambridge University Press, 2013.

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Prerequisite material

Exam 1: Next Tues

6:30-8:00pm
MEEM 111 & 112

Exam topics: Those covered on HW1

- Steady state mass balances
- Macroscopic energy balances
- Mechanical energy balances
- Newtonian fluid mechanics
- Steady heat transfer (Fourier's law, microscopic energy balances)
- Heat exchangers
- Integration/differentiation
- Use of data correlations

- **Homework 1, with answers, posted; TA has solutions**
- **TA help sessions: This Sunday 6:30-7:30pm, room 211).**
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- **Links in Canvas**

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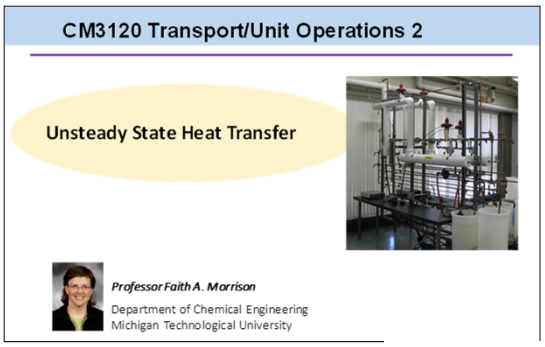
NEXT: Unsteady State Heat Transfer



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