

ChE-340

The engineering of chemical reactions

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Cursus	Sem.	Type
Chemical Engineering	BA6	Obl.
HES - CGC	E	Obl.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	4 weekly
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course applies concepts from chemical kinetics and mass and energy balances to address chemical reaction engineering problems, with a focus on industrial applications. Students develop the ability to analyze and design chemical reactors of industrial importance.

Content

1. Introduction
 - Profile of Chemical Industry
 - Chemical Processes
 - Basics of Chemical Reaction Engineering
 - Chemical reactions, mole balance equations
 - Ideal chemical reactors
2. Reaction kinetics and Rate Laws
 - Reactant conversion in closed and open systems
 - Influence of expansion Basic rate laws-formal reaction kinetics
 - Transformation in closed and open systems
 - Determination of reaction kinetics
 - Quasi steady state assumption for complex reaction systems
 - Homogeneous catalysis / enzyme kinetics
3. Isothermal Reactor Design-Simple reactions
 - Batchwise operated stirred tank reactor (BR)
 - Continuous stirred tank reactor (CSTR)
 - Plug flow reactor (PFR)
 - Cascade of CSTR
 - Combination of PFR and CSTR
 - PFR with recycling
 - Semi batch stirred tank reactor
4. Isothermal Reactor Design-Multiple reactions
 - Introduction
 - Parallel reactions, one reactant
 - Parallel reactions several reactants
 - semi-batch reactors
 - cross flow reactors
 - Consecutive reactions
 - Consecutive competing reactions
5. Nonisothermal Reactor Design

Batchwise operated stirred tank reactors
introduction, energy balance
adiabatic reactors
reactor with heat exchange, zero order (Semenov criteria)
- time to maximum rate
- reactor with heat exchange, isoperibolic reactors ($n > 0$)
reactor stability, parametric sensitivity, reactor run-away ($n > 0$)
semi-batch reactors for highly exothermic reactions
Plug-flow reactors
Continuous stirred tank reactors

Learning Prerequisites

Required courses

- Introduction to Chemical Engineering (ChE-201),
- Introduction to Transport Phenomena (ChE-204),
- Chemical Thermodynamics (CH-241),
- Chemical Kinetics (CH-342)

Learning Outcomes

By the end of the course, the student must be able to:

- Compute reactor size for required conversion
- Compute reactor space time
- Compare performance of different reactors
- Assess / Evaluate effect of concentration and temperature on reactor performance
- Design reactors for stable operation
- Design reactors for high product yield and selectivity

Transversal skills

- Assess progress against the plan, and adapt the plan as appropriate.
- Set objectives and design an action plan to reach those objectives.
- Use a work methodology appropriate to the task.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Give feedback (critique) in an appropriate fashion.
- Demonstrate a capacity for creativity.
- Access and evaluate appropriate sources of information.
- Make an oral presentation.

Teaching methods

Powerpoint lectures
Clicker questions during lecture
Example and team exercises
Practice homework problems

Assessment methods

Course Project: 25%

Mid-term: 25%

Final Exam: 50%

Resources

Bibliography

- Elements of chemical reaction engineering / Fogler
- Chemical reaction engineering / Levenspiel
- Chemical reactor design and operation / Esterterp et al.

Ressources en bibliothèque

- [Elements of chemical reaction engineering / Fogler](#)
- [Chemical reactor design and operation / Westerterp](#)
- [Chemical reaction engineering / Levenspiel](#)

Notes/Handbook

copy of the presented slides

copy of exercises and solutions

Moodle Link

- <https://go.epfl.ch/ChE-340>