Course guide
295562 - 295EQ132 - Advanced Catalytic Reactors

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER IN HYDROGEN SYSTEMS AND ENABLING TECHNOLOGIES (HYSET) (Syllabus 2024). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: LLUIS SOLER TURU

Others: Primer quadrimestre:
MONTSERRAT PEREZ MOYA - Grup: T1
LLUIS SOLER TURU - Grup: T1

PRIOR SKILLS

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REQUIREMENTS

Have passed the subject "Chemical and Catalytic Reaction Engineering" (Q1)

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
CGMUEQ-01. Ability to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which the matter undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors among which are the pharmaceutical, biotechnological, materials, energy, food or environmental
CGMUEQ-02. To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environment conservation
CGMUEQ-04. To carry out the appropriate research, undertake the design and manage the development of engineering solutions, in new or little known environments, relating creativity, originality, innovation and technology transfer

Transversal:
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

LEARNING RESULTS

Knowledges:
K03. Demonstrate an understanding of the hydrogen value chain, including hydrogen production processes and technologies, hydrogen storage technologies, hydrogen transport/logistics/infrastructure, hydrogen end uses (stationary, mobility, industrial and residential, including fuel cells), hydrogen safety, codes and standards, and all socioeconomic issues related to the energy transition, partly driven by the use of hydrogen.
K01. Conceive, analyse, design, size, optimise and exploit hydrogen technologies and processes, with a focus on both technology and systems.

Skills:
S01. Communicate effectively with others orally, in writing and graphically about learning, thought processes and decision making, and participate in discussions, using interpersonal skills such as active listening and empathy that support teamwork.
S02. Work in the field as well-trained, enthusiastic professionals with a broad multidisciplinary knowledge of hydrogen technologies and systems, educated in an international and multicultural environment to promote global cooperation in meeting the complex challenges of the energy transition.

Competences:
C05. Propose advanced scientific and technological solutions to complex industrial challenges in the field of energy, with a focus on the use of hydrogen as a vector.

TEACHING METHODOLOGY

Classroom. Self-study. Learning from projects, laboratory practices and study cases

LEARNING OBJECTIVES OF THE SUBJECT

- Define the operation of structured reactors and microreactors.
- Describe the different types of catalytic wall reactors and their operation.
- Ability to design a process using catalytic wall reactors.
- Distinguish catalyst deposition techniques.
- Understand the fundamentals and operation of catalytic membrane reactors and their applications.
- Explain the mechanism of photocatalytic reactions and the operation of photocatalysts.
- Identify the different types of photocatalytic reactors and their applications.
- Ability to design a photocatalytic process.

STUDY LOAD

Type	Hours	Percentage
Hours large group	42,0	28.00
Self study	108,0	72.00

Total learning time: 150 h

CONTENTS

Structured reactors

Description:
Honeycomb catalytic reactors with ceramic and metallic substrates. Techniques of deposition of catalysts in structured reactors. Environmental applications. Microreactors: manufacturing, mass and heat transfer, advantages of "scale out" vs. "scale up". Applications in the chemical industry. Peripheral elements

Specific objectives:
To learn the different types of catalytic wall reactors and how to coat them with a catalyst. To understand the operation of the catalytic converters of vehicles with combustion engines. To know the advantages of microreactor technology and its applications.

Related activities:
Design of a structured reactor or microreactor

Full-or-part-time: 28h 30m
Theory classes: 7h 30m
Self study : 21h

Membrane catalytic reactors

Description:
Types of membrane catalytic reactors. Transport mechanisms. Sieverts' law. Catalyst distribution in membrane catalytic reactors. Influence of the operating parameters: pressure, temperature, residence time and specific area. Dynamics and controllability of membrane catalytic reactors. Energy applications

Specific objectives:
To understand the operation of a membrane catalytic reactor and the importance of the operating conditions in its dynamics and behavior. To know the basic control tools of the catalytic membrane reactors and their main applications

Related activities:
Case study of a real application in the laboratory

Full-or-part-time: 24h
Theory classes: 6h
Self study : 18h

Photocatalysis

Description:
Principles of photocatalysis. Types and preparation of photocatalysts. Characterization of photocatalysts. Reaction mechanisms. Artificial photosynthesis and hydrogen production

Specific objectives:
To know the principles of photocatalysis and the characteristics of a photocatalyst. To understand the operation principles of photocatalysis and its application in different types of chemical processes

Related activities:
Search of information in patents and scientific literature. Laboratory practice with a photocatalytic reactor.

Full-or-part-time: 24h
Theory classes: 6h
Self study : 18h

Photoreactors

Description:
Advanced oxidation processes. Water treatment. Study of the operating parameters: photon transfer, temperature effect, mass transfer. Design of photoreactors

Specific objectives:
To know the principles of applied photocatalysis and photoreactors, with emphasis on water treatment. To understand the operating parameters of photoreactors and the optimization of photocatalytic processes

Related activities:
Study case of a real application

Full-or-part-time: 13h 30m
Theory classes: 10h 30m
Self study : 3h

GRADING SYSTEM

NF= 0,35·NEP1 + 0,25·NEP2 + 0,2·NEP3 + 0,2·NEP4
NF= final mark
NEP#= mark of each part (1=photoreactors & AOP, 2=photocatalysis, 3=structured reactors, 4=membrane catalytic reactors)
NEP#= 0.5·exam of the part + 0.5·(exercises/lab practices) of the part

There is no final exam nor resit exam.

EXAMINATION RULES.

Written exams and exercises are individual. Laboratory practices are in pairs.

BIBLIOGRAPHY

Complementary:
- Sánchez Marcano, J. G.; Tsotsis, T. T. Catalytic membranes and membrane reactors. Weinheim: Wiley-VCH, cop. 2002. ISBN 9783527302772.
- Ehrfeld, Wolfgang; Hessel, Volker; Löwe, Holger. Microreactors : new technology for modern chemistry. Weinheim [etc.]: Wiley-VCH, 2001. ISBN 3527295909.
- Ameta, Rakshit; Ameta, Suresh C. Photocatalysis : principles and applications. Boca Raton: CRC Press, [2017]. ISBN 9781482254938.
- Patrocinio, Antonio Otavio T.; Bahnemann, Detlef. Springer handbook of inorganic photochemistry [on line]. Cham, Switzerland: Springer Nature Switzerland AG, 2022 [Consultation: 16/06/2023]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/rdgucl/alma991005068333906711. ISBN 9783030637125.

RESOURCES

Other resources:
Notes from class and other documents from the Digital Campus