60463 - Sustainable chemistry and catalysis

Información del Plan Docente

Academic Year	2017/18
Faculty / School	100 - Facultad de Ciencias
Degree	543 - Master's in Molecular Chemistry and Homogeneous Catalysis
ECTS	2.0
Year	1
Semester	Second semester
Subject Type	Optional
Module	---

1.General information

1.1.Introduction

Over the past decades, the social perception of chemistry has evolved unfavorably. In part, this is because many of today's environmental problems are caused by pollution associated with the chemical industry. However, the solution to many of these problems lies precisely in the hands of Chemistry.

The bases for sustainable chemistry were established in the 90's and they are summarized in the "12 principles of green chemistry" enunciated by Paul Anastas and John Warner. This discipline of Chemistry aims to: a) reduce the use of depletable resources, b) improve the design of products that are safe and non-persistent after use, and c) improve production processes reducing the generation of polluting or dangerous chemicals.

The course on *Sustainable Chemistry and Catalysis* provides a global view of sustainable chemistry with particular emphasis on the development of efficient and environmentally friendly chemical processes, paying attention to the use of catalysis for this aim.

1.2.Recommendations to take this course

This course requires basic knowledge of chemistry and catalysis.

This subject is evaluated by continuous assessment; therefore, class attendance and daily work is crucial to pass the subject.

1.3.Context and importance of this course in the degree

Sustainable Chemistry and Catalysis is an optional subject with 2 ECTS, taught in the spring semester. This course is part of the module, *Horizons in Molecular Chemistry and Catalysis*. The course provides training to carry out sustainable processes and to design environmentally friendly products. In addition, special emphasis is placed on Catalysis as a way to carry out effective and sustainable chemistry. In this regard, this course expands the competences of the compulsory subject, *Catalysis*, and it is complementary to the optional subject, *Asymmetric Catalysis*.

1.4.Activities and key dates

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The scheduled activities will be carried out during the spring semester in weekly two-hour sessions. The oral presentation, which complements the written work, will be delivered following the schedule that will be announced in advance.

The information about schedules, calendars and exams is available at the websites of the Sciences Faculty, https://ciencias.unizar.es/calendario-y-horarios, and the Master, http://masterqmch.unizar.es.

2.Learning goals

2.1.Learning goals

To understand the principles of the Sustainable Chemistry and their application in the design of chemical processes.

To recognize the main types of renewable raw materials, their properties and applications.

To identify the important role of catalysis in a sustainable development.

To evaluate and compare the physico-chemical and toxicological properties of conventional and unconventional solvents.

To acquaint with low-impact environmental reaction methods and their applications.

To assess the degree of compliance with the principles of sustainable chemistry in a particular chemical process.

2.2.Importance of learning goals

The sustainability risks of our planet are widely recognized specially in terms of waste generation and availability of resources for a high-rate growing world population. In the current social, economic and political context, it is necessary to minimize the environmental impact associated with chemical processes and products, at both industrial and academic research level. These reasons indicate that training in *Sustainable Chemistry and Catalysis* is important at a post-graduate level within the framework of the *Master in Molecular Chemistry and Homogeneous Catalysis*, whose overall objective is to form highly qualified researchers in the fields of *Chemical Synthesis and Catalysis*. In particular, the master degree students will be capable of understanding and applying the principles of sustainable chemistry in the design of chemical products and processes, primarily at laboratory scale, respecting the environment, so that chemistry would be viewed as the solution rather that the problem.

3.Aims of the course and competences

3.1.Aims of the course

This course provides advanced training and specialized skills in the field of Sustainable Chemistry, introducing to the students the main principles and tools of this discipline and its practical application in important chemical processes. Among these principles, it should be stressed the use of renewable raw materials, "green" solvents and catalysts, as well as the optimization of energy resources. Furthermore, the course presents some tools to assess the degree of compliance with these principles in individual cases.

3.2.Competences

The student has acquired an advanced knowledge of the essential facts, principles and theories related to the

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Sustainable Chemistry, with special emphasis on current research topics.

The student is capable of using the vocabulary and terminology in the field of Sustainable Chemistry.

The student is able to apply the acquired knowledge in the design and synthesis of new molecules following the principles of "green chemistry".

The student is able to gather relevant information for the evaluation of the risks, toxicity and environmental impact of chemical products, in order to use them in a safe and responsible manner.

The student has acquired a general vision of the basic principles in catalysis, understanding the most important industrial and technological catalytic processes and the new tendencies in catalysis.

The student is able to integrate and evaluate research results in the area of *Molecular Chemistry and Catalysis*, and to discuss the data in a scientific fashion making cross-links with the theoretical knowledge.

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

According to the evaluation regulations of the University of Zaragoza, the students can be evaluated either by a continuous evaluation or by a final global exam. In the event that the students decide to be evaluated by the both methods, continuous assessment and single global exam, the highest mark will prevail.

The student should demonstrate that they have attained the expected learning outcomes through the following assessment activities:

Continuous evaluation:

Weighted average of the following activities:

1.- Individual or group works, supervised by the lecturers (30%).

2.- A written exam consisting of theoretical/practical questions (70%). The students have the choice to look up the bibliography, in paper format, during the exam.

The students will pass the course if the 30 and 70 weighted average of the two assessments is equal or higher than 5.0. The students have the opportunity to improve the grades obtained in the continuous evaluation by undertaking the single global exam. And as indicated above, the highest mark will prevail.

Global Evaluation:

The students have the option to choose a non-continuous evaluation; these students and those who have no passed the continuous evaluation could carry out a global exam which will represent 100% of the final grade, either in the first or in the second call. The global exam will consist of a written assessment dealing with the main concepts described in the

course and emphasized in the learning activities.

The number of official examination calls (two per registration) and their use will be subjected to the statements of the *Regulation of Permanence in Master Studies* and the *Regulation of the Learning Assessment* (http://www.unizar.es/ice/images/stories/calidad/Reglamento%20Evaluacion.pdf). The latest document will also regulate the general design and scoring criteria of the assessment activities, as well as the exam schedules and timetable for the post-examination review.

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The learning process designed for this course comprises participatory lectures, practical application exercises, seminars (could be given by professionals) and tutorials. The theoretical contents of the syllabus will be introduced, discussed and complemented with the solving of practical examples aimed at clarifying the concepts presented in each topic (*vide infra*).

In addition, the students should complete an individual or group written assignment on a subject related to the contents of the course, which should be agreed with the lecturers. This assignment requires a specialized bibliographic search related to the topic. The students will present it before their peers and lecturers; after the presentation, a discussion will take place.

5.2.Learning tasks

The course includes the following learning tasks:

- Participatory lectures.
- Practical application exercises and seminars.
- Supervised academic works.
- Individual or small-group tutorials.

5.3.Syllabus

The course will address the following topics:

Topic 1. Basic concepts of sustainable chemistry.

Topic 2. Sustainable Energy.

Topic 3. Reactions activated by unconventional methods.

Topic 4. Renewable raw materials.

Topic 5. Alternatives to conventional organic solvents.

Topic 6. Catalytic processes and industrial applications of green chemistry.

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Note: The order can change, depending on the teaching and organizational needs.

5.4.Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Sciences website https://ciencias.unizar.es.

The presentation of assignments will be done according to the schedule and announced in advance.

Students will be provided with different teaching material either at reprography or through the University's virtual platform https://moodle2.unizar.es/add.

5.5.Bibliography and recommended resources

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BB Domènech, Xavier. Química verde / Xavier Domènech Barcelona**:** Rubes, 2005

BB Mestres, Ramón. Química sostenible Madrid**:** Síntesis, D.L. 2011

BB Procesos orgánicos de bajo impacto ambiental**:** Química verde / Pilar Cabildo Miranda ... [et al.] Madrid**:** Universidad Nacional de Educación a Distancia, 2006

BB Transforming sustainability strategy into action**:** the chemical industry / edited by Beth Beloff, Marianne Lines, Dicksen Tanzil Hoboken**:** Wiley-Interscience, cop. 2005

BC Ahluwalia, V.K**.** Green solvents for organic synthesis / V.K**.** Ahluwalia, R.S. Varma Oxford**:** Alpha Science International, cop. 2009

BC Cann, Michael C.; Connelly, Marc E**.** Real-world cases in Green Chemistry. American Chemical Society. 2000

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BC Green chemistry metrics**:** measuring and monitoring sustainable processes / edited by Alexei Lapkin, David J. C. Constable Chichester**:** Wiley, cop. 2009

BC Introduction to chemicals from biomass / editors, James H. Clark with Fabien E. I. Deswarte Chichester**:** Wiley, cop. 2008

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BC Renewable resources and renewable energy**:** a global challenge / edited by Mauro Graziani and Paolo Fornasiero Boca Raton [etc.]**:** CRC Press, cop. 2007

BC Sheldon, Roger A**.** Green chemistry and catalysis / Roger Arthur Sheldon, Isabel Arends, and Ulf Hanefeld Weinheim**:** Wiley-VCH, cop. 2007

BC Vaclav Smil. Energy at the Crossroads, Global Perspectives and Uncertainties. The MIT Press, Cambridge, Massachusetts, 2003