Course guides
295567 - 295EQ231 - Chemistry of Polymerization

Last modified: 04/06/2021

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).

Academic year: 2021 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: Francesc Estrany Coda

Others: Núria Borràs Cristòfol
Margarita Sànchez Jiménez
Francesc Estrany Coda

PRIOR SKILLS

Basic knowledge of materials acquired during undergraduate studies, and especially in subjects that contain the topics "Biotechnological Processes" and "Polymers Industry and Technology".

REQUIREMENTS

Degree in Chemical Engineering or equivalent.

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-10. Adapt to changes, being able to apply new and advanced technologies and other relevant developments, with initiative and entrepreneurial spirit

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.

TEACHING METHODOLOGY

Classroom sessions and tutored specific work.

LEARNING OBJECTIVES OF THE SUBJECT

To know the chemical principles of the polymerization and copolymerization methods, the molecular mechanisms on which they are based and their design possibilities.
Know the technologies that are used in the manufacture of polymers on an industrial scale.
Know the procedures available for the chemical modification of polymers to modify their properties.

STUDY LOAD

Type	Hours	Percentage
Hours large group	28,0	18.67
Hours small group	14,0	9.33
Guided activities	6,0	4.00
Self study	102,0	68.00

Total learning time: 150 h

CONTENTS

Chapter 1: Introduction to the chemistry of polymerization

Description:
Composition, constitution and configuration. Molecular weights and their distribution. Classification and nomenclature. Characterization of the chemical structure: chromatography and FTIR and NMR spectroscopy. Polymerization methods.

Specific objectives:
Understand the chemical structure of polymers, how it is determined and how it relates to the behavior of polymers. Have basic knowledge about the procedures that are used for the synthesis of polymers and their application at the industrial level. Know the degradation processes that affect polymers in their use and their use in recycling and reuse.

Related activities:
Resolution of a series of specific exercises, application of the contents of the subject.

Full-or-part-time: 5h
Theory classes: 5h

Chapter 2: Polimerization

Description:
Structure and chemical properties. Monomer and polymer. Functionality, regiochemistry and reactivity. Linear polycondensation Kinetic and thermodynamics. Molecular weights: stoichiometry and chain size. Three-dimensional polycondensation: gelling. Polyaddicion Radical and ionic mechanisms. Kinetic and thermodynamics. Transaction reactions. Molecular weights: regulators and inhibitors of the chain. Living polymers
Stereochemistry of polymerization. Ziegler-Natta Polymerization. Metal • locens. Stereospecific polymerization of olefins and diens. Polymerization for opening cycles (ROP). Polymerizable cycles and ROP mechanisms. Special methods of polymerization. Hyperranated dendrimers and polymers.

Specific objectives:
To know the chemical and physicochemical principles of the polymerization methods by means of polycondensation and polyaddication mechanisms and how they are applied to the preparation of polymers at both industrial and laboratory levels. Know the chemical and physicochemical principles of the polymerization methods used in the synthesis of polymers through organometallic catalysts and through special mechanisms and how they apply to the preparation of polymers at both industrial and laboratory levels.

Related activities:
Resolution of practical problems and exercises of a theoretical nature that allow to deepen in the application of the concepts introduced in this subject.

Full-or-part-time: 8h
Theory classes: 8h

Chapter 3: Copolymerization

Description:
Structure and properties of copolymers. Copolymerization by addition. Relative reactions of the monomers. Composition and microstructure of copolymers. Condensation copolymers. Telescope polymers. Design of copolymers with structure and specific properties. Graft copolymers.

Specific objectives:
Understand the chemical and physicochemical principles of the copolymerization methods that are used in the synthesis of copolymers through the different possible mechanisms, and how they apply to the preparation and design of copolymers, both at industrial and laboratory levels, from the properties that are required for these materials.

Related activities:
Resolution of practical problems and exercises of a theoretical nature that allow to deepen in the application of the concepts introduced in this subject.

Full-or-part-time: 2h
Theory classes: 2h

Chapter 4: Polymerization technology. Modification and degradation of polymers.

Description:
Characteristics of polymerization reactions. Massive polymerization. Polymerization in dissolution. Polymerization in suspension: stability of the systems. Polymerization of emulsions: kinetic. Operational variables and properties of polymers. Other methods of polymerization. Industrial examples
Chemical reactions on polymers. Modification of properties. Interlocking linkage and formation of gels. Degradation of polymers: analysis and monitoring techniques. Thermal degradation: pyrolysis mechanisms. Depolymerization. Characteristics of polymerization reactions. Massive polymerization. Polymerization in dissolution. Polymerization in suspension: stability of the systems. Polymerization of emulsions: kinetic. Operational variables and properties of polymers. Other methods of polymerization. Industrial examples
Chemical reactions on polymers. Modification of properties. Interlocking linkage and formation of gels. Degradation of polymers: analysis and monitoring techniques. Thermal degradation: pyrolysis mechanisms. Depolymerization
Chemical degradation: hydrolysis. Photo-oxidative degradation. Biodegradation.

Specific objectives:
Know the technologies that are applied in the industrial manufacture of polymers according to the polymerization mechanism involved, the advantages and disadvantages comparatively present and the systems and equipment they need. Acquire the basic criteria for the selection of the technology of the process suitable for the preparation of a specific polymer.
Know the procedures available for the chemical modification of polymers and biopolymers, since these reactions modify the properties of the materials and the limitations presented by their practical application.
Know the parameters that define the existence of chemical, thermal and environmental degradation, the chemical mechanisms involved in the processes of degradation and how these processes are studied and followed by the appropriate techniques of chemical and physical analysis.

Related activities:
Resolution of practical problems and exercises of a theoretical nature that allow to deepen in the application of the concepts introduced in this subject.

Full-or-part-time: 12h
Theory classes: 12h

GRADING SYSTEM

1 Partial exam (written tests) and 1 final exam (written test).
Preparation and delivery of a directed work carried out individually or in groups.

EXAMINATION RULES.

Performing specific tasks and wider tasks.
Exam: It consists of different theoretical and practical issues related to the program.

BIBLIOGRAPHY

Basic:
- Painter, Paul C.; Coleman, Michael M. Essentials of polymer science and engineering. Lancaster: DEStech Publications, cop. 2009. ISBN 9781932078756.

Complementary:
- Braun, Dietrich [et al.]. Polymer synthesis : theory and practice : fundamentals, methods, experiments. 5th ed. Berlin [etc.]: Springer, cop. 2013. ISBN 9783642289798.

RESOURCES

Other resources:
Supplied by the teaching staff.