240EQ232 - Polymer Experimental Methods

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2017
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 4,5
Teaching languages: Spanish, English

Teaching staff
Coordinator: Elaine Armelin Diggroc
Others: María Teresa Casas Becerra
Lourdes Franco García
Jordi Puiggali Bellalta
Núria Saperas Plana

Opening hours
Timetable: It will be specified at the beginning of classes

Prior skills
It is a very interesting subject from a practical standpoint because most of the classes are conducted in the laboratory of experimentation, working directly with the synthesis and characterization of polymers and biopolymers. The students should have general knowledge of chemical and physicochemical characterization of polymers. It is interesting to have studied topics related to polymers such as those taught in the following subjects: Polymers and Biopolymers, Polymer Technology I and II.

Requirements
It would be interesting if the student has studied the specific subjects of polymers and biopolymers, polymers technology I and II.

Degree competences to which the subject contributes

Generical:
1. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.

Transversal:
2. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
3. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.
4. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
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Teaching methodology

Laboratory in polymer synthesis with a brief introduction at the beginning of the year regarding the types of polymerization to be carried out. Theory and practice are combined in the laboratory. Experiments are performed in small groups. Visits to private companies in the plastics sector.

Learning objectives of the subject

The student will acquire the abilities to:
- Perform the synthesis of several types of polymers: thermoplastics, thermosets and elastomers.
- Understand the characterization of polymers employing techniques like RMN, FTIR, swelling degree, viscosity, and others.
- Perform practical experiments with polyesters, proteins and polysaccharides in order to understand their applicability.
- Corroborate the properties of polymers (chemical composition, molecular weight and structure) with their applications.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group:</th>
<th>0h</th>
<th>0.00%</th>
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<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>40h 30m</td>
<td>36.00%</td>
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<td>Guided activities:</td>
<td>0h</td>
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<td></td>
<td>Self study:</td>
<td>72h</td>
<td>64.00%</td>
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Laboratory in polymer synthesis with a brief introduction at the beginning of the year regarding the types of polymerization to be carried out. Theory and practice are combined in the laboratory. Experiments are performed in small groups. Visits to private companies in the plastics sector.
# Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Learning time</th>
<th>Laboratory classes</th>
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</thead>
<tbody>
<tr>
<td><strong>Topic 1. Syntheses of thermoplastic polymers, commodities (like polystyrene) and engineering (like nylons and polyurethanes)</strong></td>
<td>In this laboratory practice, the synthesis of polystyrene will be carried out by suspension polymerization, the synthesis of nylon 6.10 by interfacial polymerization and the synthesis of a thermoplastic polyurethane (TPU) by condensation polymerization. We will also work on polymer purification and plastics processing techniques.</td>
<td><strong>Learning time: 6h</strong></td>
<td><strong>Laboratory classes: 6h</strong></td>
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<td><strong>Topic 2. Synthesis of thermoset polymers</strong></td>
<td>Two types of thermosets will be prepared: a two component epoxy and a polytriazole. Its adhesive properties, with or without catalyst or with the use of thermal curing treatments, will be evaluated.</td>
<td><strong>Learning time: 3h</strong></td>
<td><strong>Laboratory classes: 3h</strong></td>
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<tr>
<td><strong>Topic 3. Preparation of elastomers</strong></td>
<td>The polymerization of the natural rubber can be carried out in two stages, a pre-vulcanization stage and the complete vulcanization stage, the latter being the main one. In this practice, vulcanized rubber specimens will be fabricated and their degree of crosslinking will be determined using ASTM standards.</td>
<td><strong>Learning time: 3h</strong></td>
<td><strong>Laboratory classes: 3h</strong></td>
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<tr>
<td><strong>Tema 4. Preparation of glass fiber reinforced plastics: composites</strong></td>
<td>A commercial polyester resin, with an initiator (peroxide), will be used to obtain a rigid polymer with incorporated glass fiber. Glass-reinforced plastic (GRP), also known as Glass-Fiber Reinforced Plastic (GRP), is a composite material with better mechanical properties than the pure homopolymer.</td>
<td><strong>Learning time: 3h</strong></td>
<td><strong>Laboratory classes: 3h</strong></td>
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### Tema 5. Characterization of polymer structure with infrared spectroscopy and nuclear magnetic resonance

**Description:**
In this practice we will work with the chemical identification of polymers using spectroscopic techniques: FTIR and NMR. The student will learn how to use an infrared spectrophotometer and how to process the graphs in order to analyze the main absorption bands of a given polymer. In the part of RMN, they will know the equipment and how to process and interpret the chemical shifts with the help of a computer program and standard tables, which contain the relation of the different organic functional groups and their theoretical displacements.

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### Topic 6. Preparation of alginate-based hydrogel polymers: application as a biocatalyst

**Description:**
In this practice the student will work with another class of polymers, the polysaccharides. The aim is to carry out the hydrolysis reaction of an alginate gel and to evaluate the D-glucose content obtained after the hydrolysis by spectroscopic methods (UV-visible). On the other hand, it is noteworthy that in this practice the student will come into contact with the preparation of a type of biohydrogel and the immobilization of enzymes.

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### Topic 7. Determination of the presence of enzymes in a commercial detergent

**Description:**
Detergents have, in addition to surfactants and bleaches, polycarboxylates and enzymes. Enzymes accelerate certain chemical reactions by acting as a biochemical catalyst. In this practice the student will evaluate the proteolytic activity of enzymes in a commercial detergent using the electrophoresis technique. Therefore, in this subject the student will have the opportunity to work with SYNTHETIC POLYMERS, NATURAL POLYMERS and BIOPOLYMERS.

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### Qualification system

Final mark = 0.40 × (practice reports) + 0.60 × (final exam)

### Regulations for carrying out activities

Practice reports drawn up by teams of three-four students, depending on the number of students enrolled. The written exam (final exam) will be held individually at the end of the semester. There are no partial exams in this course. It has a minimum of 70% attendance at the practical classes, in order to be able to collect the qualification of practical reports.
Bibliography

Basic:


Complementary:


Others resources:

Internship dossier available at Atenea