295559 - 295EQ121 - Membrane Processes and Technologies

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: English

Teaching staff
Coordinator: Cortina Pallas, Jose Luis
Others: Cortina Pallas, Jose Luis

Opening hours
Timetable: Students have to send an email to the coordinator or the lecturer to fix a meeting

Prior skills
No aplica

Requirements
No aplica

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-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
CGMUEQ-08. Lead and define multidisciplinary teams capable of solving technical changes and management needs in national and international contexts

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
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

The following activities will be carried out, either in or outside the classroom, in the development of the course:

1. Lectures, participative sessions and problem solving sessions
2. Lectures by guest speakers
3. Autonomous learning and homework and assignments
4. Project based learning
5. Mid-term exam (MEX) and final Exam (FEX)
6. Visit to plants

Detailed project information regarding the scope, content, format, deadlines, etc., will be presented in an attached document.

The methodology designed includes also the Project based learning (PBL) where the students would have two types of projects: a) use commercial membrane design and projection tools to provide a design of a membrane based process; b) integration of membrane technologies on processing schemes of given priority sectors (chemical, pharmaceutical, agro-food, beverage, water/energy). Invited speakers are experts who work on membrane processing can participate in the definition of the system and supervising the progress of the teams.

Learning objectives of the subject

At the end of the course the student will be able to:
• Capacity to define separation, purification and concentration of solutes from streams in down-processing on chemical, biochemical, petrochemical processes based on the use of membrane materials and technologies.
• Know the operating principles of the different types of separation processes based on membranes in order to design their integration in chemical, pharmaceutical and food processes.
• To know the design tools of membrane separation processes using commercial calculation tools developed by the membrane suppliers as well as of equilibrium codes between phases to simulate and predict the operation of processes based on membranes.
• To know the methodologies of technological pre-evaluation, membrane characterization, study techniques and monitoring of the operation processes of the membranes in industrial processes.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 28h</th>
<th>18.67%</th>
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<tr>
<td></td>
<td>Hours medium group: 0h</td>
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<tr>
<td></td>
<td>Hours small group: 14h</td>
<td>9.33%</td>
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<tr>
<td></td>
<td>Guided activities: 6h</td>
<td>4.00%</td>
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<tr>
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<td>Self study: 102h</td>
<td>68.00%</td>
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# Content

## 1. Membrane Technology Fundamentals

### Description:

### Related activities:
- Homework assignment: Short exercises
- Visualization of videos on membrane preparation and modules construction.

### Specific objectives:
The student will develop a basic understanding of the main transport mechanisms and the flux equations of solvent and solutes in membrane processes. Sound knowledge on the main mass transport models will be derived from a thermodynamic approach. Finally, the main process limitations on mass transfer as concentration processes will be evaluated and the main module configuration and operation approaches to diminish them will be presented. The student will learn the main operation modes and membranes configurations.

### Learning time:
- Theory classes: 7h
- Guided activities: 2h
- Self study: 15h

## 2. Pressure driven porous membrane processes

### Description:

### Related activities:
- Homework assignment: Short exercises
- Project on developing a projection for a process using UF using a commercial design tool.

### Specific objectives:
Distinguish the conditions and requirements of the application of porous membranes: particulate and colloidal matter removal. The main tools for controlling production modes and cleaning modes including numerical tools and operation tools. The identification of the lower limit of application of UF, and their role for clean-up/separation of macromolecules would be solidified. Finally, a familiarization with software for defining porous filtration stage will be completed.

### Learning time:
- Theory classes: 7h
- Guided activities: 4h
- Self study: 16h
3. **Pressure driven non-porous membranes**

<table>
<thead>
<tr>
<th>Learning time: 27h</th>
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<tbody>
<tr>
<td>Theory classes: 6h</td>
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<td>Guided activities: 4h</td>
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<td>Self study: 17h</td>
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**Description:**

**Related activities:**
Homework assignment: Short exercises
Project on developing a projection for a process using RO/NF using a commercial design tool.

**Specific objectives:**
Distinguish the conditions and requirements of the application of non-porous membranes: removal of dissolved ions and molecules, concentration of streams, separation of target species. The main tools for controlling operation modes including fouling, scaling events. Special attention to selection of cleaning modes including numerical tools and operation tools. The identification of the criteria to identify the use of RO in front of NF or the selection of NF/RO in front of ED and MD. Finally, a familiarization with software for defining RO/NF based process will be completed.
### 4. Electrical driven membrane processes

<table>
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<th>Learning time: 29h</th>
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<tr>
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<tr>
<td>Guided activities: 5h</td>
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<tr>
<td>Self study: 18h</td>
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**Description:**

**Related activities:**
- Homework assignment: Short exercises
- Solving problems related to the unit content.
- Visit to industrial plants.

**Specific objectives:**
The students will be able to familiarize to IX membrane properties and their nitration of stacks and the principles of electrical gradients to simplify purification and concentration of streams. The application of bipolar membranes a solution to the production of chemicals as substitution to established precipitation and evaporation technologies will be considered.
5. Chemical Potential and temperature driven membrane processes

Learning time: 33h
- Theory classes: 9h
- Guided activities: 6h
- Self study: 18h

Description:
Membrane evaporation Processes. Theoretical background and membranes properties. Temperature and concentration polarization profiles. Membrane Pore wetting and membrane scaling; fouling and control. Applications.

Related activities:
- Homework assignment: Short exercises
- Solving problems related to the unit content.
- Visits to plants.
- Co-operative learning approach. Selection and discretization of membrane set-up and mass transfer description of one thermal and chemical potential based industrial example.

Specific objectives:
The student will be able to analyse and estimate the potential uses of chemical and temperature gradients for process separation/concentration and at least four relevant industrial applications will be addressed on terms material selection and operation modes. The student will be able to evaluate the use of hear waste on temperature driven or improving weak chemical potentials by using facilitated or coupled transport solutions.

Regulations for carrying out activities
The standards procedures applying to the Master
Bibliography

Basic:


Others resource:

Hyperlink


• Water Treatment Online Tools & Calculators. SUEZ. https://www.suezwatertechnologies.com/resources/online-tools
