Universitat Autònoma de Barcelona

2020/2021

Advanced Separation Operations

Code: 102401
ECTS Credits: 9

Degree	Type	Year	Semester
2500897 Chemical Engineering	OT	4	0

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

It is recommended to have reached the basic knowledge and fundamentals on: Separation processes, Heat transfer and Chemical processes simulation.

Objectives and Contextualisation

This subject deals with separation processes based on mass transfer, both equilibrium and rate-controlled. In particular, Humidification, Adsorption, Ion Exchange, Chromatography and separation by Membranes. At all times it is intended a development of each block in a cumulatie way regrading the separation operations that the student already knows, using the concepts of equilibrium, transfer rate, transport coefficients, countercurrent systems, cross-flow, etc..., and making a synthesis of the common concepts among all of them. The student must finally know the basic concepts of these operations and the different methods and applications as a necessary basis on new separation technologies in their *curriculum*.

Competences

- Analyse, evaluate, design and operate the systems or processes, equipment and installations used in chemical engineering in accordance with certain requirements, standards and specifications following the principles of sustainable development.
- Demonstrate knowledge of the different reaction, separation and processing operations for materials, and transport and circulation of fluids involved in the industrial processes of chemical engineering.
- Develop personal attitude.
- Develop personal work habits.
- Develop thinking habits.
- Observe ethics and professionalism.
- Show an understanding of the role of chemical engineering in the prevention and resolution of environmental and energy problems, in accordance with the principles of sustainable development.
- Understand and apply the basic principles on which chemical engineering is founded, and more precisely: balances of matter, energy and thermodynamic momentum, phase equilibrium and kinetic chemical equilibrium of the physical processes of matter, energy and momentum transfer, and kinetics of chemical reactions

Learning Outcomes

1. Apply the scientific and technological basics of balance and transfer of matter and separation operations.
2. Conceive and evaluate alternatives and perform design and operation calculations in binary and multicompound mixture separation processes.
3. Contribute to societys welfare and to sustainable development.
4. Critically evaluate the work done.
5. Develop curiosity and creativity.
6. Develop systemic thinking.
7. Generalise the concepts of the analysis and design of separation operations to apply them to different operations in the process industry.
8. Generate innovative and competitive proposals in professional activity.
9. Solve environmental problems by applying different separation operations both during and at the end of the process.
10. Work in complex or uncertain surroundings and with limited resources.

Content

TOPIC 0.- INTRODUCTION

Separation processes based on mass transfer. Phase equilibria. Transfer rate. Configurations. Equilibrium-stage operations.

TOPIC 1.- HUMIDIFICATION

1.1. Introduction

1.2. Definitions and nomenclature

1.3. Phase Equilibria

1.4. Adiabatic-saturation Temperature (T_s)

1.5. Measurement of humidity and wet-bulb Temperature (T_w)

1.6. Psychometric or Humidity chart

1.7. Theory and calculation of cooling towers

1.7.1. Equations and balances for cooling towers

1.7.2. Estimation of the outlet gas temperature

TOPIC 2.- ADSORPTION

2.1. Introduction. Definition and types of adsorption processes

2.2. Adsorbents

2.3. Equilibria. Adsorption isotherms. Adsorption models.

2.4. Stage adsorption processes

2.4.1. Cross flow

2.4.2. Countercurrent

2.5. Continuous contact adsorption processes and equipment

2.5.1. Fixed bed

2.5.2. Moving bed

2.5.3. Fluidized bed

TOPIC 3.- IONIC EXCHANGE

3.1. Principles of ionicexchange

3.2. Ionic exchange resins

3.2.1. Physical structure

3.2.2. Chemical structure. Polymeric matrix

3.2.3. Functional groups

3.3. Ionic equilibria between S-L phases

3.4. Rate of Ionic exchange

3.5. Ionic exchange operations

3.5.1. Countercurrent

3.5.2. Fixed bed

3.6. Techniques and their uses

3.6.1. Water softening

3.6.2. Total demineralization. Deionization

3.6.3. Waste treatment and metal ions recovery

3.6.4. Chromatography

TOPIC 4.- CHROMATOGRAPHY

4.1. Introduction. Nomenclature and definitions

4.1.1. Retention theory

4.1.2. Separation efficiency

4.2. Continuous carrier flow

4.2.1. Dispersion models

4.2.2. Equilibrium-stage models

4.2.3. Gaussian solution

TOPIC 5.- MEMBRANES

5.1. Fundamentals and typesof membrane separation processes

5.2. Microfiltration

5.3. Osmosis, Reverse Osmosis and Ultrafiltration

5.3.1. Reverse Osmosis

5.3.2. Ultrafiltration

5.3.3. Configuration of membrane systems

5.3.4. Concentration polarization

5.4. Dialysis

5.5. Electrodialysis

5.6. Membrane modules

5.7. Equipment and applications

5.7.1. Metal ions recovery. Electrodialysis

5.7.2. Recycling of degreasing baths

5.7.3. Separation of enzymes produced by fermentation

5.7.4. Desalinization

5.7.5. Hemodialysis

5.7.6. Algae harvesting and preparation as food

Methodology

The teaching methodology and the proposed evaluation may be modified depending on the restrictions applied by health authorities to the presenciality.

Teaching strategies: Expository lectures/Answers to questions. Seminars. Tutorials in group and individual. Problem solving in the classroom and proposals to the student.

Lectures and workshops: Students receive a set of, on one hand, theoretical concepts, and on the other hand practical skills for solving examples or easy problems. This learning will provide the basics for understanding the course and problem solving. In the workshop sessions the students will practice the concepts and skills acquired during the lectures. Small groups will easy the participation of the students in the problem solving process.

Specific Seminars: In these sessions the students will receive more practical and specific concepts acquired during the lectures. Presentation of case-studies are emphasized, promoting the participation of the students in the discussion of concepts and alternatives.

Communication environments: Virtual Forum. e-mail. Materials for study and documentation. Structured material: dossiers, exercises, etc ... Bibliography and other complementary materials on-line. Other teaching resources: Optional Specific software with teaching purposes.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Expository lectures	44	1.76	1, 2, 3, 6, 5, 7, 8, 9

Problem solving	19	0.76	1, 4, 2, 6, 5, 7, 8, 9, 10
Seminars	4	0.16	1, 2, 5, 7, 9
Type: Supervised			
Furhter tutorials	4	0.16	1, 2, 6, 5, 7, 8
Realization of theoretical works, problems and process simulation	8	0.32	1, 4, 2, 5, 7, 9, 10
Type: Autonomous			
Problem solving	63	2.52	1, 4, 2, 3, 6, 5, 7, 8, 9, 10
Study	73	2.92	1, 4, 2, 6, 5, 7, 8, 9
Tutorials with professor	2	0.08	1, 4, 2, 9

Assessment

The teaching methodology and the proposed evaluation may be modified depending on the restrictions applied by health authorities to the presentiality.

Continuous evaluation

The continuous evalutation will be made considering a series of tests and activities:

- Delivery and presentation of problems, activities and exercises (PAE):20% of the final course mark.

- 1st partial test (PP1) (topic 1): 10% of the final course mark.

- 2nd partial test (PP2) (topics 2 to 4): 10% of the final course mark.

- 3rd partial test (PP3) (topic 5): 10% of the final course mark.

- Synthesis test (PS) (topics 1 to 5): 50% of the final course mark.

The synthesis test will consist of theoretical questions (25%) and problem solving (75%). A minimum score of 40/100 is required in this test to be able to pass the course through continuous evaluation. The presentation to the synthesis test (PS) is mandatory to be able to make the final or recovery test (PR) in case of not passing the continuous evaluation.

The student can do the recovery test as long as it has been previously evaluated with a fraction of the activities and tests of at least 2/3 of the final mark. It will be considered Not Gradable (NA) if it has not been evaluated with a fraction of at least 2/3 parts. In addition, in order to be able to take part in the recovery, they must have a score higher than 30/100 as the average of all the activities and tests of the course.

Final test

The students who have been evaluated in a minimum of 2/3 of the total grade of the course and have not passed the continuous evaluation, will be able to dothis final test of recovery (PR 80%). Therefore, the presentation to the synthesis test (PS) of the continuous evaluation is mandatory to be able to make this final test of recovery. The required minimum score of the continuous evaluation is 30/100 in order to be able to do the final test.

The final test will cover all the content of the course and will consist of theoretical questions (25%) and problem solving (75%). A minimum score of 40/100 is required in this test to be able to pass the course by considering all the PAE (20%) carried out in the continuous evaluation.

In case of not presenting to the final test without having passed the continuous evaluation, the final qualification of the course will be Not Gradable (NA).

Second registration or more

From the second registration, the student could choose between new continuous evaluation or a synthesis test that will be the same test (equal date and time) as the synthesis test (PS) for the students of first registration. Thus, the qualification of the course will correspond either to the continuous evaluation or just the mark of this test, replacing the continuous evaluation for all purposes. They could also do a final recovery test that will be the same test (equal date and time) as the recovery test (PR) for the students of first registration).

For the review of the results of the evaluations, the time and manner will be established within the 10 working days following its communication through the virtual platform.

Granting a qualification of "matrícula de honor" (MH), apart from the minimum mark that can give access (≥ 9.00), is the decision of the faculty responsible for the course that will take into account the proactivity towards the subject, the understanding of the fundamentals and their relationship with other subjects and the fluency, reliability, expression and rational thinking. Special attention willbe paid to the theoretical part ofthe synthesis and final tests.

Beside other disciplinary measures deemed appropriate, and in accordancewith current academic regulations, will be qualified with a "zero" theirregularities committed by the student that may lead to a variation of the qualification of an act of evaluation. Therefore, copying or allowing to copy a practice or any other evaluation activity will involve not passing it with a zero, and if it is necessary to pass it to pass the course, the whole course will qualified without passing. The evaluation activities qualified in this way and by this procedure will not be recoverable, and therefore the student will not pass the course directly without the opportunity to recover it in the same academic year.

The time-schedule of the evaluation and delivery of work activities will be published in the corresponding virtual platform (Moodle) and may be subject to possible programming changes for reasons of adaptation to possible incidents. Always be informed in the corresponding virtual Platform about these changes, since it is understood that this is the usual platform for exchange of information between teachers and students.

In no case will exams be held on dates and times different from those officially published by the Grade Coordination/ School of Engineering.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery and presentation of problems, activities and exercises	20 %	0	0	1, 4, 2, 3, 6, 5, 7, 8, 9, 10
Partial tests	30 %	3	0.12	1, 4, 2, 3, 6, 5, 7, 8, 9, 10
Synthesis test	50 %	5	0.2	1, 4, 2, 3, 6, 5, 7, 8, 9, 10

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