COURSE DATA

Data Subject	
Code	34768
Name	Unit Operations of chemical engineering III
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	**Center**	**Acad. year**	**Period**
1401 - Degree in Chemical Engineering	School of Engineering	3	Second term

Subject-matter

Degree	**Subject-matter**	**Character**
1401 - Degree in Chemical Engineering	15 - Basic operations of chemical engineering	Obligatory

Coordination

Name	**Department**
DEJOZ GARCIA, ANA MARIA	245 - Chemical Engineering
VERCHER MONTAÑANA, ERNESTO	245 - Chemical Engineering

SUMMARY

The subject Unit Operations of Chemical Engineering III (OB III) is a compulsory course taught in the third year of the degree in Chemical Engineering in the second (Spring) semester. In the curriculum of the University of Valencia has a total of 6 ECTS.

The subject OB III is part of the matter Unit Operations of Chemical Engineering whose overall objective is to enable to the design and performance analysis of different types of unit operations in the chemical industry. The subjects Unit Operations of Chemical Engineering I (OB I) and III are focused on the most important mass transfer unit operations used in practice. The subject OB III is the logical continuation of the subject OB I. The following operations will be studied: Solvent Extraction, both the Liquid-Liquid Extraction and Solid-Liquid Extraction; Adsorption and Ion Exchange; Operations related to the interaction between air and water such as water cooling towers and evaporative processes air humidification and dehumidification, processes including heat transport phenomena, as in Drying Operations of wet solids and Crystallization of solutions to be also studied later. Finally, some mechanical separation operations based on fluid flow such as Sedimentation or Filtration as well as membrane separation processes will be considered necessarily in a much summarized form.

Ultimately, the goal of this subject is to apply basic principles of chemical engineering design and performance analysis of different types of basic operations of the process industry, according to

standards and specifications, with the following contents:

- Basics of mass transfer: mechanisms and basic design equations.
- Separation staged and continuous. Thermodynamic equilibrium.
- Design and analysis of mass transfer equipment and other basic operations of separation.

This is a subject with a large practical component in which, after the explanations of key concepts will be carried out numerous practical exercises.

Remarks: The theory classes will be taught in Spanish and practical classes as stated in the course information available on the website of the degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

It would be advisable to dispose of the following knowledge:
Mass and energy balances.
Basic concepts of chemistry and chemical thermodynamics.
Property transport rate equations. Transport coefficients.
Have taken the subject: Unit Operations of Chemical Engineering I.

OUTCOMES

1401 - Degree in Chemical Engineering

- G3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- G4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering.
- G5 - Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and analogous work.
- G6 - Ability to deal with specifications, regulations and mandatory standards.
- G10 - Ability to work in a multilingual and multidisciplinary environment.
- G11 - Knowledge, understanding and ability to apply the necessary legislation for practising professionally as a qualified industrial technical engineer.

- TE1 - Knowledge of material and energy balances, biotechnology, matter transfer, separation operations, chemical reaction engineering, reactor design, and valorisation and transformation of raw materials and energy resources.
- TE2 - Ability to analyse, design, undertake simulations and optimise processes and products.

LEARNING OUTCOMES

Learning results

- Understand the basic principles of mass transfer and separation unit operations and be able to use them to identify, formulate and solve problems in their area of work. (Outcomes G3, G4 and TE1)
- Understand the basic principles of thermodynamic equilibrium and be able to use them to identify, formulate and solve problems. (Outcomes G3, G4 and TE1)
- Being able to design mass transfer and separation equipment and installations according to standards and specifications. (Outcomes G4, G6 and TE2)
- Being able to operate mass transfer and separation equipment and installations of the chemical process industry, according to standards and specifications. (Outcomes G5, G6 and TE2)
- Ability to analyze equipment and process of mass transfer and separation, to assess their suitability and to propose alternatives. (Outcomes G4, G6 and TE2)
- Know how to use specific software for analysis and design of unit operations. (Outcomes TE1 and TE2)
- Interpret and extract the necessary information to solve problems. (Outcomes G4 and G10)
- Select and apply appropriate mathematical methods to solve problems. (Outcomes G3 and TE1)
- Critically analyze the results obtained by solving problems. (Outcome G4)
- Find, select and understand the information in specialized literature sources. (Outcomes G10 and G11)
- Acquire ability to work in groups. (Outcome G10)

Skills to be acquired

Students will be able to:

- Know the basis of solvent extraction process, when it is used and why it is used.
- Know and work with the different forms of liquid-liquid equilibrium and solid-liquid. Equilibrium stage and stage efficiency.
- Working with triangular diagrams and properly implement the lever rule.
- Calculate the number of equilibrium stages in ELL and ESL.
- Know the distinguishing characteristics of industrial equipment extraction (LLE and SLE).
- Know the basis of adsorption and ion exchange and its main applications and different operating modes.
- Know and use appropriately the adsorption equilibrium relations.
- Understand the fundamentals of the design of industrial equipment for adsorption and ion exchange.
- Learn the basic operations related to the processes of air-water interaction.
- Calculate the set of physical and thermodynamic properties of moist air (absolute humidity, relative humidity, dew point temperature, adiabatic saturation temperature, enthalpy, etc.).
- Qualitatively and quantitatively manage the Mollier diagram.
- Apply the enthalpy method to the design of water cooling towers.

- Design the equipments of humidification and dehumidification of air.
- Know the process of drying of wet solids.
- Handle with ease the different properties of the wet solids and the characteristics of equilibrium and kinetics of drying of solids.

- Knowing the different types of dryers that are commonly used in industry.
- Applying the fundamental equations for calculating the drying time in different types of dryers.
- Understand the fundamentals of crystallization in any form.
- Working with the crystallization equilibrium diagrams (phase diagrams and enthalpy).
- Understand the fundamentals of the formation and crystal growth.
- Know the saturation concept and its importance in the crystallization.
- Perform calculations on yields and capabilities of different types of crystallizers.
- Know the different types of crystallizers.
- Understanding the fundamentals of other separation operations based on fluid flow.
- Understand the fundamentals of sedimentation and sedimentation rates.
- Understand the fundamentals of filtration and types of filters used in the chemical industry.
- Know the separation processes that use membrane technology of greater industrial application.

In addition to the specific objectives mentioned above, the course will encourage the development of several **social and technical skills**, among which include:

- Capacity for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to communicate ideas, problems and solutions.
- Ability to argue from rational and logical criteria.
- Ability to speak properly and organized.
- Ability to develop a problem in a systematic way and organized.
- Ability to critically analyze the results of a problem.
- Ability to work independently.
- Ability to integrate and actively participate in group tasks respecting diversity, equity and gender equality.
- Ability to properly distribute the time to develop individual and group tasks.

DESCRIPTION OF CONTENTS

1. Liquid-liquid Extraction

Introduction. - Equilibrium in liquid-liquid systems. - Immiscible and partially miscible systems. Triangular diagrams. Binodal curve and tie lines. - Mass balances. Lever rule. - Calculation of number of ideal stages in immiscible systems. Operating line. - Calculation of number of ideal stages in partially miscible systems. Operating pole. Classification and selection of L-L extraction units.

2. Solid-liquid extraction

Introduction. - Equilibrium in SLE. Retention by the solid solution. - Modes of operation in SLE. - Design of extractors. Calculation of number of ideal stages. - Industrial equipment for SLE.

3. Adsorption and Ion Exchange

Introduction. - Adsorbents and ion exchangers. - Equilibrium in adsorption. Adsorption isotherms. - Kinetics of adsorption. - Design of equipment. Moving bed and fixed bed. Breakthrough curve and adsorption wave. - Industrial equipment. - Advanced Adsorption Process. - Equilibrium in ion exchange. - The ion exchange capacity. - Kinetics of the exchange.

4. Operations based on air-water interaction

Air-Water Interaction. Introduction. - Properties of moist air. Mollier diagram. - Adiabatic and non adiabatic humidification. - Wet air temperature. - Design of equipments. Fundamental equations. - Water cooling towers. Enthalpy method. - Industrial equipment cooling water. - Humidification and dehumidification of air.

5. Drying wet solids

Introduction. - Properties of wet solids.-Equilibrium in drying. - Mechanism and kinetics of drying. Drying periods. - Design and calculation of dryers. - Determination of drying time: Batch Dryers. - Continuous dryers. Adiabatic operation. - Classification and selection of dryers.

6. Crystallization in solutions

Introduction. - Characteristics of crystalline solids. - Equilibrium of crystallization. - Diagrams of equilibrium: molten mixtures, solutions, binary systems, ternary systems. - Supersaturation. - Yields. - Kinetics of crystallization. - Design of crystallizers.

7. Other separation operations

Operations based on external fluid flow. Membrane separation processes. Description of the most important operations and their industrial application.

WORKLOAD

ACTIVITY	Hours	% To be attended
Classroom practices	40,00	100
Theory classes	20,00	100
Development of individual work	35,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the subject is structured in lectures on the theory together with the resolution of related problems and carrying out activities.

In the lectures, master classes will be the basic methodology. The professor will present by means of presentation and/or explanation of the contents highlighting those key aspects for understands them. The main competences worked with these activities will be G3, G6, TE1 and TE2.

Practical sessions of problems will be developed following two models. Some of the classes will be the professor who solves a series of sample problems in order to show how to identify the essential elements of the way the problem is set out and its solution. In other practical sessions will be the students, individually or in team, who should solve similar problems under the supervision of the professor. After the work, the problems will be collected, analyzed and corrected. The main competences worked with these activities will be G3, G4, G6, TE1 and TE2.

The proposed activities will be divided into two types: complete Problems, with a similar complexity to the problem exams, and Tests, designed to prepare the most important concepts of each unit. All the proposed activities will be held at the usual schedule of the subject . After its correction, the students will be informed of the results so that they can identify their errors and strengthen the less consolidated concepts. The main competences worked with these activities will be G4, G6 and TE2.

EVALUATION

Learning evaluation in the **first call** is based on a continuous assessment model, in which the activities carried out throughout the semester will be considered of: Theoretical Questionnaires (TQ), Solved Problems (SP) and two Objective Tests (OT1 and OT2).

The grade of the theoretical part of the subject (GT) will be obtained from the average of the marks of the Theoretical Questionnaires carried out. The grade of the problems part of the subject will be obtained from the marks of the Solved Problems (GSP) and the marks of the Objective Tests (GOT1 and GOT2).

The date of completion of any evaluable activity, questionnaires or problems, will be given with sufficient advance notice, and it will always be during the usual subject timetable. With regard to the Objective Tests, the first one (Chapters 1 and 2) will be held on the scheduled date of the subject timetable, while the second one (Chapters 3 to 7) will coincide with the official date of the exam of the first call.

The Final Grade of the subject will be obtained as follows:

Final Grade = 0.20 (GT) + 0.10 (GSP) + 0.25 (GOT1) + 0.45 (GOT2)

To pass the subject in the first call, the Final Grade must be equal to or greater than 5.0 out of 10. Failure to attend any of the two Objective Tests (OT1 and OT2) will mean the grade "No Show (NS)".

If a student has a justified reason that prevents him/her from following the continuous assessment modality, he/she must contact the teaching staff responsible for the subject at the beginning of the semester to agree on an alternative assessment modality.

Learning evaluation in the **second call** will be carried out based on the mark of the Solved Problems (GSP) and the mark of a single Examination of all the contents of the subject (GEX) that will be carried out on the official date of the second call.

The Final Grade of the course will be obtained as the highest of:

Final Grade = 0.10 (GSP) + 0.9 (GEX)

Final Grade = 1 (GEX)

To pass the subject on the second call, the Final Grade must be equal to or greater than 5.0 out of 10. Failure to attend the exam of the second call will mean the grade "No Show (NS)".

In all activities (TQ, SP, OT1, OT2 and EX) the acquisition of G3, G4, G6, TE1 and TE2 skills will be assessed.

In any case, the assessment system will be governed by that established in the Reglament d'Avaluació i Qualificació de la Universitat de València per a Títols de Grau i Màster (https://goo.gl/UdDYS2).

REFERENCES

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