Course Guide
34766 Unit operations of chemical engineering I

COURSE DATA

Data Subject	
Code	34766
Name	Unit operations of chemical engineering I
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

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

Subject-matter

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

Coordination

Name	Department
LLADOSA LOPEZ, ESTELA	245 - Chemical Engineering
LORAS GIMENEZ, SONIA	245 - Chemical Engineering

SUMMARY

The course is a compulsory course taught in the third year of the degree in Chemical Engineering in the first (autumn) semester. In the curriculum of the University of Valencia has a total of 6 ECTS.

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

The course Unit Operations of Chemical Engineering I is part of the subject Unit Operations of Chemical Engineering whose overall objective is to enable the student to the design and performance analysis of different types of unit operations in the chemical industry. Courses Unit Operations of Chemical Engineering I and III are focused on the most important mass transfer unit operations used in practice. They are intended to give students the ability to design and manage the operation of the equipment needed to perform these operations. Specifically the subject Unit Operations of Chemical Engineering I is focused on the study of two very important operations in the chemical industry: distillation and absorption of gases. Being the first course of Unit Operations, the first part is a general introduction and review of some thermodynamic concepts applied to mass transfer.

The contents of the course are: Unit Operations of mass transfer: mechanisms and basic design equations. Separation in stages and continuously. Thermodynamic equilibrium. Design and analysis of mass transfer equipment.

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 for the student to dispose of the following knowledge:
Mass and energy balances
Property transport rate equations. Transport coefficients.
Basic concepts of chemistry and chemical thermodynamics

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

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 (RD 1393/2007) // NO CONTENT (RD 822/2021)

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, G5, G6, G11 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, G11 and TE1)
- Ability to analyze equipment and process of mass transfer and separation, to assess their suitability and to propose alternatives. (Outcomes G4 and TE2)
- Know how to use specific software for analysis and design of unit operations. (Outcomes G4 and TE2)
- Interpret and extract the necessary information to solve the problems. (Outcomes G4 and TE2)
- Select and apply appropriate mathematical methods to solve problems. (Outcomes G4 and TE2)
- Critically analyze the results obtained by solving the problems. (Outcomes G11 and TE2)
- Find, select and understand the information in specialized literature sources. (Outcomes G4, G6 and G11)
- Acquire ability to work in groups. (Outcome G10)

Skills to be acquired

Students will be able to:

- Know the basis of Unit Operations of Chemical Engineering.
- Know the basis of Separation Processes and their relative importance in the Chemical Process Industry.
- Know, differentiate and apply some fundamental concepts of separation processes (separation factor, separating agent, ideal stage, stage efficiency, etc.).
- Understand the fundamentals of phase equilibrium: Gibbs free energy, chemical potential, fugacity coefficients, activity coefficients, etc.
- Know and apply of thermodynamic models to estimate the phase equilibrium and other thermodynamic properties.
- Know and work with the vapor-liquid equilibrium and its application to distillation problems: bubble temperature, dew temperature, binary mixtures, multicomponent mixtures, etc.
- Know and work with different types of distillation. When and why they are used.
- Understand the operation of the rectification trayed towers and its performance.
- Know how approach and solve the equations representing the stationary operation of a rectification tower.
- Know the meaning and significance of the reflux ratio of a rectification tower.
- Determine the number of plates and the diameter of the tower.

- Understand the operation of the rectification packed towers.
- Know the different types of packings and its main characteristics
- Know and apply the different design procedures of packed towers
- Understand the concept of HETP and mass transfer coefficient.
- Calculate the necessary packing height and diameter of the tower.
- Knowing the intermittent operation (not stationary) of a rectification tower
- Know how design a batch rectification tower
- Knowing the ways of operating of a batch rectification tower
- Knowing the conditions under which the batch rectification can be attractive
- Know the most outstanding characteristics of the rectification of multicomponent mixtures.
- Know what the previous decisions to consider when dealing with multicomponent mixtures
- Apply the approximate methods (short) to design multicomponent rectification towers.
- Know the basis of the gas absorption process
- Know and work with the equilibrium solubility of gases in liquids
- Properly handle the various forms of Henry's law
- Design of trayed and packed absorption columns and their modes of operation

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 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 work independently.
- Ability to integrate and actively participate in group tasks.
- Ability to properly distribute the time to develop individual and group tasks.

DESCRIPTION OF CONTENTS

1. Mass Transfer Unit Operations

Unit Operations in Chemical Engineering. General Introduction.- Separation Processes. Generalities.- Some basic concepts about separation processes.- Characteristics, classification and selection of separation processes.

2. Basic Thermodynamics of Phase Equilibria

Phase diagram in binary systems. Thermodynamic treatment of equilibrium: Gibbs free energy, chemical potential, law of Raoult, non ideality. Bubble temperature and pressure, and dew temperature and pressure. Relative volatility. Vapor-liquid equilibrium ratio (K values).

3. Distillation

Differential simple distillation: binary and multicomponent mixtures. Continuous simple distillation. Flash distillation: isotherm and adiabatic. Partial condensation.

4. Continuous rectification of binary mixtures in trayed columns

Deduction of fundamental equations. - Optimal position of feed-stage. - Calculation of number of equilibrium stages: rigorous method, approximate methods. - Limiting conditions of operation. - Study of different alternatives of operation. - Calculation of the number of actual stages: efficiencies. - Calculation of the diameter

5. Continuous rectification of binary mixtures in packed columns

Types of packing. - Design methods. - Calculation of the diameter of the column. Packed columns versus trayed columns.

6. Batch rectification

Design: operation at constant distillate composition, operation at constant reflux ratio. - Performance: operation at constant distillate composition, operation at constant reflux ratio.

7. Rectification of multicomponent mixtures

Previous decisions: operating pressure, type of condenser, key components; approximate compositions of distillate and residue, reflux ratio, etc. - Methods of calculation: rigorous method, approximate methods. - Special Distillations

8. Absorption

Solubility of gases in liquids. Gas-liquid equilibrium. Henry's Law. - Design of absorption towers. Absorption of a single component. Trayed towers. Calculation of the diameter and number of stages. Packed towers. Calculation of the diameter and packing height. Absorption tower design. multicomponent absorption

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 course is structured in lectures on the theory together with the resolution of related problems, and carrying out works.

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, G4, G10, 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 help the students 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 by the professor. The main competences worked with these activities will be G4, G6, G10 and TE2.

The proposed work to the student 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. Part of these activities will be made during the lectures, and the rest of them will be optional deliveries for a proper preparation of the course by the students. After its correction, the students will be informed of their results and a summary of the most consolidated and frequent failures. The main competences worked with these activities will be G3, G4, G5, G6, G10 and TE2.

EVALUATION

The assessment of student learning will be carried out using two models:

Model A: The assessment with this model is based on a continuous assessment taking account the works (tests and proposed problems) and two objective exams according to two parts (Part I: units 1 to 4 and Part II: units 5 to 9). The exam of Part I will be when these contents finish, and the exam of Part II will be on the official date for first vocation.

The final mark will be calculated as the greater one of:

- the weighting between the average mark of the tests (20%), delivered problems (10%) and the grade of the two objective exams (70%),or
- the grade of the two objective exams plus a 5% of the average mark of the works (tests and proposed problems)

If a minimum mark of 4 (out of 10) is not gotten in the average score of the tests, the final mark will be the average of the two objectives tests.

On the second call the evaluation will be conducted by Model B.

Model B: The assessment of the course with this model will be realized through an exam of all contents of the course in the official date.

The final mark with this model will be obtained as the greater one of:

- the weighting between the average mark of activities (20%) and the mark of the exam (80%), or
- the mark of the exam

If a minimum mark of 4 (out of 10) is not gotten in the exam, the final mark will be the grade obtained in the exam.

The exams will have theoretical and practical questions and problems. Achievement of competences G3, G4, G6, TE1 and TE2will be evaluated.

The subject will be passed when the average final mark is equal or greater than 5 (out of 10).

Anyhow, the evaluation system will be based on the guides stated in the “Reglament d’Avaluació i

Qualificació de la Universitat de València per a Graus i Màsters” (ACGUV 108/2017).

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