VNIVERSITAT DE VALÈNCIA

Course Guide
34768 Unit Operations of Chemical Engineering III

COURSE DATA

Data Subject	
Code	34768
Name	Unit Operations of Chemical Engineering III
Cycle	Grade
ECTS Credits	6.0
Academic year	2019 - 2020

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
MONTON CASTELLANO, JUAN BAUTISTA	245 - Chemical Engineering
VERCHER MONTAÑANA, ERNESTO	245 - Chemical Engineering

SUMMARY

The course 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 course Unit Operations of Chemical Engineering III 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. The course OBIQ-III is the logical continuation of the OBIQ-I. We will study the following operations: 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 that begin to take into account the heat transport phenomena, as in Drying Operations of wet solids and crystallization of solutions that we will see later. Finally, we will necessarily much summarized form, some mechanical separation operations, based on fluid flow, such as the sedimentation or filtration.

Ultimately, the goal of this matter is that the students 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 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 for the student to dispose of the following knowledge:

Mass and energy balances
Basic concepts of chemistry and chemical thermodynamics
Property transport rate equations. Transport coefficients.
Having made the course: 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 the 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 the 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 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 (LL and SL).
- 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 what is meant by saturation and its importance in the crystallization.
- Perform calculations on income and capabilities of different types of crystallizers.
- Know the different types of crystallizers.
- Understanding the basics 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.

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.
- Ability to properly distribute the time to develop individual and group tasks.

DESCRIPTION OF CONTENTS

1. Mass Transfer Unit Operations. Introduction

General introduction to the subject. Relationship with other courses in the subject

2. Liquid-liquid Extraction

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.

3. Solid-liquid extraction

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. Supercritical extraction

4. Adsorption and Ion Exchange

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

5. 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 equipment. Fundamental equations. - Water cooling towers. Enthalpy method. - Industrial equipment cooling water. - Humidification and dehumidification of air.

6. Drying wet solids

Drying. 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

7. Crystallization in solutions

Crystallization. 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

8. Other separation operations (not based on mass transfer)

Other Separation Processes. Operations based on external fluid flow. - Description of the most important operations and their industrial application. - Filtration theory. Basic equations. - Classification and application of industrial filters. - Design of equipment for filtration

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, the seminars 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, 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 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 or students. The main competences worked with these activities will be G3, G4, G6, TE1 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. Par of theses activities will be made during the lectures, and the rest of them will have a timetable for its completion and delivery 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 G4, G6 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. If the student chooses this type of evaluation, must obtain in each of the objective exams a mark equal or higher than 3.5 (out of 10). 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 10% of the weighted average mark of the works (tests and proposed problems)

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 (30%) and the mark of the exam (70%). 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 TE2 will 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 Títols de Grau i Màster” (https://goo.gl/UdDYS2).

REFERENCES

Basic

- McCabe, W.L.; Smith, J.C.; Harriot, P. Unit Operations in Chemical Engineering. 7ª ed. McGraw-Hill. Nueva York (2005). Traducido como: Operaciones Básicas de Ingeniería Química.7ª ed. McGraw-Hill Interamericana. Madrid (2007)
- Seader, J.D.; Henley, E.J. Separation Process Principles Second edition. John Wiley and Sons. New York (2006).
- Treybal, R.E. "Mass Transfer Operations". 3ª ed. McGraw-Hill. New York (1980). Traducción al castellano: "Operaciones de Transferencia de Masa". McGraw-Hill. México (1980).

- Wankat, P.C. Separation Process Engineering Second Edition. Prentice Hall (2006). Accesible on line. http://proquest.safaribooksonline.com/book/chemical-engineering/9780132442312

Additional

- Coulson, J.M.; Richardson, J.F.; Bachurst, J.R.; Harker, J.H. Chemical Engineering. Pergamon Press. Londres. Vols. 1 y 2, traducidos ambos al castellano por ed. Reverté. Barcelona. (1991)
- Geankoplis, C.J. Transport Processes and Separation Process Principles (Includes Unit Operations) Fourth Edition. Prentice Hall (2003). Accesible on line. http://proquest.safaribooksonline.com/013101367X?uicode=valencia
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- Perry,R.H.; Green, D.W.; Maloney, J.O. "Perry's Chemical Engineers Handbook", 7ª ed. , McGraw-Hill . (2001).Traducción al castellano. "Manual del Ingeniero Químico", McGraw-Hill (2001).
- Towler, G.P.; Sinnott, R.K. Chemical engineering design: principles, practice, and economics of plant and process design. Second edition. Butterworth-Heinemann(2013). Accesible on line. http://www.sciencedirect.com/science/book/9780080966595

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

1. Contenidos

Se mantienen todos los contenidos teóricos inicialmente recogidos en la Guía Docente.

2. Volumen de trabajo y planificación temporal de la docencia

Se mantiene la carga de trabajo de las distintas partes teórico-prácticas (clases de teoría y explicación de problemas) que marca el número de créditos en la Guía Docente.

Este volumen de trabajo se desarrolla mediante una planificación temporal docente a medida que avanza el curso, siendo el horario flexible para facilitar el desarrollo de las distintas actividades que tuviese que realizar el alumno.

3. Metodología docente

- Las clases magistrales presenciales se sustituyen por materiales proporcionados a través de Aula Virtual consistentes en transparencias locutadas (power point), y videos en la que se exponen y razonan los contenidos teóricos y la resolución de los problemas ya programados desde el inicio del curso.

- En Aula Virtual están subidos todos los contenidos comentados anteriormente que se organizan por bloques. Además están colgados los apuntes de teoría de cada uno de los temas en formato pdf, enunciados de los problemas de clase, cuestiones teórico-prácticas y problemas para resolver por el estudiante con sus soluciones.

- Se mantiene el sistema de tutorías virtuales que se atienden por correo electrónico.

4. Evaluación

Se mantiene el procedimiento de evaluación presentado en la Guía Docente..

El examen se realizará a través de Aula Virtual en la fecha estipulada y aprobada en Junta de Centro y publicada en la web de la ETSE.

El examen constará de la resolución de una serie de problemas y cuestiones en los que se evaluarán todos los contenidos básicos de la asignatura. En su momento se darán a los estudiantes, a través de Aula Virtual, las instrucciones pertinentes para su desarrollo.

5. Bibliografía

En Aula Virtual se han colgado todos los temas que aparecen en la descripción de contenidos de la Guía Docente con los que el estudiante puede adquirir las competencias de la asignatura Operaciones Básicas de la Ingeniería Química III.

Además, en las referencias bibliográficas de la Guía Docente aparecen tres obras que son accesibles on line.