COURSE DATA

Data Subject	
Code	33997
Name	Basic Operations
Cycle	Grade
ECTS Credits	9.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1103 - Degree in Food Science and Technology	Faculty of Pharmacy and Food Sciences	2	Annual

Subject-matter

Degree	Subject-matter	Character
1103 - Degree in Food Science and Technology	14 - Chemical engineering	Obligatory

Coordination

Name	Department
SAN VALERO TORNERO, PAU	245 - Chemical Engineering

SUMMARY

Unit Operations is a compulsory subject that is taught annually in the second year of the Degree in Science and Food Technology. In the curriculum of the University of Valencia has a total of 9 ECTS credits. This subject aims students to apply the basic principles of chemical engineering, previously seen in the course Foundations of Chemical Engineering, to design and performance analysis of the unit operations commonly used in the food industry.

The study of the unit operations classification begins with attending to the physical phenomenon that are based predominantly in: unit operations of momentum transport, unit operations of mass transfer and unit operations of heat transfer.

The first group will deal the study of the circulation of liquids by pipeline, filtration and membrane separation operations. Later, the solid-liquid extraction will be studied in detail as an example of unit operation controlled by the mass transfer, present in the food industry. The design and operation of heat exchangers and evaporators for industrial use will be also examine, both controlled by heat transfer. Finally, we will study the processes of dehydration of solids (drying and lyophilization) that in addition to

the mass transfer, also takes into account the heat transport.

The subject is eminently applied, so that the theoretical components must be added the practical, both resolution of numerical questions and problems that simulate real situations as well as experimentation in the laboratory. In these practical components the theoretical concepts introduced will be applied, and the student will become familiar with the operation mode of the processes in the food industry.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

To successfully pass the course is essential that students have the following background:
Energy and Mass balances
Rate equations of property transport. Transport coefficients
Basics of Chemistry and Thermodynamics
Math Basics

OUTCOMES

1103 - Degree in Food Science and Technology

- Develop skills to undertake further study.
- Capacidad de interpretar datos relevantes.
- Control and optimise processes and products in the food industry.
- Develop new processes and products in the food industry.
- Poseer y comprender los conocimientos en el área de Ciencia y Tecnología de los Alimentos.
- Manufacture and preserve food.
- Saber aplicar esos conocimientos al mundo profesional, contribuyendo al desarrollo de los Derechos Humanos, de los principios democráticos, de los principios de igualdad entre mujeres y hombres, de solidaridad, de protección del medio ambiente y de fomento de la cultura de la paz.
- Asesorar científica y técnicamente a la industria alimentaria y a los consumidores en el marco de la normativa legal vigente.
- Know the modes of operation of the food industry.
- Understand and classify unit operations.
- Be able to select, size and analyse the operation of processing equipment based on momentum transfer.

- Be able to select, size and analyse the operation of processing equipment based on energy transfer.
- Be able to select, size and analyse the operation of processing equipment based on mass transfer.
- Be able to select, size and analyse the operation of processing equipment based on simultaneous mass and energy transfer.
- Use laboratory or pilot plant equipment similar to that used in the food industry.
- Interpret information regarding a problem and translate it into process variables or variables of operation of equipment.

LEARNING OUTCOMES

Classify unit operations based on the predominant transport property.

Know the rheological behavior of fluids.

Write the fundamental equations for incompressible fluid flow by pipeline.

Calculate the mechanical energy losses in pipes.

Calculate the power supplied by a pump to circulate a given flow rate.

Calculate the flow rate of fluid through a pipe.

Calculate the diameter of a pipe for a fluid flow rate.

Know the different types of pumps and their characteristics.

Indicate the conditions of cavitation of a pump.

Determine the discharge and the head supplied by a pump in a given system.

Know the basics of filtration.

Write and solve the material balances and the rate equation, in the case of a filtration at constant pressure in a filter press.

Understand the fundamentals of separation processes with membranes, their advantages and disadvantages and their main applications in the food industry.

Understand and classify the different types of membranes.

Know the transport models of species through membranes.

Describe and quantify the phenomenon of concentration polarization.

Define osmotic flow and evaluate the osmotic pressure of a solution based on its concentration.

Apply the design equations for reverse osmosis units and ultra-filtration to estimate the composition of the permeate and the membrane area.

Know the basis of solvent extraction process, when and why it is used.

Work with triangular diagrams and properly apply the lever rule.

Meet and work with different forms of solid-liquid equilibrium.

Know and apply the concept of ideal stage and the concept of stage efficiency to calculate the number of stages in a process of solid-liquid extraction.

Know the characteristics of industrial equipment in solid-liquid extraction.

Know the different flow configurations of heat exchangers for industrial use: plate and shell & tube.

Determine the effectiveness and performance analysis of a double pipe heat exchanger.

Design and performance analysis of a heat exchanger for industrial applications, applying the method of correction factor for the logarithmic mean temperature difference.

Design and performance analysis of a heat exchanger for industrial applications, using the method of the number of transfer units.

Design and performance analysis of a heat exchanger for industrial applications, applying the generalized graphical method.

Select the most suitable heat exchanger to carry out an operation of heat exchange.

Know the basics of evaporation. Single/multiple effect evaporators.

Write and solve the material balances, energy and the rate equation for the design and analysis of the performance of a single effect evaporator.

Know the different dehydration processes of solids.

Know the different properties of moist air and the wet solids.

Know how to interpret the drying curves and drying rate curves of a solid.

Know the basics of lyophilization.

Carry out experiments of property transport (mass, energy and / or momentum).

Carry out experiments of property balance.

Manage laboratory equipment or pilot plant similar to those in the food industry.

Being able to write a correct, understandable and organized report.

Being able to use software packages for the treatment of experimental results, performing calculations and graphs, and written reporting.

In addition to the specific objectives mentioned above, the course will encourage the development of several generic 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 and organized way.

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 or group tasks.

DESCRIPTION OF CONTENTS

1. Introduction

Unit operation. Classification .- Unit Operations controlled by the mass transfer.- Unit operations controlled by heat transfer.- Unit operations of simultaneous heat and mass transfer by direct contact between phases .- Operations unit controlled by the momentum transport.- Complementary Operations

2. LIQUID FLOW IN PIPES

The nature of fluids. Rheological behavior: Newtonian and non-Newtonian fluids.- Liquid flow in pipes. Mechanical energy balance. Mechanical energy loss.- Pumps. Characteristics. Types. Installation point of a pump. Discharge and head supplied by a pump. Pump selection.

3. FILTRATION

Basis of filtration. Constant pressure drop filtration in a filter press. Filter cake washing. Filtration capacity. Optimum filtration

4. MEMBRANE SEPARATION OPERATIONS

Membrane separation processes: Definition. Advantages and disadvantages. Characteristic parameters of operation. -Types of membranes. Configuring modules .- Mechanisms of transport. Friction model. Solution-diffusion model. Concentration polarization .- Reverse Osmosis. Design equations. Applications of reverse osmosis .- Ultrafiltration. Design equations. Applications of ultrafiltration

5. SOLID-LIQUID EXTRACTION

Introduction: solvent extraction .- Equilibrium in SLE. Retention of dissolution for solid .- Modes of operation in SLE .- Design of extractors. Calculating the number of ideal stages .- Concept of stage efficiency .- Industrial equipment for SLE.

6. HEAT EXCHANGE

Introduction.- Double pipe heat exchangers. Effectiveness. Performance analysis. Heat exchangers for industrial applications. Description. Design and performance analysis: method of correction factor for the logarithmic mean temperature difference, method of the number of transfer units, and generalized graphical method. Comparative analysis of heat exchangers. Practical considerations for design

7. EVAPORATION

Introduction to evaporation.- Basic equations in an evaporator. Material balances. Energy balance. Design equation.- Design and performance analysis of a single effect evaporator. Multiple effect evaporator.

8. DEHYDRATION: DRYING AND LYOPHILIZATION

Introduction to dehydration .- Dried-hot air. Properties of moist air and properties of wet solids.- Drying curves and drying rate curves .- Lyophilization

9. LABORATORY + INFORMATICS

Introduction to laboratory. Reynolds experiment. Determination of the characteristics of a centrifugal pump. Study of rheological behavior of fluids. Experimental study of drying. Mass balance in unsteady state. Simple open distillation. Heat exchangers. Circulation of fluids. Experimental study of filtration.- Simulation of fluid flow. Activity related to the food industry. Calculations and reporting.- Management software packages.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	52,00	100
Laboratory practices	24,00	100
Computer classroom practice	6,00	100
Tutorials	2,00	100
Seminars	2,00	100
Development of group work	30,00	0
Study and independent work	20,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	25,00	0
Resolution of case studies	30,00	0
TOTAL	**221,00**	

TEACHING METHODOLOGY

The development of the course is structured around theory and problems classes, seminars, laboratory sessions, the performance of works and tutoring.

In the theory classes the lecture model will be used. The teacher will explain the contents of each issue, focusing on key aspects for comprehension.

Practical classes of problems will be developed following two different models. In some classes the teacher is who solves a series of sample problems for students to learn to identify the essential elements of the approach and solve problems of theme. In the other classes of problems the students will solve, individually or in groups, similar problems under the supervision of the teacher. After the work, the problems will be collected, analyzed and corrected by the teacher or by the students themselves.

In the seminars students will expose to the group a topic proposed by the teachers, consisting in a process description of a process of the food industry, including unit operations of the three properties transport (momentum, mass and heat).

For laboratory practice sessions, activities will be scheduled for the introduction of practice to perform, development activities of experimentation and analysis activities and treatment of results (which will correspond to the computer sessions.) Students will have practical guide and experimentation will be carried out entirely by them under the supervision of the teacher.
The proposed work for the students will be of two types: problems similar in complexity to those of exams, and questionnaires. All of these activities will be done in class or at home, and will have a timetable for completion and delivery.

With respect to the tutorials, students will be attended in groups of 16. In them, the teacher will discuss and clarify general aspects of the subject as individual questions. Also, in these sessions the teacher will return the activities delivered by students, corrections, and resolve questions and errors in its resolution. The attendance to tutorials is mandatory.

EVALUATION

The evaluation of student learning will be carried out following two models:

A) By evaluating the activities (questionnaires and problems) carried out by the students, the grade from the seminar, the grade from the laboratory and the grade from the exam that is carried out.

B) From the note of the seminar, the laboratory and the exam.

To be evaluated by the modality A), the student must have completed at least 60% of the scoring activities proposed. Exceeded this requirement to qualify for this evaluation modality, the final grade will be obtained as the highest of:

- The weight between the average mark of the exam (50%), the mark of the scoring activities delivered (questionnaires 10% and problems 10%), the grade of the seminar (10%) and the mark of the laboratory (20%).

- The weight between the average mark of the exam (70%), the seminar grade (10%) and the laboratory grade (20%).

In modality B) the final grade will be obtained from the weighting between the average grade of the exam (70%), the seminar grade (10%) and the laboratory grade (20%).

The evaluation will be carried out through:

Objective test consisting of an exam with theoretical s and/or practical questions, and problems. The level of understanding and knowledge of the subject will be evaluated by the written exam. The student may consult the supporting material in some part of the examination.

To pass the course the average mark (weighted, if necessary) of the different parts of the exam is not less than 40 (over 100) will be required. This section will contribute to the final grade of the course with a percentage of 50% or 70%, according to the evaluation models. If the mark obtained in the examination is less than 40 points (out of 100), the grade for the course will be this one.

Continuous assessment of each student, based on regular attendance of classroom activities (theory classes, problems classes, seminars and tutorials), delivery of complementary activities (questionnaires and problems), attitude, participation and involvement of the student in the teaching-learning process.

The level of understanding of content and skills to approach and solve problems will be evaluated. The average mark of the questionnaires could contribute to the final mark with a percentage of 10% and the average mark of problems could contribute to the final with a percentage of 10%. Attendance at tutorial sessions is mandatory to take into account these percentages in the final mark of the course. Failure to attend these sessions without justification reduces those two percentages to 5%.

By other hand, the capacity for implementation, presentation, exhibition and discussion of a topic related to the contents of the degree will be evaluated (seminars). This section will contribute to the final of the subject at a rate of 10%. The students who cursed the subject for first time must attend to the coordinated seminars. Failure to attend them without justification involves a zero in the corresponding section of evaluation seminars.

Laboratory evaluation by supervising the knowledge of the guide lab (questionnaires), and the ability to present and discuss well detailed and organized the experimental results (laboratory reports). The laboratory mark is obtained as weighting of the average grade of the questionnaires (10%) and the average grade of the reports (90%). Attendance at all laboratory sessions, as well as computer sessions is mandatory. It is also planned to carry out an activity related to a food industry. Failure to carry out this activity reduces the mark obtained in the laboratory by 10%.

To pass the course the mark of laboratory must be equal or more than 50 (over 100). This part will contribute to the final mark of the course with a percentage of 20%.

To pass the course, the weighted average mark of the different parts (objective test, activities, seminar and laboratory) must be equal or more than 50 (over 100). If the course is not overcome but the laboratory is passed, the mark corresponding to this part remains for future courses.

To request advance date in the convocation of this course, students must have completed the mandatory activities listed in this teaching guide.

REFERENCES

Basic

- Operaciones Unitarias en la Ingeniería de Alimentos
  A. Ibarz, G.V. Barbosa-Cánovas . Ed. Mundi-Prensa (2005)
- Operaciones Unitarias en Ingeniería Química
  W.L. McCabe, J.C. Smith, P. Harriot. Ed. McGraw Hill (2007). 1ª edición en español.

Additional

- Ingeniería de la Industria Alimentaria (Volumen I; conceptos básicos)
  J. Aguado, J.A. Calles, P. Cañizares, B. López, F. Rodríguez, A. Santos, D. Serrano. Ed. Síntesis (2002)
- Ingeniería de la Industria Alimentaria (Volumen II; operaciones de procesado de alimentos)
  F. Rodríguez, J. Aguado, J.A. Calles, P. Cañizares, B. López, A. Santos, D. Serrano Ed. Síntesis (2002)
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  F. Rodríguez, J. Aguado, J.A. Calles, P. Cañizares, B. López, A. Santos, D. Serrano Ed. Síntesis (2002)
- Transmissió de calor
  M. Sanchotello, A.V. Orchillés . Publicacions UV (2007)
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  A.V. Orchillés, M. Sanchotello. Publicacions UV (2007)
- Nuevo Manual de Industrias Alimentarias
  A. Madrid. Ed. AMV. Mundi-Prensa (2010)