

28937 - Unit operations II

Información del Plan Docente

Academic Year	2016/17
Academic center	201 - Escuela Politécnica Superior
Degree	437 - Degree in Rural and Agri-Food Engineering
ECTS	6.0
Course	3
Period	Second semester
Subject Type	Compulsory
Module	---

1. Basic info

1.1. Recommendations to take this course

This subject is offered in the [English Friendly](#) form

1.2. Activities and key dates for the course

2. Initiation

2.1. Learning outcomes that define the subject

2.2. Introduction

3. Context and competences

3.1. Goals

3.2. Context and meaning of the subject in the degree

3.3. Competences

3.4. Importance of learning outcomes

4. Evaluation

5. Activities and resources

5.1. General methodological presentation

The learning process is based on:

1) The **participatory lecture technique** (PLT) will be applied during the course of the theoretical sessions. Students will be encouraged to actively participate in the lectures by asking/answering questions and/or solve short exercises.

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2) **Group work and collaborative learning** will be used during the course of the practical sessions, which will be focused on solving a number of problems (**practical problem-solving sessions**) and performing a number of laboratory experiments (**practical laboratory sessions**).

3) The **technical visits** to two agri-food industries will provide students with demonstrable knowledge on the topics covered during the course.

4) A **collaborative project** integrating concepts and techniques will be performed by the students (in groups of 2 or 3 members; the same groups as those established during the practical sessions).

5.2.Learning activities

- Theoretical sessions in the classroom (30 h).
- Practical sessions in the computer classroom (14 h).
- Practical sessions in the laboratory (10 h).
- Technical visits (2 visits).
- Cooperative learning: during the practical sessions (in class) and the collaborative project (out of class).
- Autonomous learning (out of class): students will be encouraged to resolve several exercises and questionnaires related to the subjects covered in the classroom. They will post the solution on the Moodle site and interact with each other.
- Individual or small-group tutoring, which can be face-to-face (in the desk of lecturers) or virtual (using the Moodle platform).

5.3.Program

Theoretical Programme

Block I: Unit operations based on simultaneous heat and mass transfer.

Topic 1 : FUNDAMENTALS OF PSYCHOMETRICS. Properties of wet air and characteristic temperatures (dew point, adiabatic saturation and wet-bulb). Use of psychometric diagram. Heating and humidification of air.

Topic 2 : DRYING OF SOLIDS WITH WARM AIR. Drying curve. Descriptions of the most commonly used drying equipment within the agri-food industry. Calculations of drying times in discontinuous dryers (during stages of constant or decreasing drying rate). Design equation in continuous dryers (rotary dryer or belt dryers). Applications.

Block II: Unit operations based on momentum transfer.

Topic 3 : FLUIDISATION AND PNEUMATIC TRANSPORT. Characterisation of solid particles. Grinding and sifting. Fluidisation: minimum fluidisation and drag velocity. Pneumatic transport.

Topic 4 : SEDIMENTATION and CENTRIFUGATION. Sedimentation by gravity. Calculation of a section of a continuous sedimentation system. Centrifugation: fundamentals and the most commonly used equipment for separation of immiscible liquids and separation of insoluble solids in liquid products.

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Topic 5 : FILTRATION AND SEPARATION BY MEMBRANES. Filtration: theoretical foundations, constant pressure drop filtration, filtration by constant medium flow; equipment. Separation using membranes: ultrafiltration, inverse osmosis, materials and membrane configuration, applications.

Block III: PROCESSES WITHIN THE AGRI-FOOD INDUSTRY

Topic 6 : MILK INDUSTRIES. Preliminary treatments (filtering, deaeration and clarification). Creaming. Homogenisation. Pasteurisation. Sterilisation and UHT treatment.

Topic 7 : JUICE PRODUCTION. Fruit treatments (washing, brushing and inspection). Extraction of juice and essential oils. Treatment of juice (pulp removal and clarification, blending and corrective actions, deaeration and pasteurisation). Production of concentrated juice (evaporation, freezing and separation by membranes).

Topic 8 . FLOUR INDUSTRY. Milling, silage and dispatch. Grinding. Extraction. Purification. Compression. Introduction to bread-making technology.

Topic 9 . BEER PRODUCTION. Maceration. Filtration. Brewing. Separation of solids from warm liquid using whirlpooling. Cooling of must. Fermentation. Ageing. Beer filtration. Pasteurisation. Packaging.

Practical Programme

Practical problem-solving sessions

Session 1 . Use of the psychometric diagram for air-water systems as implemented in the EES programme.

Session 2 . Resolving a problem related to drying solids with hot air in a discontinuous dryer (estimation of drying time for the stage using constant drying rate, determination of the properties of the air leaving the dryer etc.).

Session 3 . Determination of the minimum fluidisation velocity, the velocity of the drag and the airflow of an operation for drying solids in a fluidised bed.

Session 4 . Calculation of the velocity of sedimentation, assuming free and impaired sedimentation, for an operation to clarify fruit juice with bentonite.

Session 5 . Determination of the rotational speed of a centrifuge to clarify a certain quantity of wine.

Session 6 . Estimation of the filtrate mass, in terms of time, for a filtration operation using constant pressure drop.

Session 7 . Production of a flow diagram and determination of the mass and energy balances for a specific agri-food process.

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Practical laboratory sessions

Practical 1 : DRYING OF SOLIDS WITH HOT AIR. For this practical a tunnel tray dryer is available for academic purposes. It is possible to feed different airflows at different temperatures and continuously measure the weight of the solid material (such as carrot, barley or maize) in the trays. The temperature and relative moisture in the air, before and after the trays, is also measured continuously. Students must experiment in order to calculate drying times in a discontinuous dryer and compare them with data obtained from theoretical expressions.

Practical 2 : GRINDING AND FLUIDISATION. The aim of this practical is to analyse the distribution of different grain sizes attained in a coffee grinding operation through use of vibrating sieves. In the second part of the practical, a fluidisation operation using silica sand is carried out in order to quantify minimum fluidisation velocity and particle density.

Practical 3 . FILTRATION AND SEDIMENTATION BY GRAVITY. Here, a filter press device is used for the filtration of a watery solution of calcium carbonate, which operates using constant pressure drop. Using data gained from experiments highlighting filter volume in terms of time, the parameters of the system can be estimated: specific resistance of the filter cake and specific volume. During the second part of the session, experimental data is recorded from the discontinuous sedimentation process of the water-CaCO₃, using different concentrations. This data can be used to determine the minimum area required for a continuous sedimentation system operating in fixed conditions.

Practical 4 . CENTRIFUGATION OF IMMISCIBLE LIQUIDS. For this practical, whole milk is separated in two phases (skimmed milk and cream) by using a laboratory centrifuge. The influence on separation yield is analysed using three variables: working temperature, rotational speed and partition separation. The separation yield of each test is determined in terms of the results obtained relating to the fat content present in the heavy phase.

5.4.Planning and scheduling

Schedule

Week	Theoretical sessions	Practical sessions	Visits	
1	Introduction (1 h) Topic 1 (1 h)			
2	Topic 1 (1 h) Topic 2 (1 h)	Establishment of the work groups and definition of the collaborative project (2 h)		
3	Topic 2 (2 h)	Problem-solving session 1 (2 h)		

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4	Topic 2 (1 h) Topic 3 (1 h)	Problem-solving session 2 (2 h)		
5	Topic 3 (2 h)	Laboratory session 1 (2 h)		
6	Topic 3 (1 h) Topic 4 (1 h)	Problem-solving session 3 (2 h)		
7	Topic 4 (2 h)	Laboratory session 2 (2 h)		
8	Topic 4 (1 h) Topic 5 (1 h)	Laboratory session 3 (2 h)		
9	Topic 5 (2 h)	Laboratory session 4 (2 h)		
10	Spring holidays			
11	Topic 5 (1 h) Topic 6 (1 h)	Problem-solving session 4 (2 h)		
12	Topic 6 (2 h)	Problem-solving session 5 (2 h)		
13	Topic 7 (2 h)	Problem-solving session 6 (2 h)		
14	Topic 7 (1 h) Topic 8 (1 h)	Problem-solving session 7 (2 h)	Visits (4 h)	
15	Topic 8 (2 h)	Oral presentation of the collaborative projects (2 h, 15 min per		

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		group)		
16	Topic 9 (2 h)	Laboratory exam (2 h)		

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Workload

Activity	Classroom or laboratory hours	Factor	Out of class hours
Theoretical sessions	30	1,5	45
Practical problem-solving sessions	14	1	14
Practical laboratory sessions	10	1	10
Collaborative work	2	-	21
Technical visits	4	-	-
Total	60		90
Total workload	150 h		

5.5. Bibliography and recommended resources

Basic Textbooks:

- Seader, J. D.. Separation process principles / J. D. Seader, Ernest J. Henley . 2nd ed. Hoboken, NJ : John Wiley & Sons, 2006.

Complementary Textbooks:

- Rhodes, Martin. Introduction to particle technology / Martin Rhodes . Chichester [etc.] : John Wiley and sons, cop. 1998.
- Ibarz, A.; Barbosa-Cánovas G. V. Introduction to food process engineering. Boca Raton: CRC Press, Taylor & Francis, 2014.

Recommended links:

[Documentos de Mejores Técnicas Disponibles \(MTD\). Ministerio de Agricultura, Alimentación y Medio Ambiente.](#)