28936 - Unit operations I

Syllabus Information

Academic Year:	2018/19
Subject:	28936 - Unit operations I
Faculty / School:	201 -
Degree:	437 - Degree in Rural and Agri-Food Engineering
ECTS:	6.0
Year:	3
Semester:	First semester
Subject Type:	Compulsory
Module:	---

General information

Aims of the course

Context and importance of this course in the degree

Recommendations to take this course

Learning goals

Competences

Learning goals

Importance of learning goals

Assessment (1st and 2nd call)

Assessment tasks (description of tasks, marking system and assessment criteria)

Methodology, learning tasks, syllabus and resources

Methodological overview

THEORY LESSONS

The theoretical academic sessions will be used to allow students to learn through exposure professor concepts and methodologies of work needed to start developing your self-employment. These sessions will be conducted mostly with

the support of computer presentations and projected; previously will be provided to the student.

PROBLEM SOLVING:

The student will be given a series of problem sets that will solve or try to solve, then the interactive sessions will address the doubts and resolutions thereof.

WORKS:

In the classroom will be In the classroom will be proposed during the course 3 or 4 works, which the students have to solve. subsequent to the delivery, they made the defense of the same.

LABORATORY PRACTICE:

The professor made an explanation of the theoretical framework necessary for understanding the theory of practice to develop.

Explanation of equipment and instruments

Students operate the equipment, take data order that they can develop the practice report.

The completion of the practices is obligatory.

Learning tasks

The achievement of a student's basic training is based on theoretical type classes (30 hours) and problems type classes (20 hours), but active participation of students will be encouraged, especially focused on knowledge of various unit operations of the food process industry and equipment operation.
Group work/activities (20 hours) are required; they allow the acquisition of general and specific competence.
Individual tutoring will be conducted to clarify particular problems of each student and mandatory tutoring to work with reduced groups specific topics.
Also, the labs program (10 hours) allows to transpose theoretical knowledge to practical application and development of scientific and technical documents.
Tools will be used to support teaching and problem solving (spreadsheets and EES Solver).
The Virtual Campus of UniZar will also be used as support.

Syllabus

Theoretical Programme

Block 1: INTRODUCTION

Topic 1: INTRODUCTION TO CHEMICAL ENGINEERING. The food industry and chemical engineering. Chemical processing. Unit operations. Classification of basic operations according to: the transporting properties, the stages

involved or the end use. Modes of operation in the chemical industry. Intermittent and continuous operations. Steady and non-steady state. Choice of processing method. Process diagrams within the food industry. Magnitudes, units and dimensions. Systems of units.

Topic 2: TRANSPORT PHENOMENA. Unit operations and transport phenomena. Transport mechanisms. Transport in laminar flow and turbulent flow (effective transport coefficients.) Transport between phases. Individual transport coefficients. Global transport coefficients; application to heat transmission and mass transfer.

Topic 3: MASS BALANCE IN STEADY STATE. What is the balance of mass? Application within the agri-food industry. Law of conservation of mass; general equation of a mass balance (with and without chemical reaction.) Mass balance with purge, deviation and recirculation. Resolution procedure. Introduction to the balances of mass in a non-steady state without chemical reaction.

Topic 4: ENERGY BALANCE IN STEADY STATE WITHOUT CHEMICAL REACTION. What is the balance of energy? Use within the agri-food industry. Law of energy conservation; general equation of an energy balance. Forms of energy; kinetic energy, potential energy, internal energy, heat and work. Enthalpy balance; definition of enthalpy and calculations related to temperature and state of aggregation. Joint solutions for matter and energy balances.

Block 2: UNIT OPERATIONS BASED ON HEAT TRANSMISSION

Topic 5: HEAT TRANSMISSION. Heat transmission mechanisms; conduction, convection and radiation. Heat transmission through conduction; conduction through hollow cylinders, hollow spheres, flat plates and through a series of solids. Heat transmission through convection; dimensionless numbers, empirical correlations for natural and forced convection. Calculation of the global coefficient for heat transmission. Heat transmission through radiation; emission and absorption of thermal radiation, Stefan-Boltzman law, emissivity of a grey body, Kirchoff law. Heat transmission in a non-steady state. Significance of the Biot number. Equation of heat transmission relating to the controlling resistance.

Topic 6: HEAT EXCHANGERS. Definition and types. Design of exchangers; concentric tube exchangers (constant and variable global coefficient), multi-tubular exchangers (shell and tubes), plate and compact heat exchangers. Logarithmic mean temperature difference method and NTU method. Equipment details. Applications in the agri-food industry.

Topic 7: EVAPORATION. Definition and application examples. Characteristics of the different types of evaporator. Design of a simple effect evaporator; capacity, elevation of boiling point, coefficients of heat transmission and economy. Advantages of the multiple effect system over the simple effect system. Structure of multi-effect systems. Calculations for multi-effect evaporators with direct current. Mechanical vapour compression.

Topic 8: REFRIGERATION AND FREEZING. Cold production using mechanical compression. Mollier diagram and Rankine cycle. Cold machines; main elements and working principals. Cold load calculations. Calculations for freezing times; Planck equation and other similar versions. Description of the most widely used refrigeration and freezing equipment. Examples of use.

Block 3: UNIT OPERATIONS BASED ON MASS TRANSFER

Topic 9: FUNDAMENTALS OF DIFFUSION AND MASS TRANSFER BETWEEN PHASES. Transfer of mass in one phase; mechanisms, molecular diffusion (Fick's law), convection. Transfer of mass by diffusion between two phases; double layer theory. Global mass transfer coefficients.

Topic 10: EXTRACTION. Balance of extraction. Extraction kinetics. Extraction in one or various stages; simple contact, multiple contact in direct or counter current. Extraction equipment. Extraction using supercritical fluid. Uses of extraction in the agri-food industry.

Topic 10: DISTILLATION. Introduction. Liquid vapour equilibrium of binary mixtures. Simple distillation of binary mixtures; discontinuous distillation, flash distillation. Rectification of binary mixtures.

Practical Programme

Practical 1: SOFTWARE ESS. Using the ESS software for solving problems and finding properties of substances

Practical 2: HEAT EXCHANGERS. Laboratory scale equipment is available for practical teaching purposes. This allows for the use of three types of exchangers; with concentric tubes, with shell and tubes and with plates. The overall objective of this practical is to ensure that students are able to; differentiate between the steady and non steady state; evaluate the influence of a number of operational variables relating to heat transmitted through two liquids (water in both cases); and compare the efficacy obtained from the three most common types of exchangers. In order to achieve this, students must experiment to determine the global coefficient of heat transmission.

Practical 3: DISCONTINUOUS DISTILATION. Determination of the vapour-liquid equilibrium curve of an ethanol-butanol mixture. Recognition of the importance of a balanced relationship between both phases is essential in the design of a distillation process. This information is used to determine the number of plates within a distillation column. Vapour-liquid equilibrium data is obtained during experiments by measuring the compositions of the vapour phase and the liquid phase in equilibrium. The practical focuses on the system used to obtain the equilibrium curve, as well as another system, in order to carry out differential distillation.

Practical 4: SOLID-LIQUID EXTRACTON. Determination of the degree of extraction of a solid sample, in terms of the number of stages or cycles, in a theoretical and experimental way. Once the efficacy and number of theoretical stages have been determined, students are able to calculate the real stages. The experimental equipment is based on a Soxhlet extractor and allows work at different stages of extraction to be carried out.

Practical 5: HEAT TRANSFER BY CONDUCTION. Determining thermal conductivities of different solid under heating at steady state it is studied in this practice. The experimental equipment has different materials and shapes, a heating system and a continuous temperature record.

Course planning and calendar

Study time and individual work

Assistance to the presental sessions is mandatory in works/activities and laboratory practice.

The students must take up the subject (4-5 hours per week) to understand and carry out further issues and problems that arise in class.

Overall it is estimated that students must use a total of 90 hours of personal work to complete a total of 150 hours devoted to the subject.

Activity/Week	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
	17-23 sep	24-30 sep	1-7 oct	8-14 oct	15-21 oct	22-28 oct	29 oct-4 nov	5-11 nov	12-18 nov	19-25 nov	26 nov-2 dec	3-9 dec	10-16 dec	17-23 dic	24-30 dic	7-13 ene/jan	14-20 jan	21-27 jan	28 jan-3 feb	4-10 feb	
														Christmas holidays	Christmas holidays	Exams, tests	Exams, tests	Exams, tests	Exams, tests		
Classroom activity																					61
Theory	4	3	1	1	2	2	1	3		3	1	1	1	3			2				28
Troubleshooting	1	3		2	1	1		1	1	1	1	1	1	1			2				18
Laboratory sessions			2		2		2		2	2											10
Exams, tests																			5		5
Personal study and work																					89
Individual work	4	4	4	3	3	3	3	4	2	2	2	4	4	4	4	4	4	6	5		69
Group work			2	2	2	2	2	2	2	2	2					2					20
TOTAL	8	8	8	9	9	9	9	8	8	8	8	8	8	4	4	10	6	10			150

Bibliography and recommended resources

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BC	Ingeniería de la industria alimentaria. Vol. I, Conceptos básicos / José Aguado Alonso, editor ; José Antonio Calles Martín ... [et al.]. Madrid : Síntesis, 1999
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BC	Valiente Barderas, Antonio. Problemas de balances de materia y energía / Antonio Valiente, Rudi Primo Tlacatzin Stivalet . [1ª ed., 1ª reimpr.] México : Alhambra Mexicana, 1991 (reimpr.1997)

The updated recommended bibliography can be consulted in:
http://psfunizar7.unizar.es/br13/egAsignaturas.php?id=8097