Universidad Zaragoza

Year : 2020/21

28936 - Unit operations I

Syllabus Information

Academic Year: 2020/21
Subject: 28936 - Unit operations I
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 583 - Degree in Rural and Agri-Food Engineering
437 - Degree in Rural and Agri-Food Engineering
ECTS: 6.0
Year: 3
Semester: First semester
Subject Type: 583 - Optional
437 - Compulsory
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

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

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as:

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 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.

4.2.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 the 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 by virtual platform moodle2.unizar.es and by video conference via Google Meet, will be conducted to clarify the particular problems of each student and mandatory tutoring to work with reduced groups specific topics.

Also, the labs' program (10 hours) allows transposing 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).

Independent study. Before the final exam.

The Virtual Campus of UniZar will also be used as support.

4.3.Syllabus

The course will address the following topics:
Theoretical Program

Section 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 a 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.

Section 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, the 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 the evaporator. Design of a simple effect evaporator; capacity, the 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 vapor 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.

Section 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 contacts indirect or counter current. Extraction equipment. Extraction using supercritical fluid. Uses of extraction in the agri-food industry.

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

Practical Program

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 shells and tubes and with plates. The overall objective of this practice 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 DISTILLATION. Determination of the vapor-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. Vapor-liquid equilibrium data is obtained during experiments by measuring the compositions of the vapor phase and the liquid phase in equilibrium. The practice 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 EXTRACTION. 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.

4.4.Course planning and calendar

Study time and individual work

Assistance to the on-site 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.

Type of activity / Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
On-site activity											
Theory	4	3	1	1	2	2	1	3	1	3	1
Problems		1	3	3		2	1	1	1	1	1
Laboratory problems					2		2		2		2
Off-site sessions											
Autonomous work	4	4	4	3	3	3	3	3	3	2	2
Group work				2	2	2	2	2	2	2	2
Evaluation											
TOTAL	**8**	**8**	**8**	**9**	**9**	**9**	**9**	**9**	**9**	**8**	**8**

Type of activity / Week	**12**	**13**	**14**	**15**	**16**	**17**	**18**	19	Total
On-site sessions									***60***
Theory	2	1	**1**			2	**2**		**30**
Problems	2	1	1			2			**20**
Laboratory practice			**2**						**10**
Off-site sessions									***85***
Autonomous work	2	**4**	**2**	4	4	5	7	3	**65**
Group work	2		**2**						**20**
Evaluation								5	**5**

TOTAL	**8**	**6**	**8**	**4**	**4**	**9**	**9**	**8**	***150***

4.5.Bibliography and recommended resources

BB Cengel, Yunus A.. Transferencia de calor y masa : un enfoque práctico / Yunus A. Cengel ; revisor técnico Sofía Faddeva . 3ª ed. México D. F. : McGraw-Hill Interamericana, cop. 2007

BB Himmelblau, David M.. Principios básicos y cálculos en ingeniería química / David M. Himmelblau ; traducción, Roberto Luis Escalona García ; revisión técnica, Mª del Carmen Doria Serrano . 2ª ed. en español México [etc.] : Prentice-Hall Hispanoamericana, cop. 1997

BB Ibarz, Albert. Operaciones unitarias en la ingeniería de los alimentos / Albert Ibarz, Gustavo V. Barbosa-Cánovas . Madrid : Mundi-Prensa, 2005

BB McCabe, Warren L.. Operaciones unitarias en ingeniería química / Warren L. McCabe, Julian C. Smith, Peter Harriott ; revisor técnico René Huerta Cevallos ; [traductor, Alejandro Carlos Piombo Herrera] . 7ª ed. México D. F. : McGraw-Hill Interamericana, cop. 2007

BC Costa López, J., et al. Curso de ingeniería química. Introducción a los procesos, las operaciones unitarias y los fenómenos de transporte. Barcelona : Reverté, 1991 [Comentario del profesor: libro electrónico]

BC Coulson, J.M., Richardson, J.F. Ingeniería química: operaciones básicas. I. Barcelona : Reverté, 2010 [Comentario del profesor: libro electrónico]

BC Coulson, J.M., Richardson, J.F. Ingeniería química: operaciones básicas. II. Barcelona : Reverté, 2010 [Comentario del profesor: libro electrónico]

BC Hermida Bun, José Ramón. Fundamentos de ingeniería de procesos agroalimentarios / José Ramón Hermida Bun . Madrid : Mundi-Prensa : AMV, 2000

BC Incropera, Frank P.. Fundamentos de transferencia de calor / Frank P. Incropera, David P. DeWitt . 4a ed. México : Prentice Hall, 1999

BC Ingeniería de la industria alimentaria. Vol. I, Conceptos básicos / José Aguado Alonso, editor ; José Antonio Calles Martín ... [et al.]. Madrid : Síntesis, 1999

BC Ingeniería de la industria alimentaria. Vol. II, Operaciones de procesado de alimentos / Francisco Rodríguez Somolinos, editor ; José Aguado Alonso ... [et al.]. Madrid : Síntesis, 2002

BC Ingeniería de la industria alimentaria. Vol. III, Operaciones de conservación de alimentos / Francisco Rodríguez Somolinos, editor ; José Aguado Alonso ... [et al.]. Madrid : Síntesis, 2002

BC Introducción a la ingeniería química / Editor Guillermo Calleja Pardo ; Autores Guillermo Calleja Pardo...[et al.]. Madrid : Síntesis, D.L. 1999

BC Métodos experimentales en la ingeniería alimentaria / Alberto Ibarz Ribas ... [et al.] . Zaragoza : Acribia, D.L. 2000

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

BC Singh, R. Paul. Introducción a la ingeniería de los alimentos / R. Paul Singh, Dennis R. Heldman . [1ª ed. en español de la 2ª en inglés] Zaragoza : Acribia, D.L. 1997

BC Treybal, Robert E.. Operaciones de transferencia de masa / Robert E. Treybal . 2a ed. México [etc] : McGraw-Hill, 1980

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://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28936