Universidad Zaragoza

Academic Year/course: 2022/23

30810 - Basic principles of chemical engineering

Syllabus Information

Academic Year: 2022/23
Subject: 30810 - Basic principles of chemical engineering
Faculty / School: 105 - Facultad de Veterinaria
Degree: 568 - Degree in Food Science and Technology
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Basic Education
Module:

1. General information

1.1. Aims of the course

Like all the courses of the block of basic subjects, this course contributes to achieving the skills and abilities of this subject (Level 2: Chemistry), specifically in what refers to "engineering fundamentals of application in food science and technology".

Therefore, the general objective of this introductory course is that students will acquire the tools and basic knowledge of chemical engineering, to be able to face with a broad criterion the various problems that will arise in the field of food processing.

These approaches and objectives are aligned with some of the Sustainable Development Goals (SDGs) of the 2030 Agenda and certain specific goals (https://www.un.org/sustainabledevelopment/es/), contributing to a certain extent to their achievement:

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy. Target 7.3 By 2030, double the global rate of improvement in energy efficiency

Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation. Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

1.2. Context and importance of this course in the degree

The basic knowledge acquired in the course Fundamentals of Chemical Engineering together with the rest of the courses of the basic training subjects that make up the foundations for a better understanding of the rest of the specific subjects of the food field.

Specifically, this subject is closely linked to Basic Operations in the Food Industry, which is also taken in the 2nd year but during the 2nd semester. Therefore, studying Fundamentals of Chemical Engineering beforehand will be essential for students to follow up correctly.

1.3. Recommendations to take this course

This course requires having acquired the skills related to the basic training subjects of the first year. Those acquired in the subjects of General Chemistry, General Physics and Fundamentals of Physical Analysis, and Mathematics are considered especially necessary for their correct follow-up.

2. Learning goals

2.1. Competences

1. Manage information, search for sources, collection and analysis of information, etc.
2. Think and reason critically.
3. Work autonomously and carry out a self-assessment.
4. Negotiate both with specialists in the area and with people who are not experts in the field.
5. Adapt to new situations and solve problems.

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6. That students have demonstrated possession and understanding of knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects they involve knowledge coming from the forefront of their field of study.

7. That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

8. That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized audience.

9. That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy

2.2. Learning goals

1. Knows and handles the basic calculations necessary in Chemical Engineering: unit systems and calculation methods.
2. Is able to carry out mass and energy balances, which entails drawing and marking the entire flow diagram, judiciously choosing a basis for calculation, and formulating and solving the equations necessary to solve the balance. In addition, the student must know how to obtain the mass and energy balance equations for some unsteady state systems and obtain the analytical solutions for the case of first-order differential equations.
3. Is able to apply the fundamentals of transport phenomena (mass, energy and momentum transfer) and the laws that govern them to specific cases of food processing.
4. It is capable of solving fluid flow problems, heat transfer problems both in steady state and unsteady state, and mass transfer problems between phases and through porous solids.

All of them imply the acquisition of knowledge and the ability to deal with issues related to the goals associated with SDG 7 (Targets 7.2 and 7.3) and SDG 9 (Industries, innovation and infrastructure) and more specifically to Goal 9.4.

2.3. Importance of learning goals

Although, like the rest of the basic courses, it does not provide per se specific skills or abilities related to food science and technology; It is essential for the acquisition of basic knowledge that will form the foundations for a better understanding of some of the specific subjects in the food field of the degree.

The course of Fundamentals of Chemical Engineering will allow students to acquire essential basic knowledge for engineering calculation in the Process Industries, essential to acquire the skills of Food Processing and Engineering, specifically those related to Basic Operations of the food industry.

Based on the learning outcomes, the student will be able to contribute to achieving SDG 7 (Ensure access to affordable, reliable, sustainable and modern energy) and SDG 9 (Build resilient infrastructure, promote sustainable industrialization and foster innovation) designing the equipment that performs its functions with the least energy consumption and transforming into by-products some of the waste generated in the transformations of the food industry With the skills acquired together with those of the other subjects of the specialty, they contribute to the training of quality professionals in the field of the Food Industry. This implies the acquisition of knowledge and the ability to deal with issues related to the goals associated with SDG 7 (targets 7.2 and 7.3) and SDG 9 (target 9.4).

3. Assessment (1st and 2nd call)

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

Description of tasks

The student must demonstrate that they have achieved the expected learning outcomes through the following assessment activities...

The evaluation of this subject will be carried out with a GLOBAL TEST that will consist of the following activities:

1. Written evaluation test consisting of 2 parts. The first consists of theoretical-practical questions and will account for 50% of the final grade for this test. The second part consists of 2 problems and will account for the other 50% of the final grade for this test. This test will last 3 hours. The grade will be from 0 to 10 and will account for 80% of the student's final grade in the subject.

2. The competences related to the laboratory practices will be evaluated through a work in which the students must reasonably answer a series of questions and/or exercises proposed for each practice. This activity will account for 20% of the final grade for the subject.

Passing these evaluation tests accredits the achievement of learning goals 1, 2, 3 and 4. The dates of these tests will be indicated in the teaching schedule of the corresponding course.

These evaluation activities include content related to SDG goals 7.2, 7.3 and 9.4, since their objective is to achieve the learning outcomes set in the subject, which are linked to said goals.

Assesment criteria

To pass the course and demonstrate that the expected learning outcomes have been achieved, the student must obtain a

weighted average of the two tests equal to or greater than 5 and also that the grade obtained in each of the evaluation activities is equal to or greater to 4.

The evaluation criteria for the evaluation activities that consist of solving calculation problems will be: handling units and dimensions and unit conversion, searching for physical and chemical properties in tables, diagrams, abacuses and figures, the approach of the problem, the resolution of the proposed equations and the accuracy in the calculation.

In the evaluation activities that consist of brief theoretical or theoretical-practical questions, the following will be valued: the correct use of Spanish, the capacity for synthesis, the expository clarity, the coherence in the reasoning, the adequacy of the answer to what is question and the degree of knowledge of the subject matter.

For the evaluation of the work on the laboratory practices, the validity of the results obtained and the conclusions reached will be taken into account, as well as the order and clarity in the presentation of the results.

Marking system: in accordance with the Regulations for Learning Evaluation Standards of the University of Zaragoza (Governing Council Agreement of December 22, 2010), the results obtained by the student will be graded based on the following numerical scale: 0 to 10, with the expression of a decimal, to which its corresponding qualitative qualification may be added:

0-4.9: Fail

5.0-6.9: Pass

7.0-8.9: Remarkable

9.0-10: Outstanding

The "Honors" mention may be awarded to students who have obtained a grade equal to or greater than 9.0. Their number may not exceed five percent of the students enrolled in the corresponding academic year.

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.

The course is divided in 48 participatory lectures both theory and problem solving, 4 hours of seminars, 8 hours of laboratory practice (2 hours/practice) and resolution and presenting problems given at the end of each block (practical work).

The seminars will be organized in 2 sessions of 2 hours each, in which students will solve using the spreadsheet problems of mass balance of the block II of the subject.

The lab practices will be held in 4 sessions of 2 hours each and they will be made at the end of the semester. They are done in groups 12-15 students divided in 4 practices that are performed simultaneously each day (4-5 students per practice).

Students must follow the regulations described in:

- Prevention: A guide for students at the University of Zaragoza:
  http://uprl.unizar.es/publicaciones/estudiantes_ingles.pdf
- Manual de seguridad en los laboratorios de la Universidad de Zaragoza y
  normas marcadas por la Unidad de Prevención de Riesgos Laborales:
  http://uprl.unizar.es/seguridad/pdfs/seglaborUZ.pdf
  http://uprl.unizar.es/seguridad/pdfs/laboratorios.pdf

In addition, students will follow as well any instructions related to biosecurity given by the professor

4.2. Learning tasks

The course includes the following learning tasks:

- Lectures: 21 h to discuss the theoretical content. Sessions of issues and problems: 27 h for the resolution of the exercises.
- Seminars: 4 h for the resolution, comment and sharing of case studies. Lab: 8 h distributed in four sessions of 2 hours each.
- Mentored practical work: 15 hours of autonomous work in which the student will work personally in the resolution of problems proposed by the lecturer which will guide the learning.
- Study: 71 h of autonomous work, not supervised by the lecturer.
- Exams: 3-4 h for the realization of two assessment tests (theoretical and practical).

Throughout the course, learning activities related to SDG 7 (targets 7.2 and 7.3) and SDG 9 (target 9.4) will be developed.

4.3. Syllabus

The course will address the following topic:

I. INTRODUCTION.

- ***Unit 1. Introduction to chemical engineering*** . ***Systems units and calculation methods.*** The food industry and chemical engineering . Scheme of a process in the food industry. Magnitudes, units and dimensions. Systems of units. Dimensional analysis. Units conversion. Temperature scales. Dimensional homogeneity and dimensionless groups. Unit conversion in formulas. Scientific notation. Significant figures and precision.

II. MASS AND ENERGY MACROSCOPIC BALANCES

- ***Unit 2. Mass balances in steady state without chemical reaction.*** Preliminary considerations. Principle of mass conservation. Basic concepts. Processes classification. General equation of balance: balance for continuous, batch and semi-continuous processes. Flowchart of a process. System limits, calculation base, a key element. Recycle, bypass and purge. Systematic procedure for performing mass balances in steady state without chemical reaction.
- ***Unit 3. Energy balances in steady state without chemical reaction.*** General concepts. Forms of energy: 1st Law of Thermodynamics. General equation of conservation of energy. Enthalpy balances: reference state, calculation of enthalpies. Energy balances in steady state without chemical reaction. Simultaneous mass and energy balances
- ***Unit 4. Mass and Energy balances in unsteady state.*** Deduction and solving of differential equations of the balances in unsteady state. Application to concrete examples.

III. INTRODUCTION TO FLUID DYNAMICS, HEAT TRANSFER AND MASS TRANSFER.

- ***Unit 5. Fluid Dynamics.*** Continuity equation, mechanical energy balance, Bernoulli equation, loads, load loss, Fanning equation, Colebrook equation.
- ***Unit 6. Heat transfer.*** Heat transfer mechanisms: conduction, convection and radiation. Conductive heat transfer: conduction through cylindrical shells, spherical shells, flat sheets and conduction through solids in series. Heat transfer by convection: dimensionless numbers, empirical correlations for forced and natural convection. Calculating the global heat transfer coefficient. Heat transfer in non-steady state: dimensionless numbers and Sucec relationship.
- ***Unit 7. Mass Transfer.*** Mass transfer mechanisms: advective flow, molecular diffusion and turbulent diffusion. Mass transfer between phases: thermodynamic requirement (separation factor) and mechanical nature requirement. Mass transfer through porous solids: solute movement by diffusion (ordinary and Knudsen) and solute movement by hydrodynamic flow. Permeation through plastics.

4.4. Course planning and calendar

The dates and key milestones of the subject are described in detail, along with the other subjects in the second year in CTA Degree, on the website of the Faculty of Veterinary (link: https://veterinaria.unizar.es/academico/plan-estudios-grado-cta). This link will be updated at the beginning of every academic year.

4.5. Bibliography and recommended resources

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- **Hermida Bun, J.R.,** *Fundamentos de Ingeniería de Procesos Agroalimentarios*, Mundi-Prensa y A. Madrid Vicente Ediciones, Madrid, 2000.
- **Lomas Esteban, María del Carmen;** *Introducción al Cálculo de los Procesos Tecnológicos de los Alimentos*. Acribia, Zaragoza, 2002.
- **Peiró Pérez, J.J.; García Barrido, J.;** *Balances de materia. Problemas resueltos.* (3 vols.). Universidad Politécnica de Valencia. Valencia, 1989.
- **Reklaitis, G.V.;** *Balances de Materia y Energía*. Interamericana (1ª ed. en español), México (1986).
- **Ruiz Palacín, J.;** *Problemas resueltos de balances de materia en estado estacionario.* Prensas Universitarias de Zaragoza (1ª ed), Zaragoza, 2009.
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- **Toledo, R.T.;** *Fundamentals of food process engineering.* Chapman and Hall (2ª ed., reimpr.), Nueva York, 1994.
- **Valiente, A.;** *Problemas de Balance de Materia y Energía en la Industria Alimentaria. Limusa (2ª ed.), Méjico, 1997.*