Course guide
3200671 - OB1 - Basic Operations I

Last modified: 05/05/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Antoni Escalas Cañellas

Others: Antoni Escalas Cañellas

PRIOR SKILLS

It is important to have taken the subjects Fluid Mechanics (Q3), Fundamentals of Chemical Engineering (Q4), and Thermal Engineering (Q4), before taking Unit Operations I.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CHE: Knowledge of material and energy balances, biotechnology, the transfer of materials, separation operations, chemical reaction engineering, the design of reactors, and the reuse and transformation of raw materials and energy resources.

TEACHING METHODOLOGY

- Face-to-face sessions of theory presentation
- Face-to-face problem sessions: combination of problems solved by the professor with problems solved by the students under the professor's supervision
- Autonomous work of study and realization of exercises.

LEARNING OBJECTIVES OF THE SUBJECT

- To understand the theoretical concepts and equations governing the calculation and sizing of unit operations of fluid transport and heat transfer in chemical engineering processes.
- To be able to solve basic problems of analysis and design of the aforementioned unit operations of Chemical Engineering
- To develop the ability to decide with good judgment and calculate on the elements studied and adapt to new operations more or less related to those already known.
- To be able to calculate and improve the approximate energy consumption and carbon footprint of the operation of the different units.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

TOPIC 1: INTRODUCTION TO UNIT OPERATIONS

Description:
- Continuous and batch operations.
- Systems of units.

Specific objectives:
- To master the basic concepts used in the subject.
- To master the SI system of units and some non-SI units (European and English) that are often used

Full-or-part-time: 6h
Theory classes: 1h
Practical classes: 1h
Self study : 4h

TOPIC 3. FLUID TRANSPORT

Description:
- Calculation and design of operations controlled by momentum transport and mechanical energy.
- Transport of incompressible fluids in chemical engineering
- Transport of comressible fluids in chemical engineering

Specific objectives:
- To apply the concepts of incompressible fluid mechanics to Fluid Transport in Chemical Engineering.
- To apply the concepts of the mechanics of compressible fluids to the Transport of Fluids in the Chemical Engineering.
- To a lesser extent: recover basic concepts and calculations of Fluid Statics

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 4h
Self study : 10h

TOPIC 3: HEAT TRANSFER

Description:
- Fundamentals. Stationary and transient state.
- Recover basic concepts of heat transfer by conduction, convection and radiation.
- Correlations for the calculation of convection coefficients without phase change and with phase change
- Global heat transfer coefficient
- Introduction to heat exchangers
- Shell-and-tube heat exchangers
- Heat exchanger rating and design

Specific objectives:
- Learn to identify different convection situations in Chemical Engineering and choose and apply the appropriate convection equations to each situation
- Calculate the overall heat transfer coefficient in any situation
- Know how to choose and calculate heat exchangers, taking into account the requirements of each situation
- Learn to evaluate and design carcass and tube exchangers and, to a lesser extent, other types

Full-or-part-time: 68h
Theory classes: 13h
Practical classes: 13h
Self study : 42h

TOPIC 4. EVAPORATION

Description:
- Basic concepts of evaporation
- Types of evaporators
- Calculation of a single-effect evaporator without/with ebulloscopic increase of the solution
- Calculation of multiple effect evaporators without/with ebulloscopic increment
- Energy aspects and carbon footprint of evaporators
- Heat recovery in evaporation.
- Vapor recompression, mechanical and thermal.
- Evaporative heat pumps

Specific objectives:
- To get to know the different types of evaporators used in the chemical industry
- To learn to calculate single effect evaporators, with and without boiling point rise
- To learn the iterative calculation of multiple-effect evaporators
- To know energy efficiency techniques applied to evaporation, such as steam recompression (mechanical and thermal)

Full-or-part-time: 40h
Theory classes: 8h
Practical classes: 8h
Self study : 24h

TEMA 5. COOLING TOWERS

Description:
This unit operation combines heat and mass transfer but its sole purpose is water cooling (heat transfer)

- Properties of wet air. Psychrometric chart.
- Principle of operation of a cooling tower. Types of cooling towers
- Mass and energy balances
- Operation line, packing height, number of transfer units, transfer unit height
- Cooling tower design
- Cooling water circuit: evaporation, drift, blowdown, make-up. Water and solids balances. Number of concentration cycles.
- Circuit water treatment

Specific objectives:
- To understand the characteristics of humid air and learn to obtain its properties, such as absolute and relative humidity, specific enthalpy
- Get to know the basics and the types of cooling towers
- Get to know how to design a cooling tower based on water flow requirements to be cooled or environmental conditions
- To understand and know how to calculate cooling water circuits.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 4h
Self study : 10h

GRADING SYSTEM

- 1st exam: 23,5%
- 2nd exam: 23,55%
- 3rd exam: 23,5%
- 4th exam: 23,5%
- Class attendance to problem-solving sessions and in-class work during problem-solving sessions: 6%. This part will be assessed from attendance and, for attendees, also based on their attitude, preparation shown beforehand, and effective work during the problem-solving sessions.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

- During the exam, it is not allowed to have or use communication tools such as mobile phones, tablets, computers, smart watches or any other type, unless the professor expressly indicates otherwise.
Bring to the exam:
- Blank A4 sheets; blue or black pen to answer the exam
- A calculator with all the necessary mathematical functions and which, in addition, can solve implicit equations and find the zeros of polynomials and other mathematical functions.
- The formulary that the professor will publish in Atenea for each exam, and only this formulary.
- The graphs and tables indicated by the professor (Athena)

BIBLIOGRAPHY

Basic:
- McCabe, W. L.; Smith, J. C.; Harriott, P. Operaciones unitarias en ingeniería química. 7a ed. Madrid: McGraw-Hill, 2007. ISBN 9789701061749.
- Serth, R. W. Process heat transfer: principles and applications [on line]. Amsterdam ; London: Elsevier Academic Press, cop. 2007 [Consultation: 30/09/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780123735881/process-heat-transfer. ISBN 9780123735881.
- Chhabra, Raj; Shankar, V. Coulson and Richardson's chemical engineering, vol.1A, Fluid flow: fundamentals and applications [on line]. 7a ed. Kidlington, UK, etc: Elsevier-Butterworth-Heinemann, 2017 [Consultation: 22/10/2020]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780081010990/coulson-and-richardsons-chemical-engineering. ISBN 9780081010990.

Complementary:
- Levenspiel, Octave. Flujo de fluidos e intercambio de calor [on line]. Barcelona: Reverté, 1993 [Consultation: 14/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8184. ISBN 8429179682.