Universitat Autònoma de Barcelona

2022/2023

Separation Operations

Code: 102403
ECTS Credits: 6

Degree	Type	Year	Semester
2500897 Chemical Engineering	OB	3	1

Contact

Name: Albert Guisasola Canudas
Email: albert.guisasola@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Teresa Gea Leiva

Prerequisites

Having assisted to Termodinàmica Aplicada

Objectives and Contextualisation

The main objective of the subject is that the student learns to select, analyze and design different separation operations controlled by the mass transfer and the heat transmission

The specific objectives of the subject are :

• Understand the different separation operations, their modes of operation and possible applications.

• Understand the physical concepts and fundamentals of each operation studied.

• Use common and illustrative methods of calculation of separation systems

• Design the most common separation equipment

Competences

- Analyse, evaluate, design and operate the systems or processes, equipment and installations used in chemical engineering in accordance with certain requirements, standards and specifications following the principles of sustainable development.
- Demonstrate knowledge of the different reaction, separation and processing operations for materials, and transport and circulation of fluids involved in the industrial processes of chemical engineering.
- Develop personal attitude.
- Develop personal work habits.
- Develop thinking habits.

- Objectively compare and select different technical options for chemical processes.
- Show an understanding of the role of chemical engineering in the prevention and resolution of environmental and energy problems, in accordance with the principles of sustainable development.
- Understand and apply the basic principles on which chemical engineering is founded, and more precisely: balances of matter, energy and thermodynamic momentum, phase equilibrium and kinetic chemical equilibrium of the physical processes of matter, energy and momentum transfer, and kinetics of chemical reactions

Learning Outcomes

1. Adapt to unforeseen situations.
2. Apply and identify basic concepts related with chemical engineering.
3. Apply and identify velocity equations in molecular transport.
4. Apply the scientific and technological basics of matter transfer to separation operations.
5. Choose between different options for defining separation processes.
6. Conceive and evaluate alternatives and perform design and operation calculations in binary and multicompound mixture separation processes.
7. Critically evaluate the work done.
8. Develop a capacity for analysis, synthesis and prospection.
9. Develop curiosity and creativity.
10. Develop scientific thinking.
11. Generalise the concepts of the analysis and design of separation operations to apply them to different operations in the process industry.
12. Identify the fields of application of chemical engineering, its relationship with the chemical industry and its energy implications and environmental repercussions.
13. Identify, analyse and resolve balances of energy in simple chemical processes.
14. Identify, analyse and resolve balances of matter in a stationary or non- stationary state, with or without a chemical reaction, in simple chemical processes.
15. Make one's own decisions.
16. Manage available time and resources. Work in an organised manner.
17. Prevent and solve problems.
18. Use waste and energy consumption minimisation criteria in the design of separation operations.
19. Work autonomously.

Content

1.- Introduction. Classification of separation operations. Equilibrium between phases

2.- Flash distillation

2.1.- Binary mixtures. Calculation methods

2.2.- Multi-component mixtures. Calculation methods.

2.3.- Flash distillation equipment.

3.- Rectification

3.1.- Operation in multiple stages.

3.2.- General concepts. Mass and energy balances.

3.3.- Rectification of binary mixtures

3.3.1.- Lewis Method (McCabe-Thiele Method)

3.3.3.- Sorel method

3.4.- Efficiencies of stage and overall efficiency.

3.5.- Correction of multicomponent mixes

3.5.1.- Rapid ("short-cut") methods

3.5.2.-Rigorous methods.

3.6.- Distillation of azeotropic mixtures.

4.- Discontinuous distillation

4.1.- Discontinuous simple distillation

4.2.- Discontinuous rectification. Modes of operation.

5.-Design of columns

5.1.- Design of plate columns.

5.2.- Design of packed columns

6.-Absorption

6.1.- General concepts of absorption and stripping

6.2.- Absorption and strippingof a component

6.3.- Multi-component absorption and stripping

7.- Liquid-liquid extraction of immiscible mixtures

7.1.- Extraction equipment.

7.2.- Application of the methods of McCabe and Kremser.

7.3.- Liquid-liquid extraction of miscible mixtures

Methodology

During the course there will be master classes where the concepts of subject topics will be introduced. In each topic, the examples of calculation or design will be introduced and problems will be given for home work. Once the HYSYS process simulator is introduced, an individual exercise will be proposed with a practical case of separation of compounds.

Depending upon the circumstances, the classes could be switched to a non-presential mode or to a full presential mode. We will adapt the methodology to the regulations.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Absorption	12	0.48	4, 6, 8, 5, 17
Batch distillation	12	0.48	4, 6, 10, 8, 15, 17
Binary rectification	12	0.48	4, 6, 10, 8, 16, 15, 17
Equilibrium stages	5	0.2	4, 10, 8, 5
Flash distillation	10	0.4	6, 10, 8, 17
Liquid-liquid extraction	14	0.56	4, 6, 10, 8, 17
Multicomponent distillation	18	0.72	4, 6, 10, 8, 5, 15, 17
Packed columns	10	0.4	4, 6, 8, 17
Type: Supervised			
Introducing Hysys	5	0.2	6, 5, 16, 17
Type: Autonomous			
Case study of a mixture separation	30	1.2	4, 6, 10, 8, 5, 16, 15, 17

Assessment

The subject will be evaluated by means of the HYSYS software (15% of the mark) and 3 tests: 2 tests (20 and 25% of the mark each) and an exam final (40% of the note). Students who do not pass the subject will have a retake exam that will have at least one exercise of each of the three tests. The student can assist the retake exam only if he/she has assisted to a minimum of two thirds of the total subject evaluation. There is an exception: students who have already studied the subject previously can choose to go to a recovery test keeping the simulation work score or do all the tests. A minimum mark of 0.1 is needed in each of the parts of the subject in order to pass the subject.

A student will be considered non-evaluable (NA) if it has not assisted in to a minimum of 60% of the total grade of the subject (that is, at least one partial test and final test).

For each assessment activity, a place, date and time of revision will be indicated in which the student will be able to review the activity with the teacher. If the student does not submit to this review, this activity will not be reviewed later.

Honor enrollments Granting an honorific matriculation qualification is a decision of the faculty responsible for the subject. The regulations of the UAB indicate that MH can only be awarded to students who have obtained a final grade of 9.00 or more. It can be granted up to 5% of MH of the total number of students enrolled.

Notwithstanding other disciplinary measures deemed appropriate, the irregularities committed by the student that can lead to a variation in the rating of an evaluation act will be graded with a zero. Therefore, copying, plagiarizing, cheating, copying, etc. In any of the assessment activities it will imply failing with a zero. Assessment activities qualified in this way and by this procedure will not be recovered

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes

Exercise HYSYS	15	7	0.28	1, 4, 7, 6, 10, 8, 9, 5, 16, 15, 17, 19, 18
Final test	40	4	0.16	4, 2, 3, 6, 10, 8, 5, 11, 16, 12, 13, 14, 15, 17
Retake exam	85	7	0.28	4, 2, 3, 7, 6, 10, 8, 5, 16, 12, 13, 14, 15, 17
Test 1: Flash and binary distillation	20	2	0.08	4, 6, 8, 5, 16, 15, 17
Test 2: Multicomponent and batch distillation, Absorption and column design	25	2	0.08	4, 6, 10, 8, 5, 16, 15, 17

Bibliography

- Wankat Ph.C. "Separation Process Engineering". 2nd ed. Prentice-Hall (2007)

- Wankat Ph.C. "Separations in Chemical Engineering: Staged Operations". Elsevier, N.Y. (1988).

- King C.J. "Procesos de separación". Reverté, BCN (1980)

- Treybal R.E. "Mass Transfer Operations". McGraw-Hill, N.Y. (1980)

- Coulson J.M. and Richardson J.F. "Chemical Engineering". Pergamon Press (1971)

Software

Knowledge of basic MS Office package, MATLAB and HYSYS will be introduced assoftware for simulation of rectification columns