

Bachelor in Industrial Chemical Engineering

Course information

Year 2020-21

GENERAL SPECIFICATIONS				
English name				
Unit Operations of Chemical Engineering II				
Spanish name				
Operaciones Básicas de Ingeniería Química II				
Code		Type		
606210216		Compulsory		
Time distribution				
	Total	In class	Out class	
Working hours	150	60	90	
ECTS:				
Standard group	Small groups			
	Classroom	Lab	Practices	Computer classroom
4.14	0	0	0	1.86
Departments		Knowledge areas		
Chemical Engineering, Physical Chemistry and Materials Science		Chemical Engineering		
Year		Semester		
3º		2º		

TEACHING STAFF			
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SPECIFIC INFORMATION OF THE COURSE
1. Contents description
1.1. In English:
Separation operations involving mass transfer between phases will be studied: distillation, steady state and batch rectification, gas absorption, and liquid-liquid and solid-liquid extractions. They will be further classified into equilibrium-staged and continuous contact processes.
1.2. In Spanish
Se estudian operaciones de separación que implican la transferencia de materia entre fases (destilación, rectificación en estado estacionario y por lotes, absorción de gases, extracción líquido-líquido y extracción sólido-líquido) y se hace la distinción entre procesos que se producen por etapas de equilibrio y aquéllos que se llevan a cabo por contacto continuo.
2. Background
2.1. Situation within the Degree:
This course addresses mass transfer separation operations; thus, previously gained knowledge on mass and enthalpy balances, fluid mechanics, heat transmission and phase equilibria are applied.

2.2. Recommendations:

For the course contents to be properly understood, students must have previous knowledge on mass and enthalpy balances, estimation of equilibrium data, phase diagrams and fluid dynamics on packed beds. Moreover, students should be familiar with the use of advanced engineering calculation software.

3. Objectives (as result of teaching):

To provide students with knowledge on how to analyze, select, design, calculate and optimize industrial chemical processes based on heat and mass transfer, and controlled by phase equilibrium.

4. Skills to be acquired

4.1. Specific Skills:

E01: knowledge on mass and enthalpy balances, biotechnology, mass transfer, separation operations, chemical reaction engineering, reactors design, raw materials and energy resources valorization and transformation.

4.2. General Skills:

CB2: students are expected to develop professionalism in their study field
CB5: students are expected to develop self-learning capability with a view to their further postgraduate studies
G01: Solving problem
G02: Making decisions
G04: Putting theoretical knowledge into practice
G09: Creativity
CT2: Analysis capability
CT4: ICT competences

5. Training Activities and Teaching Methods

5.1. Training Activities:

- Theoretical contents lectures.
- Solving problem seminars.
- Computer aided case studies workshops.
- Teacher-guided assignments.

5.2. Teaching Methods:

- Master class.
- Computer aided case studies, in small groups.
- Problem solving.
- Assessments and exams.

5.3. Development and Justification:

1. Master class, which will address theoretical contents and will promote acquisition of competences E01 and G04.

2. Problem solving: this methodology will be used to put the theoretical contents into practice through the resolution of numerical problems. These seminars are related to competences E01, G01, G04, G09 and CT2.

3. Computer aided case studies, in small groups: the process design simulator Aspen Plus and the software PTC Mathcad will be used to analyze the effect of process variables through specific case studies on distillation, rectification, absorption and extraction. These workshops will be aimed to the acquisition of competences E01, G01, G02, G04, G09, CB2, CB5, CT2 and CT4.

4. Assessments and exams, in groups or individually, on the computer workshops or on problem solving exercises; they address competences E01, G01, G02, G04, G09, CB2, CB5, CT2 and CT4.

6. Detailed Contents:

BLOCK I: Introduction to mass transfer separation operations

CHAPTER 1. GENERAL CONCEPTS

1. Introduction
2. Operations. Description and equilibrium data
 - 2.1. Distillation and Rectification (fractional distillation)
 - 2.2. Absorption/Stripping (desorption)
 - 2.3. Liquid-liquid extraction
 - 2.4. Leaching (solid-liquid extraction)

CHAPTER 2. CONTACT TYPES AND FLUID DYNAMICS

1. Equilibrium staged columns
 - 1.1. Description
 - 1.2. Diameter calculation
 - 1.3. Efficiency concept
 2. Packed columns
 - 2.1. Description
 - 2.2. Diameter calculation
- #### CHAPTER 3. SINGLE CONTACT OPERATIONS
1. Application to distillation
 - 1.1. Flash distillation
 - 1.2. Rayleigh (differential) distillation
 2. Application to L-L extraction
 3. Application to leaching

BLOCK II: Equilibrium staged separations

CHAPTER 4. PONCHON-SAVARIT BASED METHODS

1. Application to binary rectification
2. Application to leaching
 - 2.1. Crosscurrent flow
 - 2.2. Countercurrent flow

CHAPTER 5. McCABE-THIELE BASED METHODS

1. Application to binary rectification
 - 1.1. Continuous rectification
 - 1.2. Batch rectification
2. Application to absorption
3. Application to L-L extraction

CHAPTER 6. TRIANGULAR DIAGRAM METHODS

1. Application to L-L extraction

1.1. Crosscurrent flow

1.2. Countercurrent flow

2. Application to leaching

BLOCK III: Continuous contact (rate based) separations

CHAPTER 7. TRANSFER UNIT BASED METHOD

1. Introduction

2. Mass transfer coefficients. Concept and estimation

3. Packed column height calculation

3.1. Application to binary rectification

3.2. Application to absorption

7. Bibliography

7.1. Basic Bibliography

MASS TRANSFER OPERATIONS (3rd ED.)

R.E. Treybal. McGraw-Hill, México D.F., 1981

EQUILIBRIUM STAGED SEPARATIONS

P.C. Wankat. Prentice Hall, New Jersey, 1988

PRINCIPLES OF CHEMICAL SEPARATIONS WITH ENVIRONMENTAL APPLICATIONS

R.D. Noble, P.A. Terry. CUP, Cambridge, 2004

SEPARATION PROCESS PRINCIPLES (2nd ED.)

J.D. Seader, E.J. Henley. John Wiley & Sons, New York, 2006

SEPARATION PROCESS ENGINEERING (2nd ED.)

P.C. Wankat. Prentice Hall, New Jersey, 2007

MASS TRANSFER AND SEPARATION PROCESSES. PRINCIPLES AND APPLICATIONS (2nd ED.)

D. Basmadjian. CRC Press, Boca Raton, 2007

PRINCIPLES AND MODERN APPLICATIONS OF MASS TRANSFER OPERATIONS (2nd ED.)

J. Benitez. John Wiley & Sons, New Jersey, 2009

MASS TRANSFER OPERATIONS FOR THE PRACTICING ENGINEER

L. Theodore, F. Ricci. John Wiley & Sons, New Jersey, 2010

MASS TRANSFER CONCEPTS

K. Asokan. CRC Press, Boca Raton, 2011

MASS TRANSFER II (16th ED.)

K.A. Gavhane. Nirali Prakashan, Pune, 2017

7.2. Additional Bibliography:

SEPARATION PROCESSES (2nd ED.)

C.J. King. McGraw-Hill, New York, 1981

HANDBOOK OF SEPARATION TECHNIQUES FOR CHEMICAL ENGINEERS

P.A. Schweitzer. McGraw-Hill, New York, 1997

CHEMICAL ENGINEERING, VOL. 2, PARTICLE TECHNOLOGY AND SEPARATION PROCESSES (5th ED.)

J.F. Richardson, J.H. Harker. Butterworth-Heinemann, Oxford, 2002

TRANSPORT PROCESSES AND SEPARATION PROCESS PRINCIPLES: (INCLUDES UNIT OPERATIONS)

C.J. Geankoplis. Prentice Hall, New Jersey, 2003

ASPEN PLUS V8.0. GETTING STARTED BUILDING AND RUNNING A PROCESS MODEL

Aspen Technology Inc., Burlington, 2012

DISTILLATION DESIGN AND CONTROL USING ASPEN SIMULATION (2nd ED.)

W.L. Luyben. New Jersey, Wiley, 2013

DISTILLATION: EQUIPMENT AND PROCESSES

A. Gorak, Z. Olujic. Elsevier, Amsterdam, 2014
DISTILLATION: FUNDAMENTALS AND PRINCIPLES
A. Gorak, E. Sorensen. Elsevier, Amsterdam, 2014
USING ASPEN PLUS IN THERMODYNAMICS INSTRUCTION: A STEP-BY-STEP GUIDE
S.I. Sandler. New Jersey, Wiley: AIChE, 2015

8. Systems and Assessment Criteria

8.1. System for Assessment:

- Theory/Problems Exam
- Practical assignment

8.2. Assessment Criteria and Marks:

1. Theory/Problems Exam: competences E01, G01, G04 and CT2 will be assessed through a final exam which will be composed of numerical problems on the course contents. This part will represent 70 % of the overall mark.

2. Practical assignment: competences E01, CB2, CB5, G01, G02, G04, G09, CT2 and CT4 will be evaluated through an assignment, in English language, which will deal with the computer sessions contents (Aspen Plus, PTC Mathcad, etc.). This part will represent 30 % of the overall mark. 100 % attendance to computer sessions is required.

Please, do NOTE that:

- A minimum overall mark of 5 over 10 is required to pass.
- If a minimum mark of 4 over 10 is not attained in part 1, part 2 will not be considered. Likewise, part 2 mark will not be considered if it is lower than part 1 mark. In both cases, part 1 will represent 100%.
- For those students who are not able to attend the computer sessions, part 1 mark will be 100%.
- Students are free to opt for maintaining part 2 mark forever (as long as they reach a minimum mark of 5 over 10) or repeating part 2 the following academic course.
- Mobile phones are forbidden in class, computer sessions and exams.