Bachelor in Industrial Chemical Engineering

Course information

Year 2019-20

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: 6				
Standard group	**Small groups**			
	Classroom	**Lab**	**Practices**	**Computer classroom**
4.14	0	0	0	1.86
Department		**Knowledge area**		
Chemical Engineering, Physical Chemistry and Materials Science		Chemical Engineering		
Year		**Semester**		
3º		2º		

TEACHING STAFF			
Name	**E-Mail**	**Telephone**	**Office**
Moisés García Morales	moises.garcia@diq.uhu.es	959218207	ETSI building, ETP033 (floor -1)

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 must be used to 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 (16^{th} 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 TECNOLOGY 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 75% 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, both Aspen Plus process simulator and PTC Mathcad. This part will represent 25% 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.