INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Transport Phenomena II			Field of study	Thermodynamics and Transport Phenomena		
Bachelor in	Chemical Engineering			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9125-755-3101-00-23		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Rolando Carlos Pereira Simões Dias

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Identify the fundamentals of mass transfer.
2. Apply general equations of conservation of mass and mass transfer in the presence of chemical reactions and using rectangular, cylindrical and spherical coordinates.
3. Apply equations of conservation and transport in steady-state molecular diffusion process.
4. Analyze unsteady-state molecular diffusion.
5. Identify local convective mass transfer coefficients and the correspondent mean mass transfer coefficient.
6. Quantify convective mass transfer between phases using the two resistance theory.
7. Apply convective mass transfer correlations for systems involving different flows and geometries. Design mass transfer equipment.
8. Apply MATLAB in the numerical resolution of mass transfer problems, namely considering initial value problems (IVP) and boundary value problems (BVP).

Prerequisites

Before the course unit the learner is expected to be able to:
1. Know and quantify heat transfer phenomena.
2. Establish and solve conservation laws.

Course contents

Diffusion and convection mass transfer and equations governing these processes. General equations of conservation of mass in the presence of chemical reactions. Steady-state and unsteady-state molecular diffusion. Convective mass transfer coefficient. Mass transfer between phases. Convective mass transfer correlations. Mass transfer devices. The course includes also experimental work concerning the study of diffusional processes, namely involving hydrogels with biotechnological applications.

Course contents (extended version)

1. Diffusion and convection mass transfer and equations governing these processes
   - Fick´s first law of diffusion
   - Convective mass transfer
   - Models to predict diffusion coefficients
   - Correlations to estimate convective mass transfer coefficients
2. General equations of conservation of mass in the presence of chemical reactions
   - Equations of conservation of mass in rectangular, cylindrical and spherical coordinates
   - Fick´s second law of diffusion
   - Analogies between heat and mass transfer
3. Steady-state molecular diffusion
   - One dimension diffusion without chemical reaction
   - Arnold diffusion cell
   - Pseudo-steady-state diffusion
   - Equimolar counter diffusion
   - Diffusion associated with chemical reaction
   - Steady-state diffusion in multidimensional systems
4. Unsteady-state molecular diffusion
   - Semi-infinite medium
   - Finite-dimensional medium with negligible surface resistance
   - Gurney-Lurie charts
5. Local convective mass transfer coefficient
   - Significant parameters in convective mass transfer
   - Convective mass and energy transfer analogies
   - Hydrodynamic, thermal and concentration boundary-layers theory
6. Mass transfer between phases
   - Two-resistance theory
   - Individual mass transfer coefficients
   - Overall mass transfer coefficients
7. Convective mass transfer correlations
   - Influence of hydrodynamics and geometry
   - Capacity coefficients for contact towers
8. Design of mass transfer equipment
   - Gas-liquid mass transfer in well mixed tanks
   - Continuous contact towers
   - Height of continuous columns operating in co or countercurrent flow

Recommended reading

1. Fundamentals of Momentum, Heat, and Mass Transfer, J. Welty, G. L. Rorrer, D. G. Foster, 7th Ed, Wiley, 2019
2. Transport Phenomena, RB Bird, WE Stewart, EN Lightfoot, Revised Second Edition, 2007
3. Transport Phenomena, W. J. Beek, K. M. K. Muttzall, J. W. van Heuven, Wiley, 2nd Edition, 2000
4. Fundamentos de Transferência de Massa, Maria Norberta de Pinho, Duarte Miguel Prazeres, 2ª ed. , IST Press, 2014
5. Elementos de Fenómenos de Transferência II, Rolando Dias, ESTIG, IPB, 2019

Teaching and learning methods

The unit will be taught using a combination of lectures, self guided learning and practice classes. Students will be provided with a study guide and support material, including e-learning facilities.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
   - Practical Work - 20%
   - Intermediate Written Test - 25%
   - Intermediate Written Test - 25%
   - Final Written Exam - 30%
2. Alternative 2 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100%
3. Alternative 3 - (Student Worker) (Final, Supplementary)
   - Final Written Exam - 100%

Language of instruction

English

Electronic validation

Rolando Carlos Pereira Simões Dias	Hélder Teixeira Gomes	Ramiro José Espinheira Martins	José Carlos Rufino Amaro
08-10-2023	25-10-2023	25-10-2023	31-10-2023