INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Engineering of Biotechnological Processes			Field of study	Engeneiring and related techniques		
Master in	Biotechnological Engineering			School	School of Agriculture		
Academic Year	2023/2024	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1	Code	5010-784-1103-00-23		

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

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): António Manuel Coelho Lino Peres

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Recognise the main components of a bioreactor and make their design;
2. Determine mass transfer coefficients to evaluate the aeration system;
3. Know the different operation modes and geometries of a bioreactor;
4. Determine the residence time distributions in order to verify the existence of deviations from ideal reactor behavior;
5. Identify the equations that represent the bioprocesses dynamics;
6. Identify the key state variables that should be monitored during a bioprocess;
7. Distinguish physical sensors and software sensors used for monitoring the main state variables of bioprocesses;
8. Apply control algorithms to maintain the state variables of the process nearby pre-established reference values.

Prerequisites

Before the course unit the learner is expected to be able to:
Integral and differential calculus. Basic concepts of Reaction Engineering and Bioreactors

Course contents

Main components of a bioreactor and their design; Oxygen transfer coefficients; Operation modes and geometry types most commonly used; Selection of the most appropriate biological reactor; Residence time distributions; Equations that represent the bioprocesses dynamics; Main state variables that should be monitored during a bioprocess; Physical sensors and software sensors used for monitoring the main state variables of bioprocesses; Control algorithms.

Course contents (extended version)

1. Design and construction of industrial fermenters:
   - Determination of the volume, geometry and material of construction;
   - Agitation and aeration systems – determination of mass transfer coefficient - KLa;
2. Geometries and Operating Modes of Fermenters:
   - Geometry-type Ex. fixed-bed and fluidized-bed reactors, bubble column reactor, air-lift reactor;
   - Operating modes;
3. Selection of the most appropriated biological reactor;
   - Bioreactor versus chemical reactors. Key issues in bioreactor design and operation.
   - Fermentation technologies
   - Other: Product concentration/purity Degree of substrate conversion Separation/purification processes
4. Non-ideal behavior of reactors: Residence time distributions and how to predict them.
   - Characterization and diagnostics
   - Residence-time distribution (RTD) function Measurement of RTD and its characteristics
   - RTD in Ideal reactors
   - Non-ideal reactors
5. Instrumentation and control of biological reactors.
   - Parameters: to be monitored/controlled: Temperature, Pressure, Agitator power, Flowrate, pH, DO, etc
   - Type of sensors
   - Control systems (e. g. , Feedback Control Loop, automatic control loop)

Recommended reading

1. Stanbury, P. F. ; Whitaker, A. ; Hall, S. J. 1995, “Principles of Fermentation Technology”, 2nd Edition, Elsevier Science Ltd. (ISBN 0-7506-4501-6);
2. Shuler, M. L. ; Kargi, F. 2001, “Bioprocess Engineering: Basic Concepts”, 2nd Edition, Prentice Hall (ISBN 978-0130819086).
3. Bailey, J. E. and Ollis, D. F. , 1987, “Biochemical Engineering Fundamentals”, McGraw-Hill (ISBN 978-0070032125);
4. Fonseca, M. M. e Teixeira, J. A. , 2007, “Reactores Biológicos: Fundamentos e Aplicações”, Lidel (ISBN 978-9727573660).
5. Fogler, H. S. , 2011, "Elements of Chemical Reaction Engineering", Prentice Hall (ISBN-13: 978-0-13-714612-3)

Teaching and learning methods

Theoretical classes: the theoretical concepts will be presented. Theoretical and practical classes: it is intended to solve exercises related to the topics addressed in the discipline; Laboratory classes: experiments will be undertaken in the laboratory to address the determination of yields, oxygen transfer coefficients and fermentations in batch mode.

Assessment methods

1. Exame - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%
2. Continuous evaluation - (Regular, Student Worker) (Final)
   - Final Written Exam - 80%
   - Practical Work - 20% (Works presented by the students.)

Language of instruction

1. English
2. Portuguese

Electronic validation

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19-01-2024	01-02-2024	02-02-2024	02-02-2024