UCL

Faculté d'ingénierie biologique, agronomique et environnementale

AGRO

BIRC2108 Biochemical and Microbial Engineering

[30h+30h exercises] 5 credits

Teacher(s): Spyridon Agathos
Language: french
Level: 2nd cycle course

Aims

The general goal is to train the students to understand the physical, chemical and engineering fundamentals that allow the design and sizing of biological [enzymatic or microbial] reactors. More specifically, the principles of thermodynamics coupled to the analysis of mass, momentum and energy transport phenomena will be applied to the analysis, design and integration of biocatalyst-based engineering systems of transformation. This training aims to prepare the students for professional activities involving analysis or management in the bioprocess industries. The students should be able to analyse precisely the phenomena underlying the production of useful substances or the destruction of pollutants by biochemical means at the process level. They will be able to analyse and model the different components of bioreaction systems (bioreactors, recycling systems) as well as those of associated operations (e.g. sterilisation).

Main themes

From design to pilot scale-up of microbial and enzymatic processes. Production and bioseparation processes. The content of this course makes use of the theoretical and methodological foundations of applied chemical kinetics and of chemical reactor design by taking into account the special features (kinetics and transport phenomena) of biochemical and microbial processes in order to apply in a systematic manner the underlying principles to the analysis and sizing of bioreactors. Specific themes: (Micro)biological processes characterised kinetically and thermodynamically: cell growth, its measurement or estimation, substrate utilisation, product formation. Yields. Productivities. Kinetic models. Parameter estimation. The application of the methodology of mass and energy balances to the analysis of biotechnological systems and of their performance. Batch, continuous and fed-batch reactors. Transport phenomena applied to the analysis of aeration, agitation, rheology, scale-up and sterilisation of bioreactors. Bioseparation engineering: general scheme; applications to cell culture.

Content and teaching methods

Definitions: definitions in bioprocess engineering - physical quantities and reactors - microbial processes - yields of biological processes in reactors. Models of growth kinetics. Modeling of batch reactors - modeling of a continuous stirred tank bioreactor with and without recycle. Two-stage continuous stirred tank systems. Proceses in enzyme reactors. Sizing and performance. Sterilisation processes. Scale-up from the laboratory to the industrial scale via pilot scale. Bioseparations engineering. Ideal recovery process: primary separation, isolation, purification, polishing. Separation devices in industrial cel culture: continuous perfusion reactor with cell retention. Advantages and limitations of each design in an industrial context. Teaching methods: (a) conventional lectures, interactive audiovisual presentations (video projections, powerpoint) (b) exercises aiming to familiarise the student with the methods of solving quantitative problems in bioprocess analysis and design: making use of sizing or performance calculations, designing flow sheets combining several unit operations, searching the real values of constants or other parameters useful in bioprocess design, modelling or optimisation. Contact between the students and professionals from industry or university (doctoral candidates or project leaders on contracts) apply this knowledge to fermentation technology.

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

Prerequisite courses Basic courses (Bachelor's level) in physics, chemistry, biochemistry and microbiology; Course BIRCxxx on Unit Operations: fluid-flui and fluid-soild separations; Course MAPR 2330 (Reactor design and modeling)
Supplemental courses The course can be extended thanks to the courses CABI 3002 (Advanced design and modeling of bioreactors) and CABI 3004 (Cell culture science and technology)
Evaluation Open book (theory) and closed-book (problems) written examination; personal assignment (critical appraisal of an article)
Support Course notes ; video projections ; transparencies In-class lectures; in-class exercises (practicals) or in small groups
Teaching team S. Agathos and teaching assistant

Other credits in programs

BIR22/0C	Deuxième année du programme conduisant au grade de bio-ingénieur: Chimie et bio-industries (Technologies & gestion de l'information)	(5 credits)	Mandatory
BIR22/1C	Deuxième année du programme conduisant au grade de bio-ingénieur: Chimie et bio-industries (Sciences, technologie & qualité des aliments)	(5 credits)	Mandatory
BIR22/2C	Deuxième année du programme conduisant au grade de bio-ingénieur : Chimie et bio-industries (Ingénierie biomoléculaire et cellulaire)	(5 credits)	Mandatory
BIR22/3C	Deuxième année du programme conduisant au grade de bio-ingénieur : Chimie et bioindustries (Nanobiotechnologies, matériaux et catalyse)	(5 credits)	Mandatory
BIR22/4C	Deuxième année du programme conduisant au grade de bio-ingénieur : Chimie et bio-industries (Technologies environnementales: eau, sol, air)	(5 credits)	Mandatory
INCH22	Deuxième année du programme conduisant au grade d'ingénieur civil chimiste	(5 credits)	
INCH23	Troisième année du programme conduisant au grade d'ingénieur civil chimiste	(5 credits)	