BioInh

Modelling and optimisation of the bioconversion of plant raw materials in an inhomogeneous environment

ABSTRACT

The BioInh project has evidenced a bi-stability phenomenon that occurs during the enzyme-catalyzed bioconversion of cellobiose in a non-homogeneous medium (i.e. the presence of two sustainable functioning modes with different performance). The originality of the approach consisted in studying this phenomenon using a mathematical model in a first step, which allowed the characterization of its precise conditions of existence (which would have been very difficult to achieve empirically). This result has been published in the proceedings of the CAB international conference (Computer and Applications in Biotechnology) and presented orally in the same conference. This first study has then permitted the design and the realization of laboratory experiments.
Concerning the mathematical formalism of the problem, the spatial inhomogeneity, one of the key points of the project, was chosen to be simply represented as "dead zones" instead of using the commonly used continuous and explicit space representations. Indeed, the latter would have required the model to be in the form of partial derivatives, with which the study would have been very difficult to be realized analytically and would have allowed numerical simulations only.
Unfortunately, the enzyme chosen for the experimental studies displayed a different behaviour than described in the literature, which prevented the experimental data to be used for the validation of the model.
This study has also resulted in the design of a control law aiming at driving the system toward the equilibrium with the highest conversion efficiency. The new law has unfortunately not been able to be experimentally tested because of lack of time (and has therefore not been the subject of a paper yet).
The BioInh project, financially supported by Agropolis Fondation, has resulted in closer scientific relations between IATE and MISTEA Joint Research Units and has permitted to launch new long term collaborations. Indeed, the present project has put forward the coupling of mathematical modelling with experiments for the study of a specific object (cellobiose hydrolysis). Beyond the theoretical study and the experimental results obtained, it is a generic approach for modelling and mathematical formalization that has developed between the two partners, with a working mode. The foreign partners have played a determining role: R. Lortie (Montréal), who has initiated the definition of the project, has proposed original and pertinent orientations that would not have been chosen without his expertise, thanks to his stays in Montpellier granted by the project. Moreover, a large part of the experiments has been realized by the post-doc researcher A. Saddoud, from Sfax, relayed by G. Nogaro at the end of the project.

Keywords : Operation, Transformation, Model

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Project leader : Eric Dubreucq Jerome Harmand AlainRapaport
Project leader's institution : InstitutAgro
Project leader's RU : IATE

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PERSPECTIVES

Several research tracks have been opened:85
- To identify new enzymes and strains better adapted to the evidenced phenomenon (in partnership with the Biotechnology Research Institute of the National Research Council of Canada.
- To explore other interconnected configurations, in a follow-up of Action incitative INRA INRIA ‘VITELBIO’ (web site : http://sites.google.com/site/vitelbio/) steered by the Modemic team of UMR MISTEA.
- To take into account both active (viable) and non-active (non-viable) biocatalysts in the model, as discussed with C. Ghommidh, a senior scientist who has recently joined UMR IATE.
- To develop a collaboration project with CBS (Biotechnology centre of Sfax, Tunisia) for a course on mathematical modelling for bioprocesses (the Modemic team has already welcome two PhD students in France for such a course, in the framework of the euro mediterranean project 3+3 ‘Treasure’).