On the Mathematical Modelling of Fermentation Processes Using Uncertain Data: Case Studies

Venko Beschkov[1], Stanko Dimitrov[2], Svetoslav Markov[3],
Vencislav Pirinski[4], Gergana Velikova [2]
[1] Institute of Chemical Engineering, BAS
[2] University of Sofia, Faculty of Mathematics and Informatics
[3] Institute of Mathematics and Informatics, BAS
[4] Technical University Sofia
vbeschkov@yahoo.com, stankod@fmi.uni-sofia.bg, smarkov@bio.bas.bg,
vpirinski@gmail.com, gergana_velikova@yahoo.com

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Experimental data for the dynamics of fermentation processes including enzymes, substrate and product are obtained together with bounds for the systematic errors in the data [1]. The availability of error bound allows us to study mathematically and computationally these experimental data using verification methods paying special attention to the errors involved. We describe and motivate our modelling approach on several case studies applying the Henri-Michaelis-Menten (HMM) biochemical reaction schemes of the enzyme-substrate dynamics where two fractions of enzymes (free and bound) are involved. We briefly demosntrate how basic ideas from these case studies can be applied to fermentation processing involving bacteria cells [2], [3]. The aim of this presentation is to demonstrate how verification methods can be used to confirm or reject the proposed mathematical models as possible fermentation mechanisms. Advanced computational and visualization tools are demonstrated.

References

[1] V. Beschkov, S. Velizarov, S. N. Agathos, V. Lukova, *Bacterial denitrification of wastewater stimulated by constant electric field*, *The Biochemical Engineering Journal* **17** (2) 141–145, 2004.

[2] R. Alt, S. Markov, *Theoretical and computational studies of some bioreactor models*, Computers and Mathematics with Applications **64** 350–360, 2012.

[3] S. Markov, *Cell Growth Models Using Reaction Schemes: Batch Cultivation*, Biomath **2** (2) Article ID: 1312301, 2013.