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PII: S0098-1354(16)30398-2
DOI: http://dx.doi.org/doi:10.1016/j.compchemeng.2016.12.004
Reference: CACE 5639

To appear in: *Computers and Chemical Engineering*

Received date: 18-5-2016
Revised date: 2-12-2016
Accepted date: 4-12-2016

Please cite this article as: Jennifer Puschke, Alexandr Zubov, Juraj Kosek, Alexander Mitsos, Multi-model approach based on parametric sensitivities ndash A heuristic approximation for dynamic optimization of semi-batch processes with parametric uncertainties, <*![CDATA[Computers and Chemical Engineering]]*> (2016), http://dx.doi.org/10.1016/j.compchemeng.2016.12.004

Multi-Model Approach Based on Parametric Sensitivities - A Heuristic Approximation for Dynamic Optimization of Semi-Batch Processes with Parametric Uncertainties

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Abstract

Optimal processes often exhibit active path constraints. Parametric uncertainties in the process model might thus lead to constraint violations. A heuristic approach is presented to overcome this challenge. The nominal model is optimized with additional path constraints due to worst-case models. A heuristic method of choosing these models is proposed based on sensitivities of the constraints with respect to the uncertain parameters. The presented approximation does not guarantee robust feasibility, but path constraint violations are less likely to occur compared to the optimization using the nominal model solely. Two case studies are presented: a complex emulsion copolymerization process (DAE with 139 equations) and the penicillin formation (four differential equations and two algebraic equations). The results of both case studies show that, in contrast to the optimization in the nominal case, the multi-model approach does not violate the path constraints for different scenarios of the parametric uncertainty set.

Keywords: Parameter uncertainty, uncertain dynamic systems, optimal control problem, robust dynamic optimization

1. Introduction

In chemical process engineering practice semi-batch and batch processes are traditionally operated based on recipes. A promising alternative to recipe-based production are optimization or control strategies, e.g., the application of nonlinear model-predictive control

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[1] Developed the method, applied it to the case studies and wrote the paper
[2] Developed the polymerization model