



Modeling Operating Modes during Plant Life Cycle

Jørgensen, Sten Bay; Lind, Morten

Published in:
Proceedings of the 17th Nordic Process Control Workshop

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Jørgensen, S. B., & Lind, M. (2012). Modeling Operating Modes during Plant Life Cycle. In J. B. Jørgensen, J. K. Huusom, & G. Sin (Eds.), *Proceedings of the 17th Nordic Process Control Workshop* (pp. 60). Technical University of Denmark. <http://npcw17.imm.dtu.dk/>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Modeling Operating Modes during Plant Life Cycle

Sten Bay Jørgensen¹ and Morten Lind²

¹CAPEC, Department of Chemical and Biochemical Engineering

²Department of Electrical Engineering
Technical University of Denmark, Denmark

Abstract

Modelling process plants during normal operation requires a set of basic assumptions to define the desired functionalities which lead to fulfillment of the operational goal(-s) for the plant. However during start-up and shut down as well as during batch operation an ensemble of interrelated modes are required to cover the whole operational window of a process plant including intermediary operating modes.

Development of such a model ensemble for a plant would constitute a systematic way of defining the possible plant operating modes and thus provide a platform for also defining a set of candidate control structures. The present contribution focuses on development of a model ensemble for a plant with an illustrative example for a bioreactor.

Starting from a functional model a process plant may be conceptually designed and qualitative operating models may be developed to cover the different regions within the plant operating window, including transitions between operating regions. Subsequently qualitative functional models may be developed when the means for achieving the desired functionality are sufficiently specified during the design process. Quantitative mathematical models of plant physics can be used for detailed design and optimization. However the qualitative functional models already provide a systematic framework based on the notion of means-end abstraction hierarchies. Thereby functional modeling provides a scientific basis for managing complexity. A functional modelling framework has been implemented to facilitate model development and application in a computer environment. Defining means-end causal relations makes it possible to perform qualitative causal reasoning within a functional modelling framework. Thus such a framework renders it possible to develop potentially feasible control structures. This ability is based on goal reasoning and development of goal trees from causal relations. These capabilities of functional models extend the application potential of functional modelling significantly beyond that of conventional mathematical modeling representing quantitative physical phenomena.

The example case is a continuously operating bioreactor for manufacturing single cell protein from methane where also the bioreactor start-up is illustrated with switching between operating modes and their associated control structures as seen in a multiloop control configuration.