GUELPH ENGINEERING

Leadership Lecture Series

Model-Based Concepts in Bioprocess Engineering: Design, Optimization and Control

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In the last years, computer-assisted methods for process design and control have become increasingly popular and were applied in many industrial processes. This resulted in the development and application of several novel sensors and powerful technologies. However, not all industries make use of this high potential for specifying model-assisted designs, process optimization and controlled reproducibility. This is especially true for biotechnological processes due to the comparably high complexity of biological systems.

Commonly, manual samples and off-line techniques are still the main methods used for process control and quality assurance. However, using these methods, only a handful of process variables can be monitored. Many important efficiency parameters such as the productivity of the biomass can neither be monitored nor controlled using this approach. Therefore models can serve as tools to bridge the gap between the information that is available and the efficiency parameters required for designing and optimizing a bioprocess.

Furthermore, models can also serve as powerful tools for advanced control applications. The techniques for this purpose are mainly classified according to three tasks: adaptive control, predictive control and other neuro-(fuzzy)-based approaches. The system of adaptive control uses information on changes in process dynamics to adjust control parameters accordingly to maintain correct operation. Model predictive control (MPC) can be regarded as a complex add-on for existing control systems. MPC relies on dynamic models with varying degrees of structure and complexity which are used to predict the future progression of process variables and compare this prediction to reference trajectories. The predicted data is then used to adjust the appropriate control variables thus eliminating future deviations from the reference trajectory.

This lecture summarizes the application of models in bioprocess design, optimization and control. Furthermore, current challenges and future trends are highlighted by discussing emerging novel techniques for advanced applications in model predictive bioprocess-control.