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MPC4BATCH

ONLINE CONTROL AND OPTIMIZATION
SOLUTIONS FOR THE BATCH INDUSTRY

ON-LINE CONTROL & OPTIMIZATION

Until recently, PID controllers were the only control solution for batch processes. Unfortunately PID control performance is limited and tuning is often a challenge. Neither can they push the batch process to minimum cycle time while guaranteeing operational and quality constraints.

Model Predictive Control (MPC) provides a solution for online control and optimization in many continuous processes. MPC4BATCH is a new control tool for online optimization and tight control of the reaction phase of batch processes at an affordable cost.

TESTED!
**Improves
batch cycle time**

WHY MPC4BATCH?

Make cycle time reproducible, limiting batch to batch variations

Reduce cycle time further by pushing the process against heat transfer and quality limits, increasing overall asset efficiency

Decrease product quality variance

Reduce downtime by elimination of emergency situations due to insufficient PID control performance

Enhance process safety by tighter process control

Reduce runaway risk for exothermal batch processes

Reduce operator attention to follow up a poorly PID controlled batch

Monitor on-line conversion, heat of reaction and unreacted raw material, as well as batch to batch degradation phenomena

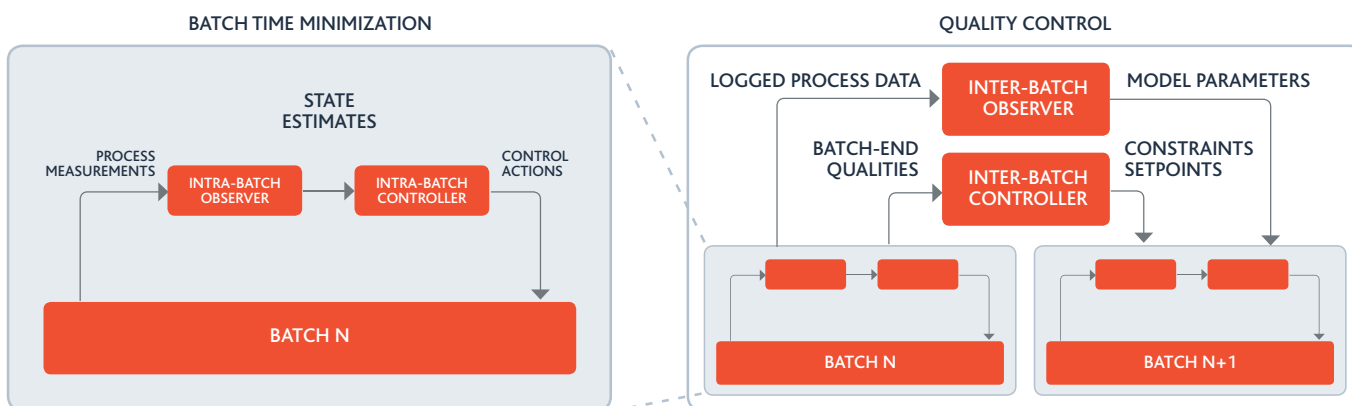
Extending common proven technology for continuous processes towards Batch processes

Standard model-based solutions are widely used in the continuous processing industry. However, they are not applicable in the batch processing world. The main reasons are:

- **Model Predictive Control and the underlying modeling technology are not transferable from steady-state continuous processes to transient batch processes.** Models linearized around a stable operation point and corresponding controllers are of no use for rapidly changing non-linear batch processes. Also controller constraints and references tend to vary much more in batch processes. Additionally product quality is often only measured once the batch has finished, and can therefore not be used during the batch. MPC4BATCH has been developed to deal with these technical issues.
- **Economic drawbacks originate from the fact that a batch reactor is often used to produce multiple products.** The modeling cost for all these products often becomes prohibitively high for a model-based project. IPCOS has developed a new modeling technology focusing on reduction of the engineering time per product and reactor. With this new technology online control and optimization of your batch process becomes economically attractive.



MPC4BATCH AT WORK



MPC4BATCH Modeler

Modeling of batch processes must be done very efficiently in order to reduce the implementation cost. The approach of elaborate testing as known in the continuous process world is replaced by knowledge extraction from normal production batch data and a very limited number of dedicated tests with minimal impact on the process.

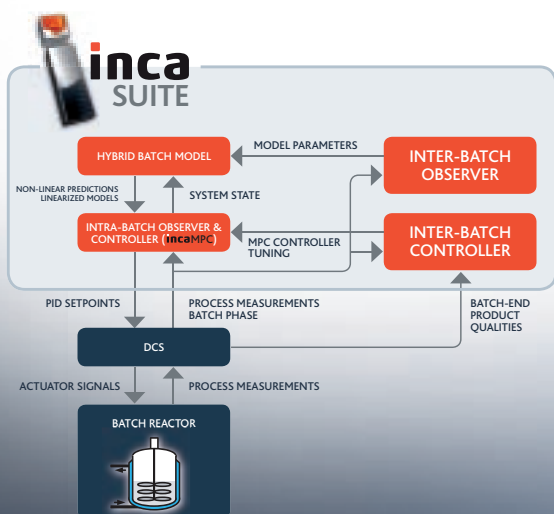
MPC4BATCH Hybrid Modeling Technology combines the extrapolation qualities of a mechanistic model for the heat fluxes, and a fast non-linear black-box approach for the reaction kinetics. Essentially, a large portion of the model is readily extracted and embedded in pre-configured, simplified models of cooling coils, half tube (and other) jackets and condensers. The reaction specific model is largely extracted from normal operation data. The result is a fast assembly of

an accurate batch process model. The model predicts the heat balance at all times, as well as the reaction energy and the excess of unreacted product.

MPC4BATCH Control and Optimization Tool

The model, generated by the MPC4BATCH Modeler, is used as a prediction model in the model predictive control application. Based on these predictions, the MPC4BATCH controller calculates optimal heat transfer and (for a fed-batch process) optimal feed flow setpoints to be applied to the process at every control sample. At all times the non-linear Model Predictive Controller predicts the batch behavior and acts correspondingly if constraints are hit. The system is based on a reliable real-time QP optimization solution taking into account all actual and future dynamic constraints.

Constraints can be heat transfer limitations, product quality related issues, maximum unreacted product concentrations, etc. Given the freedom that is observed in the process, MPC4BATCH will at all times push the process to its limits in order to reduce the batch cycle time. MPC4BATCH is seamlessly integrated in the batch sequencing procedure and is based on proven INCA technology.



IPCOS INTERBATCH controller

Since a product quality measurement only becomes available after a batch has finished, it cannot be used within the batch. This measurement can however be used for future batches. The INTERBATCH controller will modify the setpoints and constraints of future batches accordingly, so that at all times product quality is controlled. The INTERBATCH controller is integrated with the LIMS system.



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