Model-Based Monitoring of an Industrial Batch Pectin Extraction

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ABSTRACT

Monitoring and control strategies play a crucial role in the various stages of a product/process life-cycle, from process development to the optimization of an established process. These strategies are used to address a large number of objectives such as process understanding, statistical process control, real-time control actions, troubleshooting and continuous process optimization.
Currently one of the major limitations in the biochemical industry is the multitude of disturbances that each process is subjected to, which can derive from processing biological feedstock or by working with living (micro) organisms. Nowadays the industry operates in a heuristic recipe-driven way, dependent on rule-of-thumb experience which results too often in batch-to-batch discrepancies. These difficulties can be mitigated by an appropriate monitoring strategy and model building comes as an integral part of such a strategy as models supply a representation of the underlying physical/chemical phenomena, allowing prediction and subsequent control decisions.
Our work reports the attempt of implementing a flexible monitoring strategy in an industrial case-study focusing on the performance monitorization of a pectin batch extraction process. First principle dynamic models, which describe the reactions and transport phenomena of the pectin extraction, were developed for the considered key performance indicators: pectin bulk concentration($C_{pectin,bulk}$), degree of esterification (%DE) and intrinsic viscosity (IV). The parameters that describe the models were tuned based on experimental pilot plant data. These mathematical models were verified to properly forecast process behaviour at this scale. The challenge of validating the obtained models to fullscale plant data is described, highlighting the efforts of developing a robust integrated model scheme that is suitable to cope with a different scale and with the discrepancies in raw material, allowing the product quality to hold consistently at the required standards despite variations of different raw material. A procedure for a fullscale monitoring strategy is proposed, with the ultimate goal of providing the process operators with a guideline for process optimisation and a decision making tool.

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