Model-based control of a pilot scale fermentation process using a predictive control strategy

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Industrial fermentation systems are often operated in fed-batch mode [1], however this mode of operation can make planning and scheduling challenging due to batch-to-batch variation. There is natural variability in the length of the batch phase due to biological variations, in addition to batch-to-batch variations in initial process conditions from raw materials [2]. These affect the reproducibility of the batch, and also affect the final batch fill due to the feed addition. This therefore leads to variation in the total product achieved from each batch. It is desirable to always achieve full vessel capacity [3] to maximize the productive volume of each tank in every fermentation run, within a given process time.

A control strategy is developed in order to achieve full vessel capacity at a defined process time. This should be achieved subject to oxygen transfer rate in the aerobic system. In order to achieve this goal a mechanistic model based control strategy is developed in order to drive the process to reach a target mass at a specified time, whilst maintaining the dissolved oxygen concentration above a minimum constraint. The model is used in order to predict the future mass trajectory and determine the error between the target mass and the trajectory in order to adjust the current feed rate accordingly.

In order to challenge the model-based control strategy, four different process conditions are chosen, resulting in different oxygen transfer capacities. The model based strategy is implemented in 550L fermenters at Novozymes A/S.

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