A compartment model for risk-based monitoring of lactic acid bacteria cultivations

A soft sensor for on-line risk-based monitoring was applied for a 700-L Streptococcus thermophilus cultivation using a biochemical model that was coupled with a compartment model, the latter to account for mixing effects. The process risk, defined as the likelihood of not achieving the target biomass production per batch, was calculated continuously during the cultivation process. A Monte Carlo simulation accounted thereby for uncertainties in the model parameters. In the present cultivation, the estimated process risk was to lose ca. 3.5% of the total production capacity. The compartment model allowed the prediction of the spatial distribution of the pH in the bioreactor. The compartment model was based on a computational fluid dynamics (CFD) simulation and its computational speed (<2s for one simulation) enables both on-line applications, e.g., as soft sensor, and rapid off-line process condition testing, in contrast to a CFD simulation that takes several hours/days to simulate. With the on-line soft sensor, pH gradients between pH 5.8 and 6.1 were predicted with an accuracy of ± 0.1 pH units in comparison to experimental measurements. This process analytical technology (PAT) tool was therefore further applied to test different scenarios with the aim to propose a better base addition position for pH control to reduce pH gradients in the bioreactor.

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