CFD predicted pH gradients in lactic acid bacteria cultivations - DTU Orbit (09/04/2019)

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The formation of pH gradients in a 700 L batch fermentation of *Streptococcus thermophilus* was studied using multi-position pH measurements and computational fluid dynamic (CFD) modelling. To this end, a dynamic, kinetic model of *S. thermophilus* and a pH correlation were integrated into a validated one-phase CFD model, and a dynamic CFD simulation was performed. First, the fluid dynamics of the CFD model were validated with NaOH tracer pulse mixing experiments. Mixing experiments and simulations were performed while multiple pH sensors, which were placed vertically at different locations in the bioreactor, captured the response. A mixing time of about 46 s to reach 95 % homogeneity was measured and predicted at an impeller speed of 242 rpm. The CFD simulation of the *S. thermophilus* fermentation captured the experimentally observed pH gradients between a pH of 5.9 and 6.3, which occurred during the exponential growth phase. A pH higher than 7 was predicted in the vicinity of the base solution inlet. Biomass growth, lactic acid production, and substrate consumption matched the experimental observations. Moreover, the biokinetic results obtained from the CFD simulation were similar to a single-compartment simulation, for which a homogeneous distribution of the pH was assumed. This indicates no influence of pH gradients on growth in the studied bioreactor. This study verified that the pH gradients during a fermentation in the pilot-scale bioreactor could be accurately predicted using a coupled simulation of a biokinetic and a CFD model. In order to support the understanding and optimization of industrial-scale processes, future biokinetic CFD studies need to assess multiple types of environmental gradients, like pH, substrate, and dissolved oxygen, especially at industrial scale. This article is protected by copyright. All rights reserved.

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