Interaction of mechanical stresses and productivity of biological agglomerates in aerated stirred fermenters

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The proposed project is concerned basically with the experimental and numerical characterisation of local mechanical stresses occurring in gassed stirred fermenters and their effect on biological agglomerates. The findings thus obtained are practically tested on the fermentation of *Aspergillus niger*. Furthermore, the results will be used for the identification and development of low-shear stirrers.

In real fermentation broths measurement of mechanical stresses is only partially or not at all possible. Therefore, a part of the investigation is carried out with a rheologically largely identical model system. The particles are formed by a second liquid phase. The drop size is roughly adjusted to the size of the biological agglomerates occuring in the fermentation process. The rheology of the continuous phase in the model systems is adjusted to the fermentation broth. The fluid dynamic investigations include the measurement of particle size distributions, which reflect the effect of the mechanical stress in the form of more or less large drops. Second, the mechanical stress is quantified on the basis of the measurement of local shear and energy dissipation rates in the stirred tank by means of particle image velocimetry (PIV). These mechanical stresses are largely dependent on the geometric and operating parameters.

The data of the fluid dynamic studies serve as the basis and for the validation of further detailed studies using computational fluid dynamics. This allows on the one hand a better analysis of the immediate proximity of the stirrer compared to the measurements. Secondly, the distribution of the mechanical stresses over the entire fermenter can be determined as a distribution function. Finally, a stress analysis for selected particles can be realized by monitoring their pathways over a period of time throughout the stirred tank. The fluid dynamic detailed investigations in conjunction with the droplet size distributions are to be used as a basis for a mechanistic description of break-up processes in stirred fermenters based on a coupling of CFD and population balances (PBE).

In order to apply the basic findings of the characterization of the shear stress in stirred tanks to real fermentations, the production of invertase with *Aspergillus niger* is used as a model fermentation. In addition to the usual method for rheological characterization of the fermentation broth over time specifically the size of agglomerates is determined by means of in situ endoscope technology and image analysis. In addition, the productivity of the organisms under the different conditions is measured.