Life Sciences and Facility Management

ICBT Institute of Chemistry and Biotechnology
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Computational Fluid Dynamics (CFD)

Summary

The knowledge of the fluid flow behavior in bioreactors is of great importance in order to find the optimal process conditions, which are required to fulfil the particular requirements of the cells of interest. The simulation of fluid flow in bioreactors by means of Computational Fluid Dynamics (CFD) is used to better understand the hydrodynamics and to define process transfer and scale-up parameters.

Vision

Our vision is the flawless process scale-up and transfer, based on a defined set of parameters, so that users can operate all types of bioreactors no matter what mixing principle is underlying. The transfer from a small scale shake flask to a large scale bioreactor and vice versa, or the scale-up of a set of wave-mixed bag bioreactors is defined and the hydrodynamic environment of the cells is well-known and fully understood.

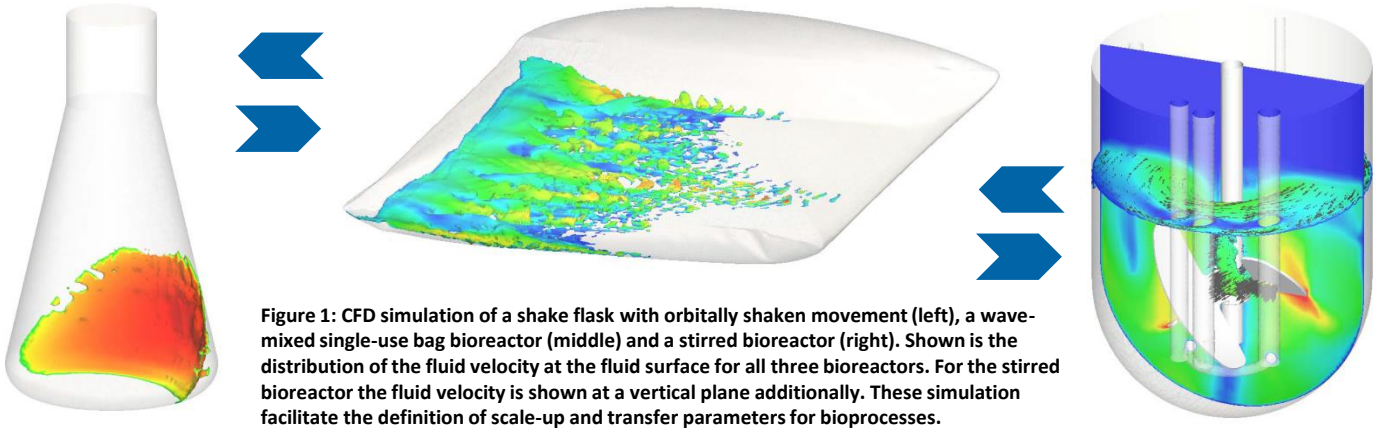

Figure 1: CFD simulation of a shake flask with orbitally shaken movement (left), a wave-mixed single-use bag bioreactor (middle) and a stirred bioreactor (right). Shown is the distribution of the fluid velocity at the fluid surface for all three bioreactors. For the stirred bioreactor the fluid velocity is shown at a vertical plane additionally. These simulation facilitate the definition of scale-up and transfer parameters for bioprocesses.

Services and Research

- Calculation of fluid flow in upstream processing equipment (bioreactors, pumps, tubings, valves)
- Calculation of engineering parameter for bioreactors
- Support for development, scale-up and optimization of upstream processes for microorganisms, animal and human as well as plant cell lines
- Calculation of fluid flow for medical devices

Team and Infrastructure

- Dedicated team of 4-5 researchers
- High performance computing (HPC) cluster with 256 cores and 1 TB of RAM
- OpenFOAM (open source CFD software)
- ANSYS Fluent (commercial CFD software)
- AutoDesk Inventor (commercial CAD system)
- Particle Image Velocimetry (PIV) for CFD simulation verificatio

Selected Publications

Werner, S., Kaiser, S. C., Kraume, M., & Eibl, D. (2014). Computational fluid dynamics as a modern tool for engineering characterization of bioreactors. Pharmaceutical Bioprocessing, 2(1), 85–99.

Kaiser, S. C., Löffelholz, C., Werner, S., & Eibl, D. (2011). CFD for Characterizing Standard and Single-use Stirred Cell Culture Bioreactors. In I. V Minin & O. V Minin (Eds.), Computational Fluid Dynamics Technologies and Applications (pp. 97–122). InTech.

Collaboration Opportunities

We have carried and are carrying out projects in co-operation with companies (Zeta, AkzoNobel, Bründler, Egemin, Sartorius Stedim, PBS Biotech, Levitronix, Lonza, Finesse, Merck Millipore, CerCell, Infors, Subitec, DasGip, Phyton, GE Healthcare, Polpharma) and academic partners (TU Berlin, TU Hamburg, TU Dresden, BTU Cottbus, University of Applied Sciences Anhalt).
In addition, we are closely linked with companies as well as research groups being members of the biotechnet Switzerland and the DECHEMA working group “Single-Use Technology”.

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