

Bioreactor product development for new foods

GEA advances bioreactor development with digital twin

- Simulation with digital twin improves bioreactor testing and validation prior to construction
- Risk-free environment for scaling up bioreactors for new food applications
- Cell behavior inside bioreactor can be mapped using computational fluid dynamics

Düsseldorf (Germany), October 10, 2023 – To facilitate the configuration of bioreactors – a key technology for the new food industry – GEA has developed a digital twin for virtual testing prior to construction. The aim is to create an optimum growth environment for cultured cells, which behave differently in mass production volumes than at laboratory scale.

Digital twin simulates cell and microorganism behavior

Developing higher-performance bioreactors is a priority for the GEA Center of Competence for Bioreactor Technologies due to an impending dramatic capacity shortfall on the bioreactor market. Validation of large-scale fermenters using a digital twin is a key step in ensuring optimal growth conditions and making it possible to take new food processes successfully to scale.

“A bioreactor is a vessel that has to function like a living body. Inside it, life develops under highly complex conditions. Working on an industrial scale, we have to make living organisms predictable, because we need reliable and replicable performance to go hand in hand with maximum productivity,” explains Daniel Grenov, Product Manager Bioreactor Technologies at GEA. “A digital twin simulates the environment inside bioreactors in a wide variety of scenarios. This lets us precisely match the tank design and the mechanical configuration for fine-tuning parameters such as shear stress, temperature, nutrient and oxygen distribution to what the cells need.”

CFD improves bioreactor performance

The virtual bioreactor testing is based on computational fluid dynamics (CFD), which models the growth behavior of cells as well as the oxygen and nutrient delivery radii inside the reactor. “Experts estimate that, when scaling up bioreactors, uneven distribution of oxygen and nutrients inside the tank often leads to performance losses of up to 30%,” Grenov says.

Like all living organisms, cells locate near sources of oxygen and nutrients. Temperatures and pH levels are critical and the environmental conditions must be kept homogeneous. Conversely, a lack of oxygen or nutrients puts cells under stress, causing them to lose productivity or release growth-inhibiting metabolites when they live in a confined space for an extended period of time.

“So we can’t simply stir the tank more, because the resulting shear stresses might kill cells and, in large reactors, contribute to oxygen gradients – in other words, an uneven distribution of oxygen.” This risk can be banished by using CFD simulation and by calculating kinetic models, both of which are powerful product development tools. Combined with physical test rigs to measure bubble sizes,

and equipment behavior, GEA optimizes the performance of large-scale bioreactors right on the drawing board.

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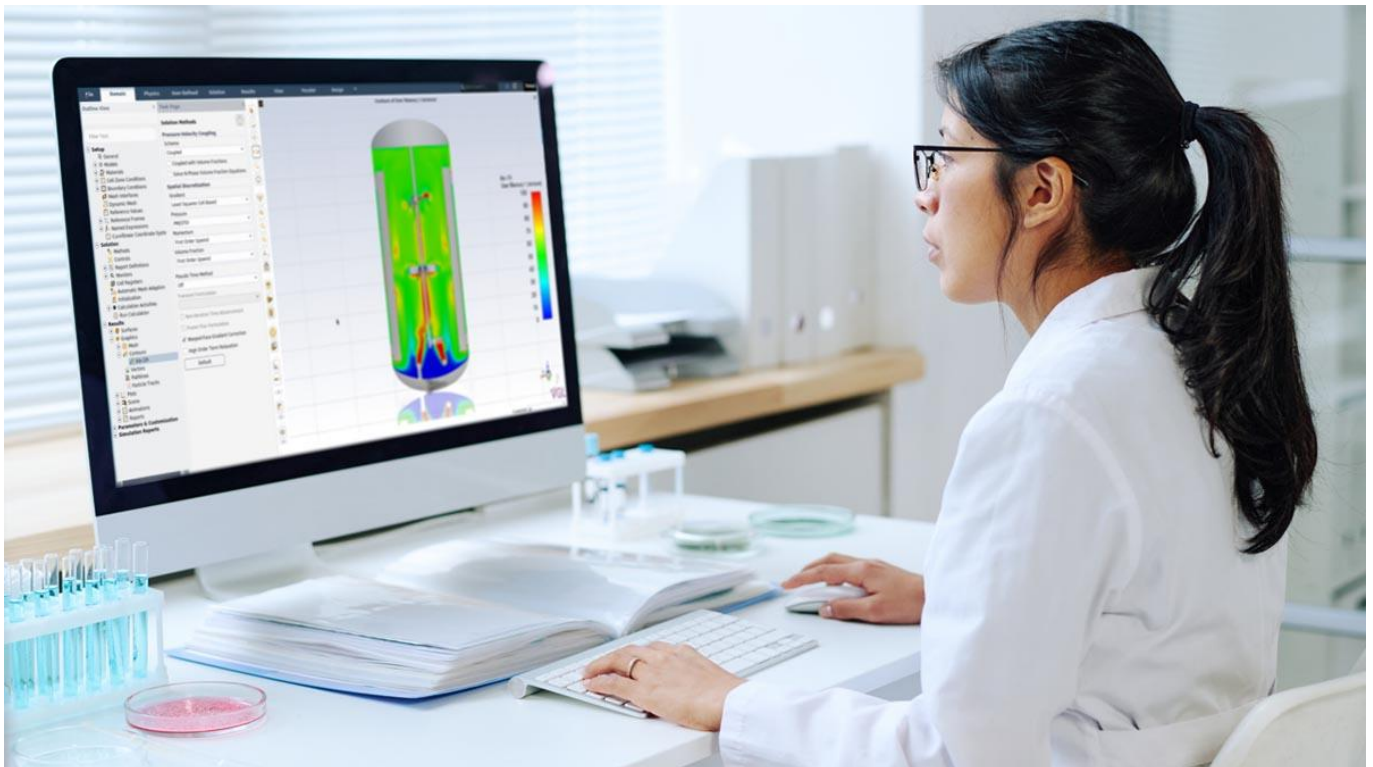


Fig. 1: The digital twin uses computational fluid dynamics (CFD) to simulate cell behavior in bioreactors along oxygen and nutrient supply gradients inside the tanks. Source: GEA

NOTES TO THE EDITORS

- Product information: [Accurately forecast the optimum bioreactor setup with GEA Virtual Bioreactor Testing.](#)
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GEA is one of the world's largest suppliers of systems and components to the food, beverage, and pharmaceutical industries. The international technology group, founded in 1881, focuses on machinery and plants, as well as advanced process technology, components, and comprehensive services. With more than 18,000 employees working across five divisions and 62 countries, the group generated revenues of more than EUR 5.1 billion in fiscal year 2022. GEA plants, processes, components, and services enhance the efficiency and sustainability of production processes across the globe. They contribute significantly to the reduction of CO₂ emissions, plastic usage, and food waste. In doing so, GEA makes a key contribution toward a sustainable future, in line with the company's purpose: "Engineering for a better world".

GEA is listed in the German MDAX and the STOXX® Europe 600 Index and is also among the companies comprising the DAX 50 ESG and MSCI Global Sustainability and the Dow Jones Sustainability Europe Indices.

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