CASE STUDY BY GEA AND PRG

SAVING COSTS BY FIT FOR PURPOSE AGITATORS IN NEW FOOD BIOREACTORS

THE CONCEPT OF NEW FOOD AND ITS WORLDWIDE IMPORTANCE

As the global population continues to grow, the demand for food is expected to rise significantly.

New Food has the potential to meet this demand while reducing the environmental footprint associated with conventional agriculture.

The concept of New Food encompasses the production of food through methods such as precision fermentation or cultured meat. In precision fermentation, a microbial host produces a specific product, which can be a particular protein. The cells and the product can be separated during downstream processing, resulting in the pureproduct and the host organism being separated. In contrast, the cell itself is the product in cultured meat application. Typically, muscle cells from animals are used for this application and can be processed into meat products after harvesting. This approach offers a sustainable and resource-efficient alternative to traditional livestock farming, addressing concerns such as animal welfare, environmental impact, and food security.

FIT FOR PURPOSE AGITATOR DESIGN FOR OPTIMIZED ENERGY CONSUMPTION

The development and implementation of New Food present challenges, particularly in ensuring aseptic fermentation and preventing contamination by other microorganisms. Although aseptic technologies are well known in the pharmaceutical and biotech sectors, they are more expensive than conventional food production equipment. To achieve a competitive price level to conventionally produced food, it is necessary to achieve a high yield in the production process.

In general, a high fermenter volume and a carefully engineered design have a positive impact on the yield, resulting in higher product output and lower production costs per kg of final product. Inefficient system planning not only leads to high procurement costs due to oversized or over-engineered equipment but can also result in higher maintenance and production costs. Operational expenditure is significantly driven by the energy consumption during the production process. One of the main contributors to energy consumption are the agitators.

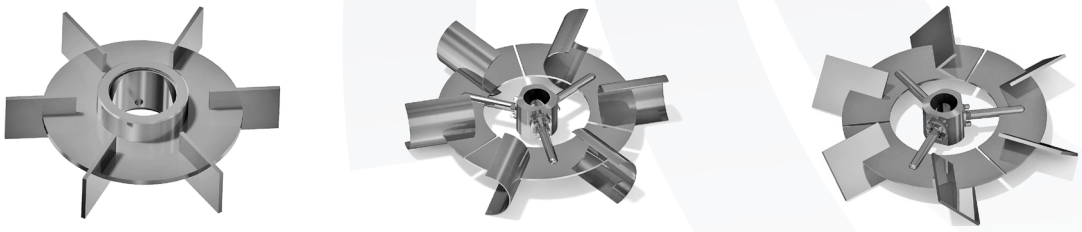
> *Agitators play a crucial role in the fermentation process as they ensure an even distribution of gases, nutrients, and temperature within the system.*

With a larger fermenter size and possibly a higher viscosity of the fermentation broth, stirring of the product becomes more difficult, requiring more torque, which leads to higher power input by the agitator. An optimized design of the agitator can significantly reduce the technically required motor power, thereby reducing the energy consumption, production costs, and ultimately leading to a more sustainable product.

EVALUATION OF IMPELLER DESIGNS

Until now, PRG and GEA have been strategic partners for over three decades. To gain exceptional process understanding and support throughout the process, GEA and PRG have decided to deepen their cooperation and have performed extensive testing at GEA's Application Technology Center in Hildesheim, Germany. The GEA Application Technology Center is ideally equipped for the joint research work with various test vessels and agitators from manufacturer PRG. In order to meet the challenge of precision fermentation, PRG and GEA performed the tests in equal partnership.

Modified Rushton impellers with an increased d/D ratio[1] of 0.4 compared to a standard design (d/D = 0.33) and an additional 45° inclination of the impeller blades were tested on several trials. Various possible combinations of Rushton and Hollowblade impellers for use in precision fermentation were investigated. There were three different types of impellers which were used for the trials: a Hollowblade, a "classic" Rushton impeller and a Rushton impeller with a 45° inclination.



Left to right: Rushton, Hollowblade & modified Rushton impeller

To substantiate and verify the test results, various tip speeds (max. 6.2 m/s) and gassing rates (0.5 – 2.0 vvm) were examined during the trials, which could then be used to determine the characteristic Power Number (NE-values) for each impeller design. The purpose was to match the choice of impeller with the corresponding Power Numbers precisely to the application for new technical designs.

[1] *d/D ratio = impeller diameter d in relation to vessel diameter D*

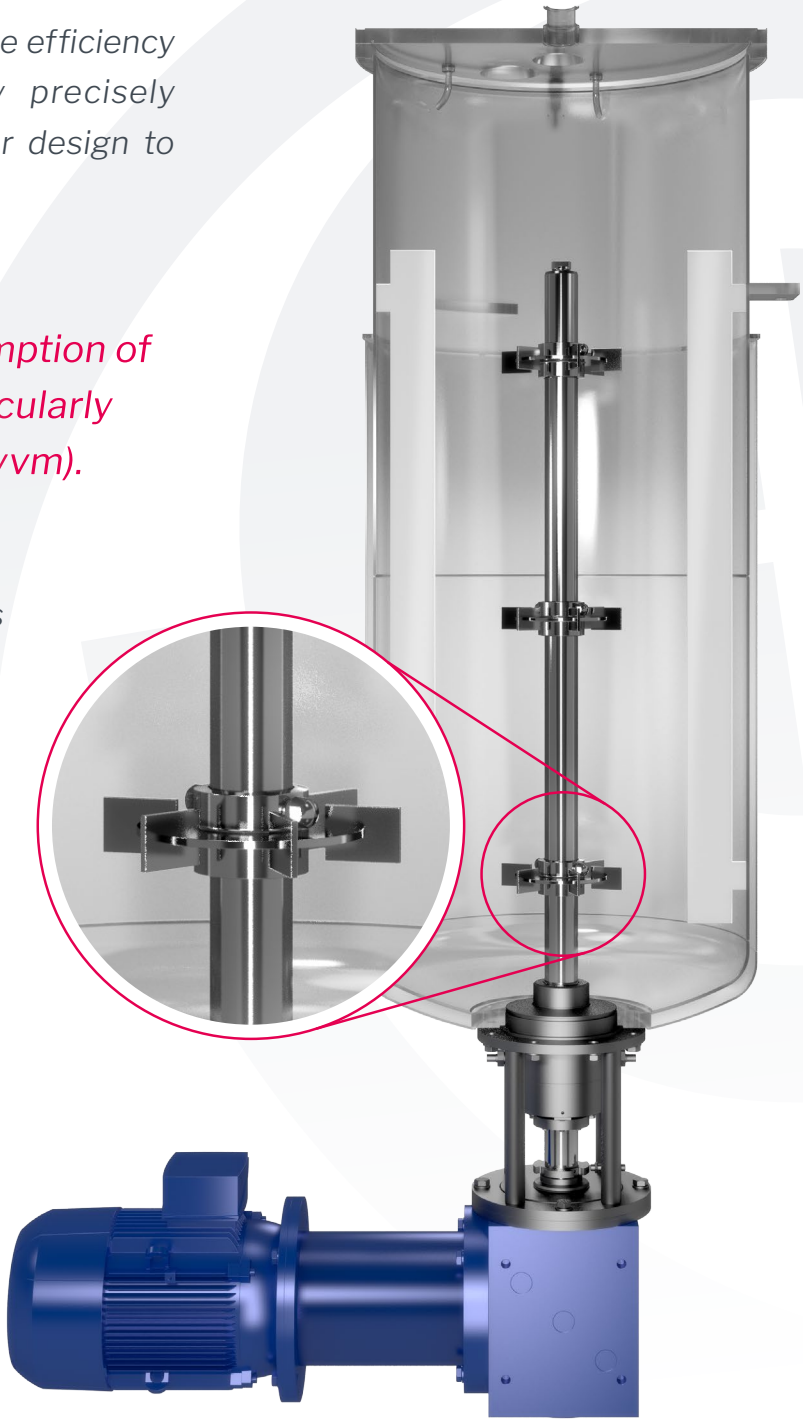
FIND THE RIGHT MATCH AND ARRANGEMENT OF IMPELLERS FOR OPTIMIZED PROCESS CONDITIONS

It could be noted that a considerable efficiency potential can be exploited by precisely matching and selecting the agitator design to the respective application.

A reduction in power consumption of up to 25 % is possible, particularly at low aeration rates (< 0.5 vvm).

Fermenters with low gassing rates play an important role in the constantly growing New Food sector. Hence, a sophisticated process-adapted agitator design can realize significant energy savings. These savings are particularly important for large scale fermenters, as they can reduce both high capital expenses (CAPEX) as well as operating expenses (OPEX).

The knowledge gained enables PRG and GEA to make an important contribution to the emerging New Food sector by developing customized production plants.



Bioreactor setup with 3 classic Rushton impellers at GEA's Application and Technology Center

FURTHER TRIALS FOR CULTIVATED MEAT AHEAD

GEA and PRG are convinced on the positive results of these investigations. For this reason, further studies with model cell cultures are already planned at the Technology Center.

> *Following this strategic approach, GEA and PRG show up as a future-oriented, partnership-based consortium of New Food experts.*

The process engineering advances outlined here have created a more cost-effective basis for precision fermentation, which is now to be used to achieve further advantages for plant design, especially in large scale bioreactors. Different New Food applications require different approaches, which must be taken into account for all plant components. PRG and GEA are excellently prepared for these challenges.

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