Application Note

Technical Application Publication

Maximizing fermentation productivity and process efficiency with TURBOSEP

Summary

Industrial-scale fermentation is used to manufacture a wide variety of products from pharmaceutically active compounds such as antibiotics, to food additives such as vitamins and amino acids. Excessive foaming is a common problem during the course of a fermentation process. To work around the problem customers often operate fermenters with reduced volume. This is an inefficient use of capital costs, reduces throughput and is detrimental to productivity and profitability. Foaming and aerosol release can be effectively controlled with the use of the Parker domnick hunter TURBOSEP which has been demonstrated to considerably increase the productivity of industrial-scale fermentation processes.

Parker domnick hunter can work with you to increase productivity by 30% and reduce expenditure on antifoam to 70%.

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Key Benefits:

- Increased productivity
- Reduced costs
- Allows greater working volumes
- Reduced antifoam usage
- Reduced losses
- Improved fermentation performance
- Improved agitation
- Improved oxygen transfer
- Reduced foaming
- Improved downstream processing efficiency

Influence of foaming and antifoams on fermentation productivity

The need to agitate and aerate aerobic fermentations leads to the creation of foam. In severe cases enough foam can be generated that it will overflow from the fermenter through the gas outlet resulting in the loss of growth media and product. In fermentations in which the off-gas is filtered before being released to the environment, foam in the gas outlet can block filters and cause a pressure build-up within the vessel that can damage equipment if the control system does not shut the fermenter down. If the vessel shuts down in this way the fermentation is likely to be terminated.

The impact of foaming can have less dramatic effects on productivity. Bubbles trapped in foam will have longer residence times within both conventional and specialist fermenter designs. Over the duration of this residence time the bubbles will become oxygen depleted leading to a reduction in the Oxygen Transfer Rate (OTR) of the system. Perhaps more significantly, foam that collects in the region of the impellers can greatly reduce agitation efficiency and hence reduce the performance of the fermenter by decreasing parameters such as the volumetric mass transfer coefficient (K_La).

Reducing the level of foaming has traditionally been achieved by using mechanical foam breaking systems or chemical antifoam additions. Both methods have associated operating costs derived from increased energy consumption in the case of mechanical foam breakers and the consumption of a raw material in the case of chemical antifoams. Chemical antifoams also represent an additional impurity that must be removed in downstream processing and can in themselves have deleterious effects on purification operations. The use of surfactant antifoams has been shown to reduce OTR by causing bubbles in the liquid bulk to coalesce thereby increasing bubble sizes, reducing the gas surface area to volume ratio and lowering the K_La.

As a consequence, fermenters are often operated at reduced liquid heights and hence volumes in order to maximize K_La values that would otherwise be lowered by excessive antifoam usage. Operating at reduced capacity is an inefficient use of capital assets, reduces facility throughput and is detrimental to productivity and profitability.

Case study 1

Productivity of food additive production increased by 30%

The food additive monosodium glutamate was being manufactured in 200 m^3 fermenters by a customer in China.
The customer was operating the fermenters at a reduced working volume in order to minimize losses through the off-gas outlet. The installation of the TURBOSEP system enabled the customer to increase the fermenter working volume while eliminating losses through the gas outlet. Furthermore the reduction of foaming increased the OTR within the fermenters thereby greatly increasing the productivity of the facility.

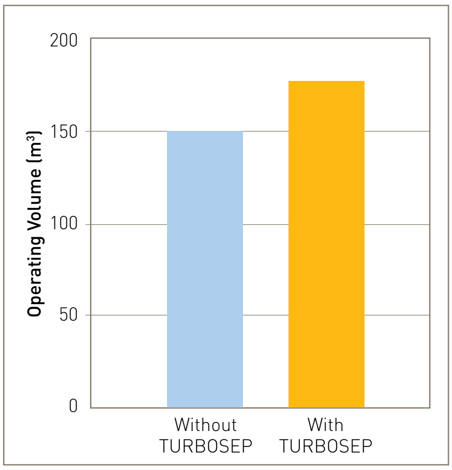


Figure 1a

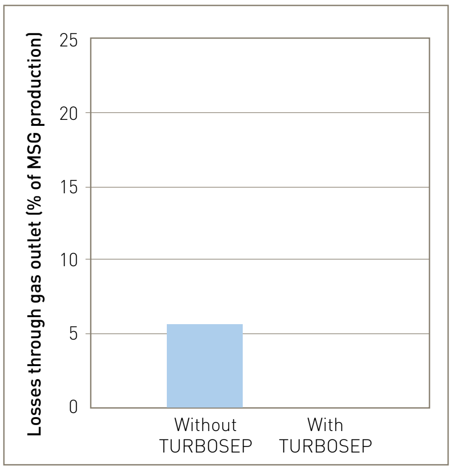


Figure 1b

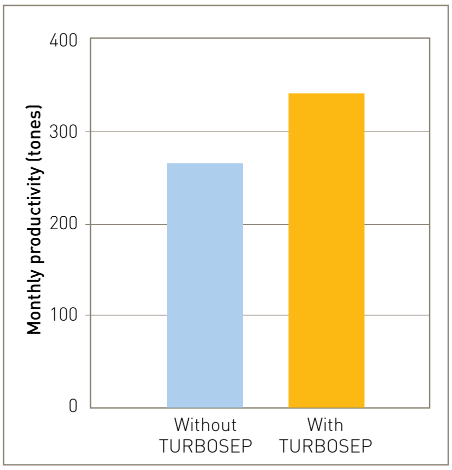


Figure 1c

Case study 2

Cost of antifoam usage reduced during the production of amino acids

A leading European manufacturer was performing 50 m^3 fermentations with a working volume of 44 m^3 over a duration of 48 hours for the production of an amino acid product. The TURBOSEP foam control system was installed and all other foam control systems switched off. During the course of the fermentation, foam was collected by the separator and returned to the vessel. After 35 hours the TURBOSEP control system detected the need to make small injections of antifoam. The use of the TURBOSEP systems reduced antifoam usage by 70%.

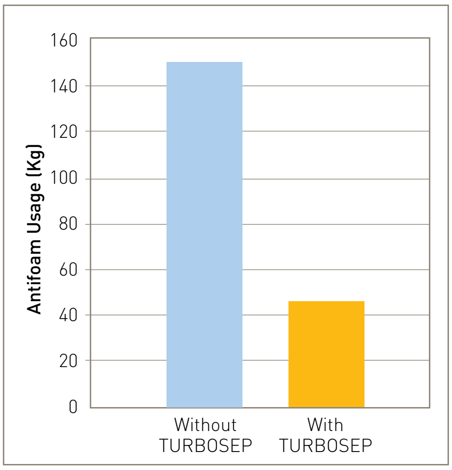
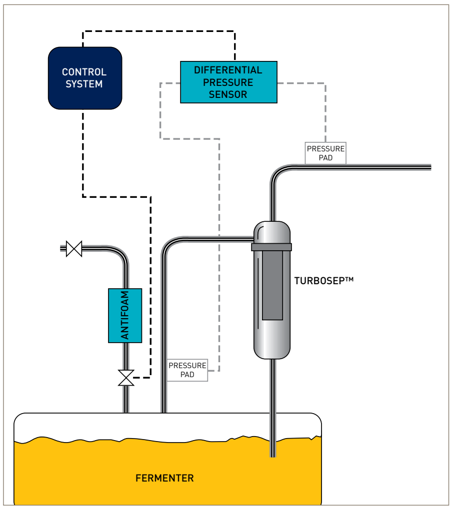


Figure 2

Use of TURBOSEP to minimize foaming



Control of foaming and aerosol release can be achieved in fermenters using the TURBOSEP mechanical separation device and associated control system. The TURBOSEP mechanical separation device is located on the gas outlet pipe and removes foam by the creation of a cyclone which causes foam and liquid to migrate to the outer wall. Additional foam removing capacity is provided in the form of an impingement plate. Separated exhaust gases then flow out through an outlet at the centre of the separator. Coalescing liquid spirals down through a return pipe back into the fermenter. The location of the return pipe is important and depends on the fermenter design and agitation system being used.

The TURBOSEP control system measures the cross-device pressure drop and detects the optimum moment to deliver precise doses of antifoam from the antifoam inlet via a feedback loop.

TURBOSEP design and manufacture

TURBOSEP is manufactured as standard 'generally in accordance' with international pressure vessel rules. It can also be manufactureed fully in accordance with specific rules such as ASME VIII Division 1 or the European Council Pressure Equipment Directive (PED 97/23/EC).

TURBOSEP can also be manufactured in accordance with hygienic design rules such as ASME BPE (Bio Processing Equipment).

Conclusion

Both the presence of foam and the excessive use of antifoam can reduce the performance of fermentations by reducing the rate of transfer of oxygen to the growing organism and interfering with vessel agitation mechanisms. Fermentations in which a large degree of foaming is observed are less productive and more expensive to operate. Use of TURBOSEP from Parker domnick hunter has been demonstrated to significantly reduce foaming and the amount of antifoam that is required for its control thereby boosting productivity and reducing operating costs.

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