# Application Note

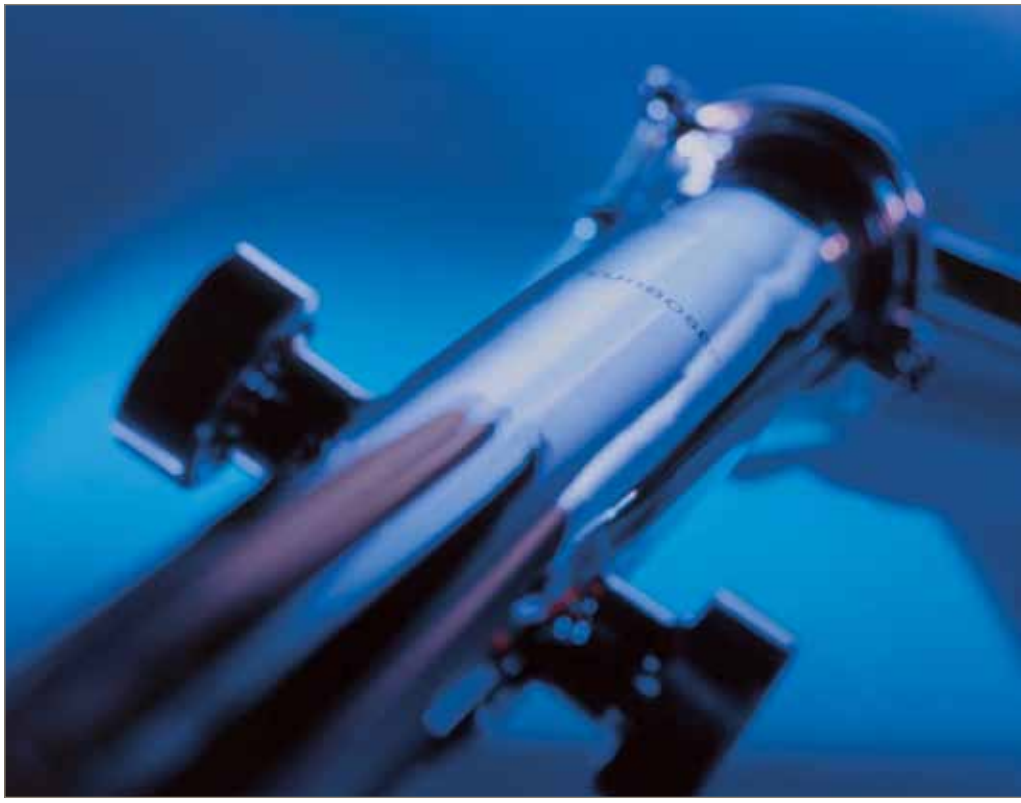
## Technical Application Publication

## 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 by 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
- Improved downstream processing efficiency

Parker domnick hunter

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# 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 ($K_L a$).

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 $K_L a$.

As a consequence, fermenters are often operated at reduced liquid heights and hence volumes in order to maximize $K_L a$ 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.

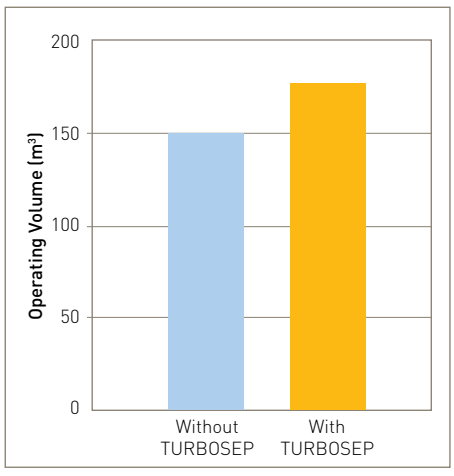



Figure 1a

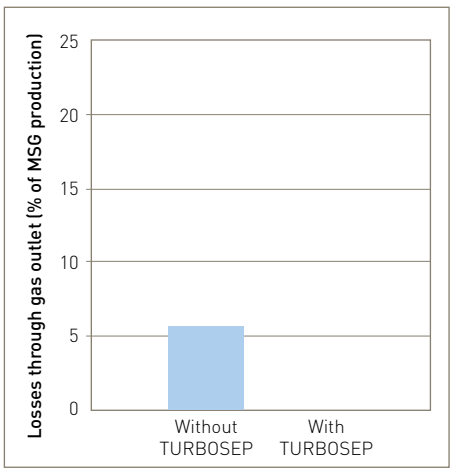



Figure 1b

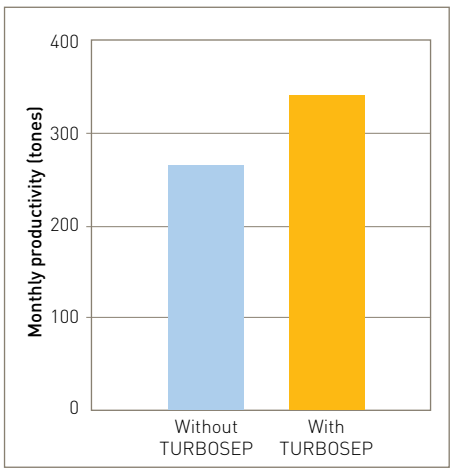



Figure 1c

# 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%.

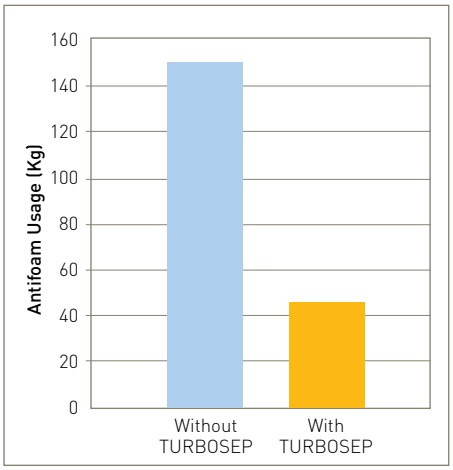
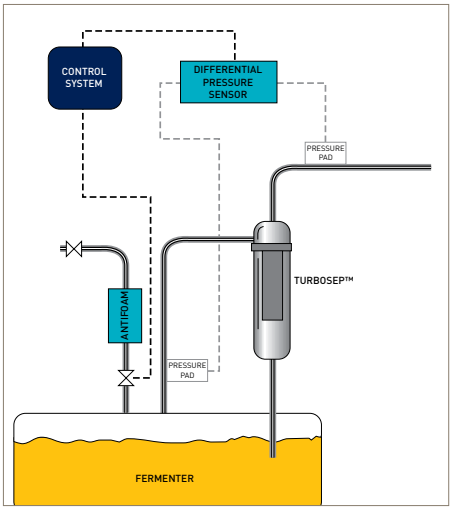



Figure 2

# Use of TURBOSEP to minimize use of antifoam control




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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Váš lokální distributor Parker

# TURBOSEP

- mechanical separator
- off-gas filtration

TURBOSEP is a key part of Parker domnick hunter's filtration solutions for fermentation applications.

Specifically designed for the removal of foam aggregate and aerosol from fermenter off-gas, TURBOSEP improves the overall efficiency of the fermentation process and facilitates the effective operation of final sterilizing grade filters.

This highly efficient mechanical separator has no moving parts and very low pressure drop. Foam, aerosol and entrained liquid removal from the off-gas are returned to the fermenter housing thereby minimizing product loss.

TURBOSEP is a patented product of Parker domnick hunter.

Note: TURBOSEP is a registered trademark of Parker domnick hunter

## Features and Benefits

- Highly efficient separation of liquid and foam from off-gas
- Increases fermenter capacity by up to 30%
- Protection of off-gas filters for extended life
- Reduction in antifoam usage of up to 70%
- Continuous operation of the fermenter throughout the foaming process
- Improved downstream processing efficiency through reduced antifoam consumption
- ASME Code Certification available

## Specification

### Materials of Construction

- TURBOSEP 304L or 316L Stainless Steel
- Seals: EPDM (FDA)

### Standard Surface Finish

- Internal: Linished to 0.8 µm Ra
- External: Bead Blast to 0.5 µm Ra

### Welding

All assembly welds are full penetration.
All welds are crevice and undercut free.
*Weld finish & detail drawings available upon request.*

### Design Conditions

- Maximum Allowable Working Pressure (MAWP): 3 Barg (43.5 psig)
- Maximum Allowable Working Temperature (MAWT): 149°C (300 °F)

### Directives

Housings designed in accordance with the European Council Pressure Equipment Directive (PED).
ATEX (where applicable).

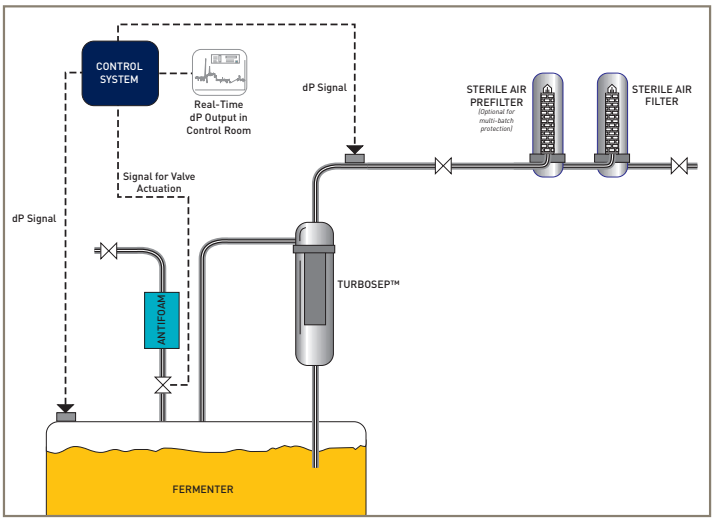
### Design Basis

ASME VIII Division 1.
ASME Code Stamp Option available

### Approvals

EAC 032-2013, (No. RU C-GB.АИ01.B.00094)
Approval type: Import Certificate, TRCU
Pressure Equipment (available on request)

## Installation of TURBOSEP




### Typical Installation

When off-gas exits the fermenter it enters the TURBOSEP unit. Fixed turbine blades spin the incoming air forcing foam and liquid to the outer walls.

The off-gas then flows across a specially designed impingement plate and spirals down the wall of the TURBOSEP. The off-gas is now free of foam and entrained liquid and exits the TURBOSEP.

### Applications

TURBOSEP can be employed in any fermentation application where the creation of foam is causing process control problems. This includes:

- Healthcare products (e.g. penicillin, cephalosporin)
- Food and feed additives (e.g. lysine, M.S.G.)
- Organic chemicals (e.g. citric acid)
- Enzymes (e.g. proteases, carbohydrases)

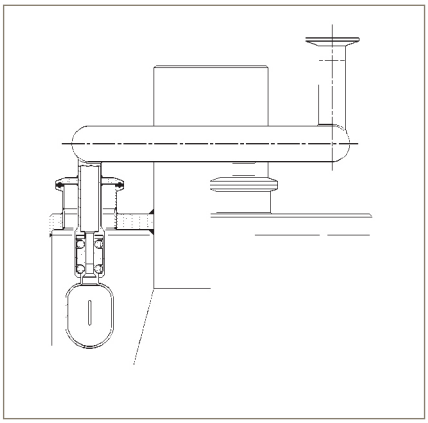
### Process Optimization

When employed with a differential pressure monitoring unit, TURBOSEP optimizes the fermentation process by utilizing off-gas separation and antifoam injection.

When foam-over occurs, foam and liquid entering the TURBOSEP cause an increase in the differential pressure monitoring unit which triggers the controlled release of antifoam, at a predetermined level of foam-over, into the fermenter.

This process control system has proven to substantially reduce the levels of antifoam required to control foam-over and has led to fermenter capacity being increased in many applications.

### Validated cleaning via internal spray balls



## Ordering Information

TURBOSEP sizing is normally based upon the completion of a TURBOSEP questionnaire available from Parker domnick hunter. Below we give an indication of the product range based on the typical gas flow (actual rather than normalized) through the fermenter.

Each TURBOSEP is tailor made to its application to ensure maximum effectiveness in operation and overcome critical issues with respect to installation.

| Typical Process Flow Rate (A l / min) | (Acfm) | TURBOSEP Code | Pipe Connection *1 |
|---|---|---|---|
| 200 | 7.0 | ZVT-200-BTE | $^{3}/_{4}$" Tri-Clamp |
| 500 | 17.7 | ZVT-500-BTE | 1" Tri-Clamp |
| 1000 | 35.0 | ZVT-1K-BTE | $1^{1}/_{2}$" Tri-Clamp |
| 2000 | 71.0 | ZVT-2K-CTE | 2" Tri-Clamp |
| 3000 | 105.0 | ZVT-3K-CTE | $2^{1}/_{2}$" Tri-Clamp |

| Typical Process Flow Rate (A $m^3$ / min) | (Acfm) | TURBOSEP Code | Pipe Connection *2 |
|---|---|---|---|
| 5 | 176 | ZVT-5K | 3" Weld Prepared |
| 10 | 350 | ZVT-10K | 4" Weld Prepared |
| 20 | 707 | ZVT-20K | 6" Weld Prepared |
| 40 | 1414 | ZVT-40K | 8" Weld Prepared |
| 60 | 2118 | ZVT-60K | 10" Weld Prepared |
| 90 | 3177 | ZVT-90K | 12" Weld Prepared |
| 120 | 4236 | ZVT-120K | 14" Weld Prepared |

*1 Other connections styles available upon request.

*2 Pipe size is nominal bore. Connection style options include flange variants.

*Tri-Clamp® is a registered trademark of Alfa-Laval, Inc.*
*Note: All Tri-Clamp® Connections conform to BS4825 Pt.3*



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