Europe, Middle East, Africa

AE – United Arab Emirates, Dubai
Tel: +971 4 8127100
parker.mea@parker.com

AT – Austria, Vienna
Tel: +43 (0)2622 2351 0
parker.austria@parker.com

BE/FR – Belgium, Brussels
Tel: +32 (0)2 888 90 00
parker.belgium@parker.com

BG – Bulgaria, Sofia
Tel: +359 2 824 01 20
parker.bulgaria@parker.com

CH – Switzerland, Etroy
Tel: +41 (021) 321 22 88
parker.switzerland@parker.com

CN – China, Shanghai
Tel: +86 21 7900 0000
parker.cn@parker.com

CZ – Czech Republic, Kladno
Tel: +420 383 000 000
parker.czechrepublic@parker.com

DK – Denmark, Ballerup
Tel: +45 43 56 04 00
parker.denmark@parker.com

DE – Germany, Klecany
Tel: +49 33 34 8 83 9000
parker.germany@parker.com

EY – Cyprus, Nicosia
Tel: +357 241 24 245
parker.cyprus@parker.com

ES – Spain, Barcelona
Tel: +34 902 330 001
parker.spain@parker.com

ET – Estonia, Tallinn
Tel: +372 652 2650
parker.eeasternEurope@parker.com

FI – Finland, Vantaa
Tel: +358 (0)9 5990 8000
parker.finland@parker.com

FR – France, Contamine suArve
Tel: +33 (0)1 16 08 40 00
parker.france@parker.com

GR – Greece, Athens
Tel: +30 210 933 6450
parker.greece@parker.com

HU – Hungary, Budapest
Tel: +36 1 220 4155
parker.hungary@parker.com

IE – Ireland, Dublin
Tel: +353 (0)1 466 6370
parker.ireland@parker.com

IT – Italy, Corisico (MI)
Tel: +39 02 45 19 21
parker.italy@parker.com

KZ – Kazakhstan, Almaty
Tel: +7 727 505 800
parker.easternEurope@parker.com

NL – The Netherlands, Oldenzaal
Tel: +31 (0)54 1 98 5500
parker.nl@parker.com

NO – Norway, Asker
Tel: +47 66 75 34 00
parker.norway@parker.com

PL – Poland, Warsaw
Tel: +48 (022) 573 24 00
parker.poland@parker.com

PT – Portugal, Leca da Palmeira
Tel: +351 22 989 7360
parker.portugal@parker.com

RO – Romania, Bucharest
Tel: +40 21 252 1382
parker.romania@parker.com

RU – Russia, Moscow
Tel: +7 495 654 2156
parker.russia@parker.com

SE – Sweden, Sponga
Tel: +46 (0)8 59 79 50 00
parker.sweden@parker.com

SK – Slovakia, Bratislava
Tel: +421 484 162 252
parker.slovakia@parker.com

SL – Slovenia, Novo Mesto
Tel: +386 7 337 6650
parker.slovenia@parker.com

TR – Turkey, Istanbul
Tel: +90 216 499 0781
parker.turkey@parker.com

UA – Ukraine, Kiev
Tel: +380 44 494 2731
parker.ukraine@parker.com

UK – United Kingdom, Warwick
Tel: +44 (0)1905 317 878
parker.uk@parker.com

ZA – South Africa, Kempton Park
Tel: +27 (0)11 961 0700
parker.southafrica@parker.com

North America

CA – Canada, Milton, Ontario
Tel: +1 905 693 3000
US – USA, Cleveland
Tel: +1 216 896 3000

Asia Pacific

AU – Australia, Castle Hill
Tel: +61 (02) 9643 7777

CN – China, Shanghai
Tel: +86 21 2899 5000

HK – Hong Kong
Tel: +852 2228 6008

IN – India, Mumbai
Tel: +91 22 6513 7081-85

JP – Japan, Tokyo
Tel: +81 3 6408 3901

KR – South Korea, Seoul
Tel: +82 2 559 0400

MY – Malaysia, Shah Alam
Tel: +60 3 7849 0800

NZ – New Zealand, Mt Wellington
Tel: +64 9 574 1744

SG – Singapore
Tel: +65 6887 6300

TH – Thailand, Bangkok
Tel: +662 717 8140

TW – Taiwan, Taipei
Tel: +886 2 2298 8967

South America

AR – Argentina, Buenos Aires
Tel: +54 9 327 44 4129

BR – Brazil, Sao Jose dos Campos
Tel: +55 12 4009 3500

CL – Chile, Santiago
Tel: +56 2 623 1216

MX – Mexico, Apodaca
Tel: +52 81 8156 6000

VE – Venezuela, Caracas
Tel: +58 212 238 5422

Contact Information:

Parker Hannifin Manufacturing Ltd
domnick hunter
Process Filtration - Europe
Durham Road
Birtley
Co. Durham DH3 2SF
UK
Tel: +44 (0)191 4105121
Fax: +44 (0)191 4105312
Email: dhpsales.uk@parker.com
www.parker.com/processfiltration

Parker Hannifin Corporation
domnick hunter
Process Filtration - North America
2340 Eastman Avenue
Oxnard, California, USA 93030
Tel: +1 877 784 2234
Fax: +1 805 604 3400
Email: dhpsales.na@parker.com
www.parker.com/processfiltration

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%.

Key Benefits:

• Increased productivity
• Reduced costs
• Allows greater working volumes
• Reduced antifoam usage
• Reduced losses

Application Note

Technical Application Publication

Maximizing fermentation productivity and process efficiency with TURBOSEP

Key Benefits:

• Increased productivity
• Reduced costs
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• Reduced antifoam usage
• Reduced losses
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 (KLa).

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 KLa.

As a consequence, fermenters are often operated at reduced liquid heights and hence volumes in order to maximize KLa 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 m³ 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.

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 to standard ‘generally in accordance’ with international pressure vessel rules. It can also be manufactured 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.

For further information, please contact: nick.hutchinson@parker.com

Case study 2
Cost of antifoam usage reduced during the production of amino acids

A leading European manufacturer was performing 50 m³ fermentations with a working volume of 44 m³ 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%.
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Application Note

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Contact Information:

Parker Hannifin Manufacturing Ltd
domnick hunter
Process Filtration - Europe
Durham Road
Birtley
Co. Durham DH3 2SF
phone +44 (0)191 4105121
fax +44 (0)191 4105312
dhprocess@parker.com

Parker Hannifin Corporation
domnick hunter
Process Filtration - North America
2340 Eastman Avenue
Oxnard, California, USA 93030
toll free: +1 877 784 2234
phone: +1 805 604 3400
e-mail: dhpsales.na@parker.com

www.parker.com/processfiltration

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 Worldwide

Europe, Middle East, Africa
AE – United Arab Emirates, Dubai
Tel: +971 4 8127100
parker.mea@parker.com
AT – Austria, Wiener Neustadt
Tel: +43 (0)2622 23501-0
parker.austria@parker.com
AT – Eastern Europe, Wiener Neustadt
Tel: +43 (0)2622 23501-0
parker.easterneurope@parker.com
AZ – Azerbaijan, Baku
Tel: +994 50 2333 458
parker.azerbaijan@parker.com
BE/LU – Belgium, Nivelles
Tel: +32 (0)2 827 900
parker.belgium@parker.com
BY – Belarus, Minsk
Tel: +375 17 209 2399
parker.belarus@parker.com
CH – Switzerland, Etoy
Tel: +41 (0)21 281 87 00
parker.switzerland@parker.com
CZ – Czech Republic, Kladno
Tel: +420 284 083 111
parker.czechtcpub@parker.com
DE – Germany, Karast
Tel: +49 (0)2311 4016 0
parker.germany@parker.com
DK – Denmark, Ballerup
Tel: +45 43 56 04 00
parker.denmark@parker.com
ES – Spain, Madrid
Tel: +34 902 330 001
parker.spain@parker.com
FI – Finland, Vantaa
Tel: +358 (0)20 753 2500
parker.finland@parker.com
FR – France, Cordemais
Tel: +33 (0)5 40 25 80 25
parker.france@parker.com
GR – Greece, Athens
Tel: +30 210 933 6450
parker.greece@parker.com
HU – Hungary, Budapest
Tel: +36 1 220 4155
parker.hungary@parker.com
IE – Ireland, Dublin
Tel: +353 (0)1 466 6370
parker.ireland@parker.com
IT – Italy, Corisico (MI)
Tel: +39 02 45 19 21
parker.italy@parker.com
KZ – Kazakhstan, Almaty
Tel: +7 727 505 800
parker.easterneurope@parker.com
NL – The Netherlands, Oldenzaal
Tel: +31 (0)34 588 001
parker.netherlands@parker.com
NO – Norway, Askov
Tel: +47 66 75 34 00
parker.norway@parker.com
PL – Poland, Warsaw
Tel: +48 (0)22 573 24 00
parker.poland@parker.com
PT – Portugal, Leca da Palmeira
Tel: +351 22 989 7360
parker.portugal@parker.com
RO – Romania, Bucharest
Tel: +40 21 252 1382
parker.romania@parker.com
RU – Russia, Moscow
Tel: +7 495 645 2156
parker.russia@parker.com
SE – Sweden, Sthlm
Tel: +46 (0)8 59 79 50 00
parker.sweden@parker.com
SK – Slovakia, Banska Bystrica
Tel: +421 484 162 252
parker.slovakia@parker.com
SL – Slovenia, Novo Mesto
Tel: +386 7 337 6650
parker.slovenia@parker.com
TR – Turkey, Istanbul
Tel: +90 216 4990781
parker.turkey@parker.com
UA – Ukraine, Kiev
Tel: +380 44 494 2731
parker.ukraine@parker.com
UK – United Kingdom, Warwick
Tel: +44 (0)1902 317 878
parker.uk@parker.com
ZA – South Africa, Kempton Park
Tel: +27 (0)11 961 0700
parker.southafrica@parker.com

North America
CA – Canada, Milton, Ontario
Tel: +1 905 693 3000
US – USA, Cleveland
Tel: +1 216 896 3000

Asia Pacific
AU – Australia, Castle Hill
Tel: +61 (0)2-9634 7777
CN – China, Shanghai
Tel: +86 21 2899 5000
HK – Hong Kong
Tel: +852 2128 8008
IN – India, Mumbai
Tel: +91 22 6513 7081-85
JP – Japan, Tokyo
Tel: +81 3 6408 3901
KR – South Korea, Seoul
Tel: +82 2 559 0400
MY – Malaysia, Shah Alam
Tel: +60 3 7849 0800
NZ – New Zealand, Mt Wellington
Tel: +64 9 974 1744
SG – Singapore
Tel: +65 6887 6300
TH – Thailand, Bangkok
Tel: +662 717 8140
TW – Taiwan, Taipei
Tel: +886 2 2298 8967

South America
AR – Argentina, Buenos Aires
Tel: +54 3327 44 4129
BR – Brazil, Sao Jose dos Campos
Tel: +55 12 4009 3500
CL – Chile, Santiago
Tel: +56 2 623 1216
MX – Mexico, Apodaca
Tel: +52 81 8156 6000

Contact Information:

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