



HIGH FLOW Fermentation Playbook

A guide to delivering value for the industrial fermentation market



ENGINEERING YOUR SUCCESS.

This industrial fermentation playbook introduces the HIGH FLOW fermentation concept, detailing ways of linking Parker products and services to meet productivity demands and increasing needs to control microbial hazards from ingredients, additives and process gas.



Increasing market need for sterile liquid and gas filtration technologies.



Parker Bioscience Filtration is the sole provider of TURBOSEP™ for fermentation off-gas treatment and foam control technologies.



HIGH FLOW fermentation range offers a one stop solution for process filtration needs in the industrial fermentation markets.

Innovative solutions

Parker Bioscience Filtration has more than 40 years of experience in providing dedicated filtration and separation products to the global industrial fermentation market.

Parker's sterile filtration and off-gas control solutions meet manufacturers' needs to reduce costs and increase productivity by;

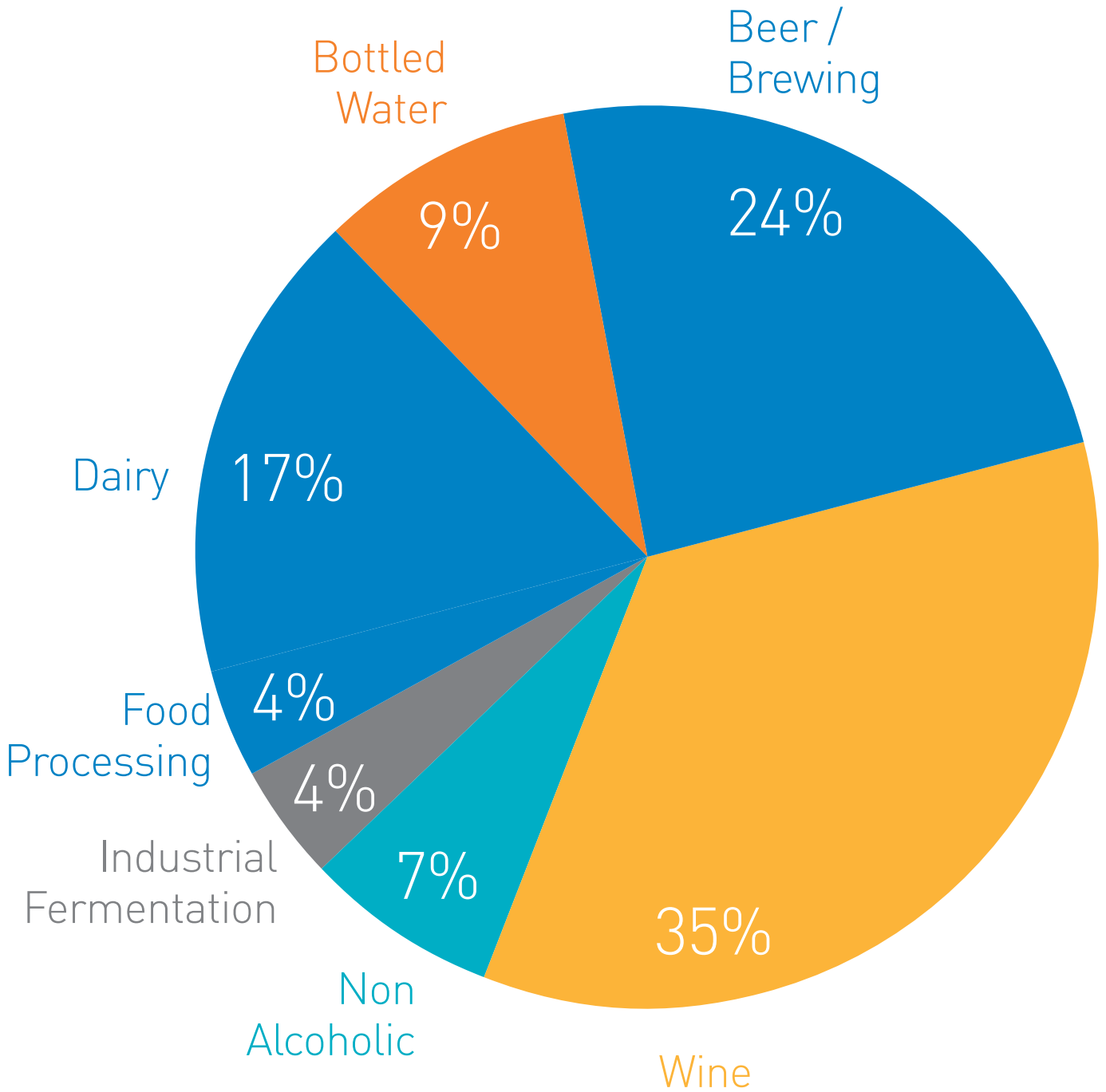
- Eliminating contamination risks.
- Increasing fermentation capacities and yields.
- Reducing operational expenditure.
- Reducing energy costs.
- Optimising speed of fermentation.

With industrial fermentation market growth expected to continue up to at least 2023, it is crucial that manufacturers can capitalise on opportunities provided by innovative technology to maximise productivity and minimise waste.



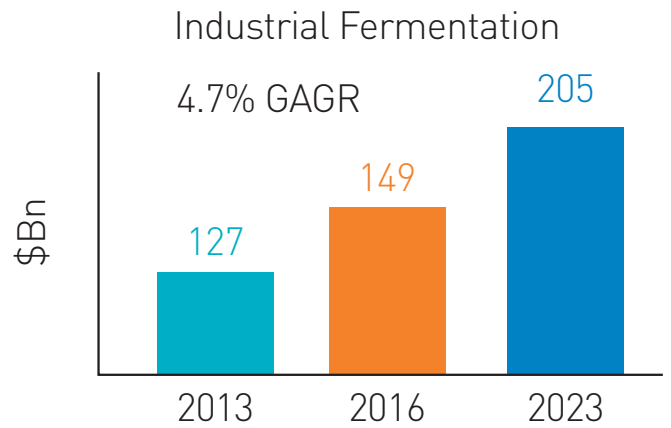
Parker Bioscience Filtration EMEA Food and Beverage Sales FY19

Industrial fermentation currently accounts for only 4% of sales in EMEA. Given the market growth rate and size, this presents a significant opportunity for Parker to grow sales and develop presence in this market.



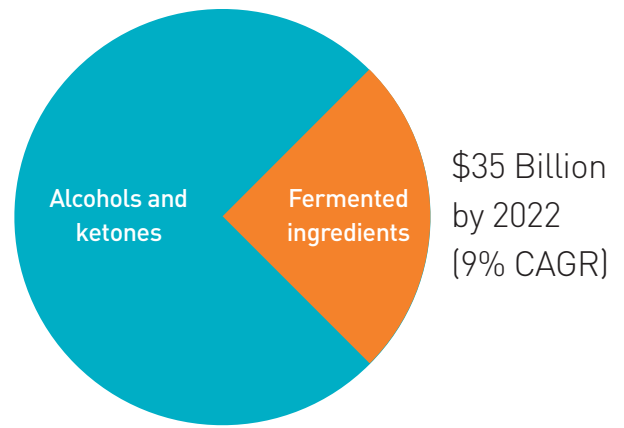
Market Outlook

The industrial fermentation market continues to grow with an estimated GAGR of 4.7%



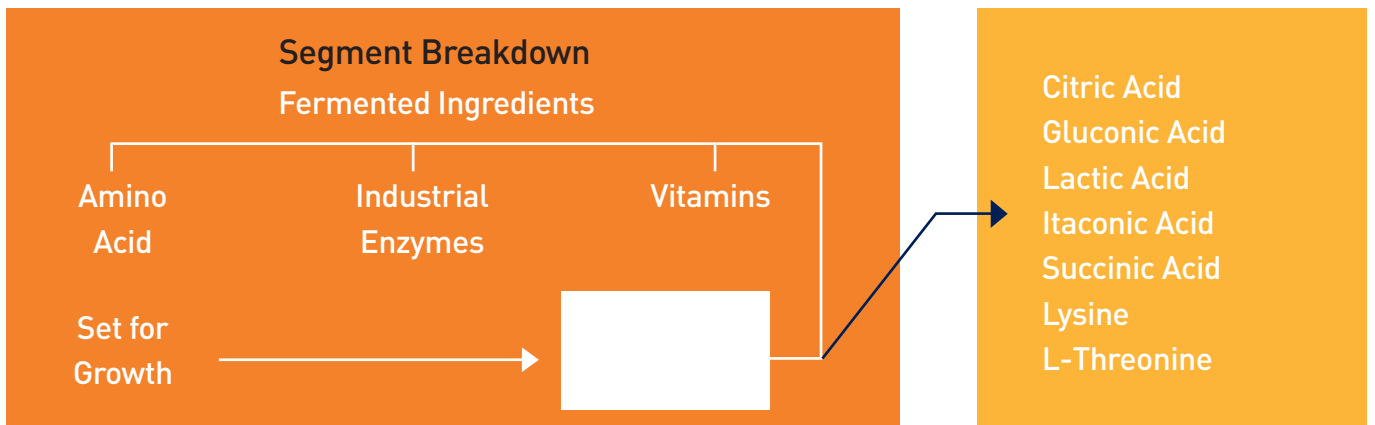
Segmentation

The market can be subdivided into key segments, the largest being alcohols and ketones and fermented ingredients.



Focused Growth

Our key focus is the fermented ingredients sector which can be broken down further as shown below;



The world market for fermentation ingredients is growing substantially. Worth \$29 billion in 2017, it is expected to grow at a CAGR of 10.2% to reach \$69.59 billion by 2026.*

The key reasons for this include an increase in the consumption of crude fermentation antibiotics, the popularity of citric acid as an acidifier in foods and as a pH regulator, and the growth of lysine’s use in the compound feed industry.

*Fermentation Ingredients - Global Market Outlook (2017-2026)

01 Sustainability and waste management

Global sustainability and waste management challenges drive focus from media and regulators. Initiatives in Europe look for ways to convert waste from agro-industrial sources into valuable raw materials for animal feed.

By-products of fermented products for human consumption have long been repurposed as animal feed, with brewer's yeast noted as an early example and dried distillers' grains with solubles (DDGS), from bioethanol production among the latest.

Industrial biotech strives to innovate sustainable feed streams with a focus on animal health, optimum productivity and yield whilst minimising resource usage and environmental impacts.



02 Increasing opportunities in developing nations

Expanding populations, busy lifestyles and changing eating habits continue to drive growth in the market for processed foods and beverages and increase the demand for fermented ingredients.

Growing awareness and desire for healthier diets and lifestyles is expected to lead to greater demand for natural and whole food products. This has increased the demands for food products processed with fermented ingredients. The majority of growth in demand for processed fermented products is expected to come from China and India, with strong growth also seen in Europe and North America.*

*Fermented Ingredients Market www.marketsandmarkets.com



03 Increasing product diversity

Applications for fermented ingredients continue to expand into food and beverages, nutraceuticals, livestock feed, pharmaceuticals, personal care and biofuels.

Fermented amino acids are extensively used to enhance flavour in food products and increase nutritional value of animal feed. Monosodium Glutamate (MSG), lysine and leucine are established products in these sectors.



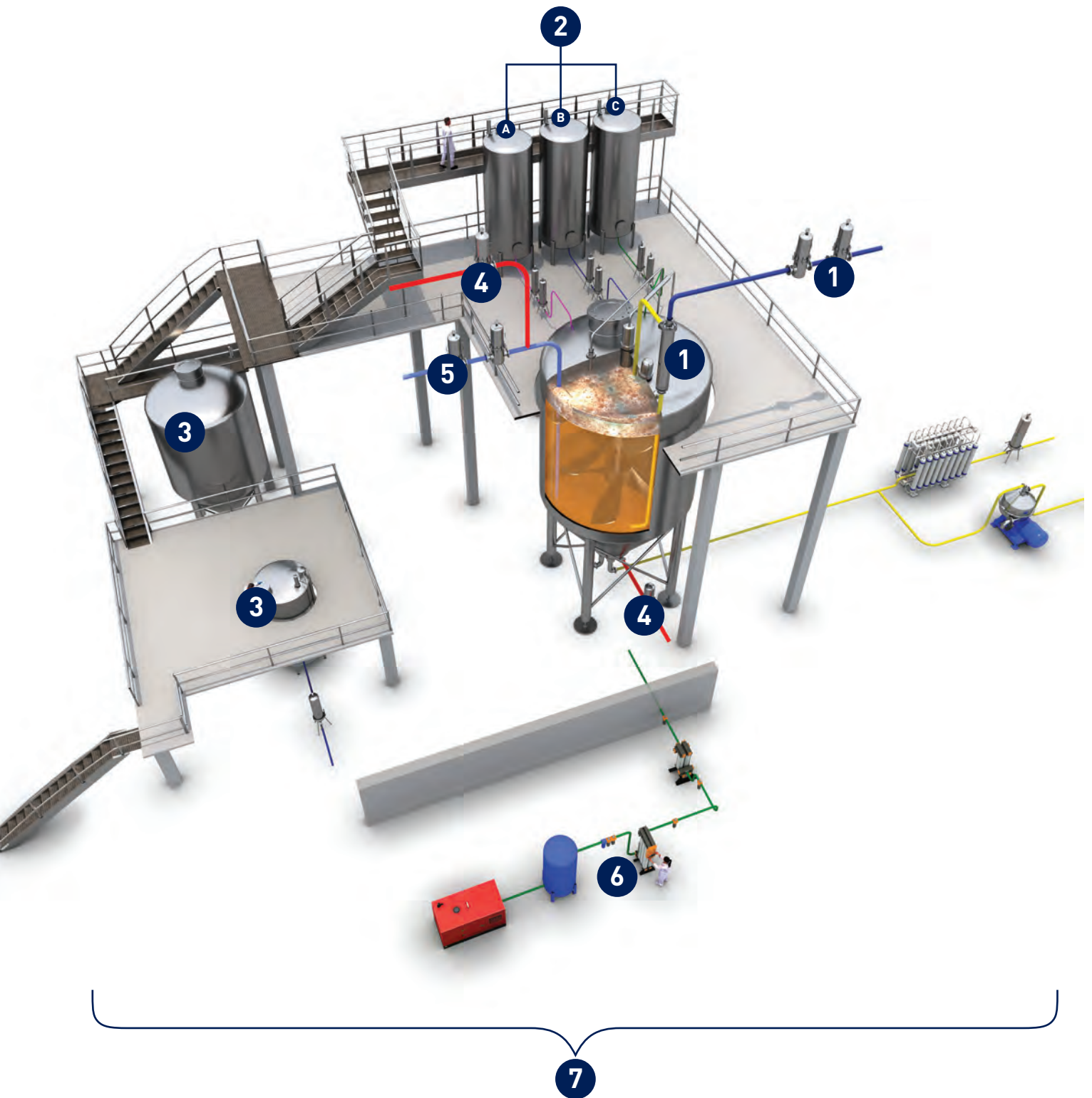
04 The threat of new microbial contaminants

Fermenter feed stock in the form of processed pulses and grains, high sugar syrups and unrefined sugars can introduce persistent microbial hazards.

In recent years, microbial threats from heat resistant moulds (HRM) or thermophilic acid bacteria (TAB) have become more prevalent as organisms can survive, and even be activated by, traditional heat exchange and pasteurisation techniques, potentially leading to contamination of the fermentation broth and total batch loss.



Applications Overview / Value Proposition



Our value proposition to the industrial fermentation market is...



Key

1. Fermenter off-gas
2. Fermentation liquid additions
 - A. Make up water
 - B. PH adjusts
 - C. Nutrient media
3. Seed fermenter
4. Process steam
5. Fermenter inlet air
6. Compressed gas utilities
7. Integrity testing

A quick look at the key applications

Industrial fermentation currently accounts for only 4% of sales in EMEA. Given the market growth rate and size this presents a significant opportunity for Parker to grow sales and develop presence in this market.

Fermenter Liquid Additions - Antifoam Sterilisation

Challenge

Sparged air and mechanical mixing improve oxygen transfer rates but contribute to foam production. Excess foam reduces effective fermentation volume and impacts product yield.

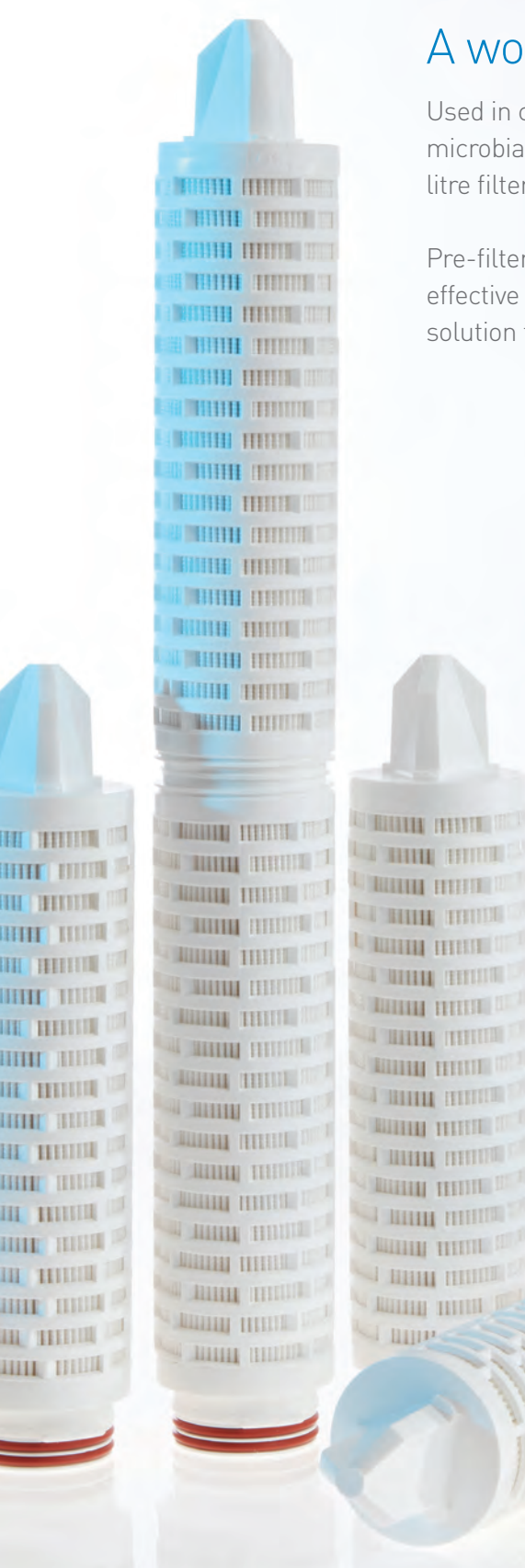
Antifoam additions control foam levels improving the productive volume of the fermenter but can introduce microorganism contamination, risking complete spoilage of the fermentation and the high costs associated with wasted materials and lost productivity.

Traditional heat transfer stabilisation is very difficult to validate and reduces the efficacy of the antifoam thereby increasing fermenter demand for antifoam, increasing the cost of fermentation and complicating downstream processing.

Solution

Parker recommends filtration of antifoam using PROPOR SG 0.2 micron sterilising grade membrane filters and pre-filtration with PEPLYN PLUS pleated depth pre-filters.





A word about pre-filtration

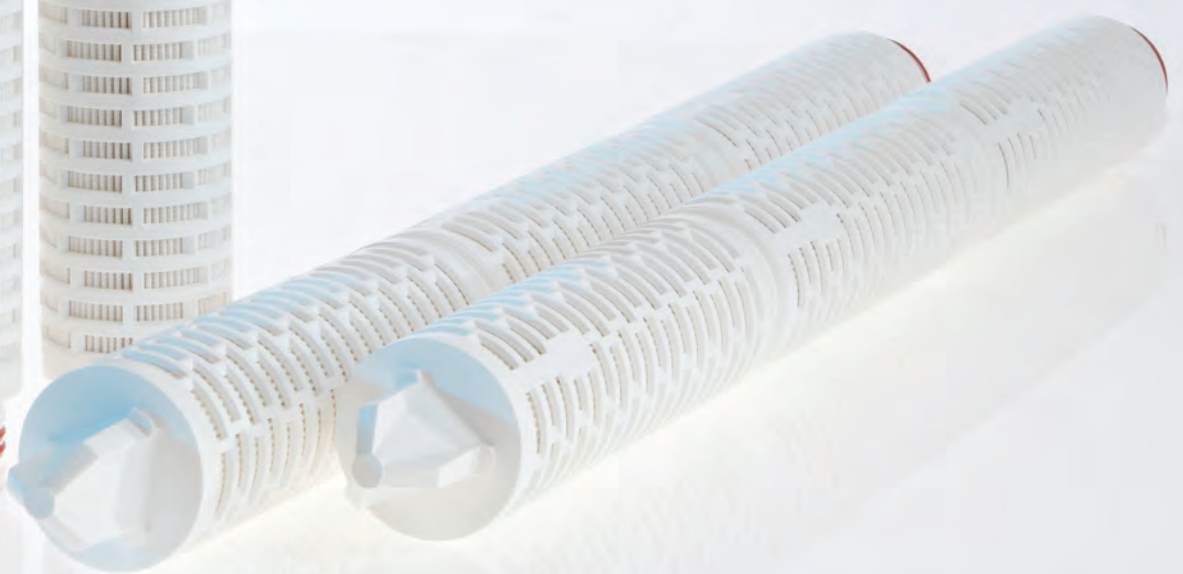
Used in conjunction, Parker pre-filters and sterilising grade filters provide microbial security coupled with long filter life to ensure the lowest cost per litre filtered.

Pre-filters are optimised for high bio-burden capacity, removal rate and effective filtration area. Parker pre-filtration products provide a cost-effective solution to increasing the life of sterilising grade membrane filters.

A word about microbial stabilisation by heat transfer & steam injection

The traditional methods of stabilising ingredients and additions are heat transfer and direct steam injection. Both methods are difficult to validate and potentially unreliable. Parker has a dedicated laboratory team that can support customers with provision of fully validated sterile filtration solutions.

Heat transfer and steam injection can denature and reduce efficacy of active ingredients resulting in increased addition rates and higher costs. Sterile filter products from Parker secure the microbial integrity of the fermenter, protect functional ingredients from damage and reduce operator costs.



Fermenter Liquid Additions - pH Adjust Sterilisation

Challenge

As nutrients are metabolised the pH can drift and slow the rate of fermentation. pH adjusters maintain the optimal environment for the active organism and shorten the time to complete the process. pH adjusters can however, carry resistant spores that threaten complete spoilage of the fermentation resulting in high costs associated with wasted materials and lost productivity.

Traditional heat transfer stabilisation is difficult to validate and can denature acid and base efficacy increasing consumption and cost of pH adjusters. Being acidic or basic in nature pH adjust fluids also present chemical compatibility issues to the microbial stabilisation device.



Solution

TETPOR LIQUID 0.2 micron sterilising grade filters have been developed specifically for use with acidic and basic pH adjust additions.

PEPLYN PLUS pleated depth pre-filters are compatible for use with both acidic and basic additions.



Fermenter Liquid Additions - Sterile Make-up Water

Challenge

As sparged air transits the fermenter it picks up moisture and carries it towards the off-gas treatment and exhaust. Addition of make-up water maintains optimum liquid volume in the process but can carry unwanted microorganisms that threaten complete spoilage of the fermentation.

Solution

Sterile filtration with Parker PROPOR SG filters protects the fermentation from waterborne spoilage organisms and reduces the energy costs from traditional stabilisation methods.

Pre-filtration with Parker PEPLYN PLUS filters will extend the life of PROPOR SG sterilising grade filters and optimise the cost of filtration.



Fermenter Liquid Additions - Nutrient Media

Challenge

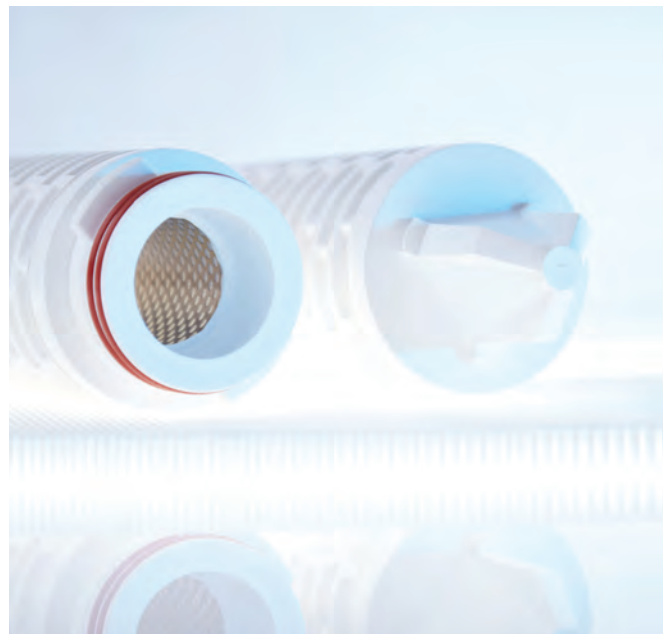
Especially susceptible to contamination from unwanted organisms due to its highly nutritious nature, nutrient media can carry unwanted microorganisms that threaten complete spoilage of the fermentation.

Traditional heat exchange technologies can denature the media and reduce fermentation efficiency whilst commonly used media salts, such as calcium and sodium chlorides, can foul and corrode heat exchange surfaces resulting in high maintenance costs and frequent downtime.



Solution

Parker recommends filtration of antifoam additions with PROPOR SG 0.2 micron sterilising grade membrane filters and pre-filtration with PEPLYN PLUS pleated depth pre-filters.



Sterile gas applications

Inlet Air

Challenge

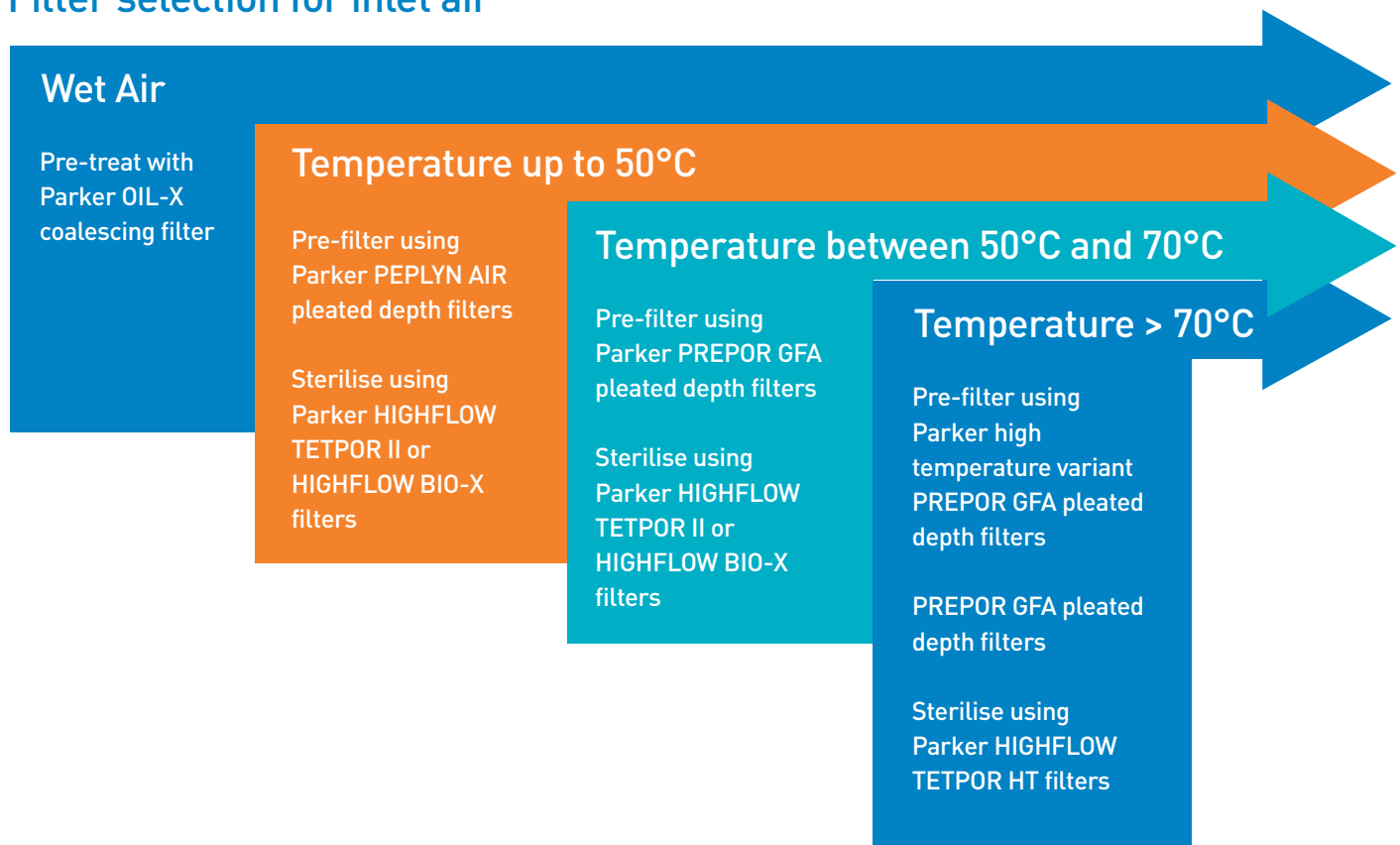
Sparged air oxygenates the broth for optimum aerobic metabolism, expediting process completion and maximising productivity. However, this can introduce unwanted spores and bacteria that threaten reduced productivity, increased process duration and even complete spoilage of the fermentation.

Depending on compressor types and fermentation parameters the inlet air can vary in both moisture and oil content and in temperature. Variation in inlet air conditions pose a more complex filter selection challenge.

Solution

Parker recommends conditioning and filtration of fermenter inlet air with filters that are designed and optimised to meet specific process conditions.

Filter selection for inlet air



Sterile gas applications - Fermenter Off-gas

Challenge

Safe exhaust of off-gas presents many challenges.

Fermentation yield and productivity can be reduced as valuable ingredients and fermented products are lost through uncontrolled venting of wet, aerosol laden off-gas.

Genetically modified organisms are commonly used to metabolise the desired products. If untreated the off-gas stream can threaten compliance with regulations that clearly prohibit release of GMOs to the external environment.

Ineffectively controlled fermentation can result in over production of foam transiting the off-gas pipelines and blinding the off gas filters resulting in costly downtime and maintenance.



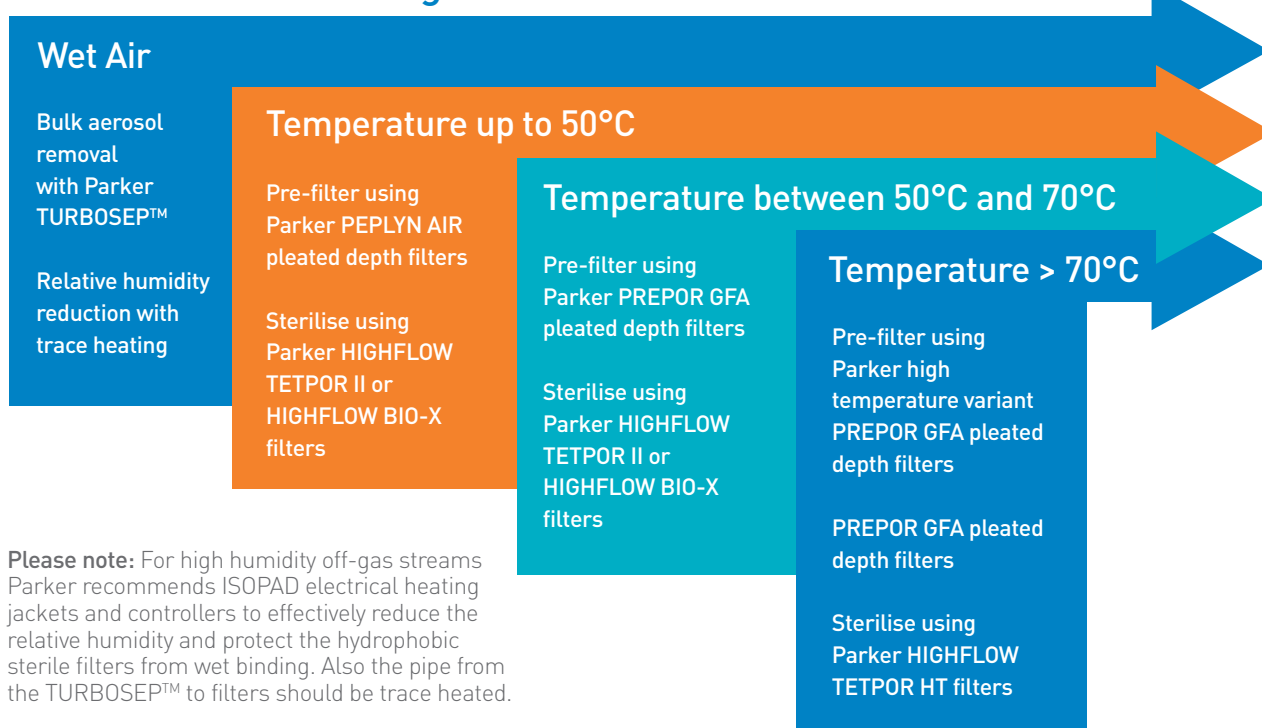
Solution

The Parker TURBOSEP™ offers a unique off-gas treatment solution. It separates aerosol from gas and returns it to the fermenter, thereby conserving valuable fermentation ingredients and better preparing off-gas for stabilisation by sterile filtration.

TURBOSEP™ is configured to reduce antifoam use and increase fermenter capacity by up to 10%.

TURBOSEP™ and HIGH FLOW sterile gas filters work together to contain microorganisms and assure compliance with European Council directive 90/219/EEC, on the contained use of genetically modified microorganisms.

Filter selection for off-gas



Steam Filtration

Process Stream

Challenge

Process steam is used for steam-in-place sterilisation of process lines and equipment but can introduce particulate contamination from steam generation plant and steam distribution pipework.

Please note:

For high humidity off gas streams Parker recommends installation and trace heating of the off gas pipework and filter housings. Parker design and protect team offer specialist design advice on trace heating during the project design continuation process.



Solution

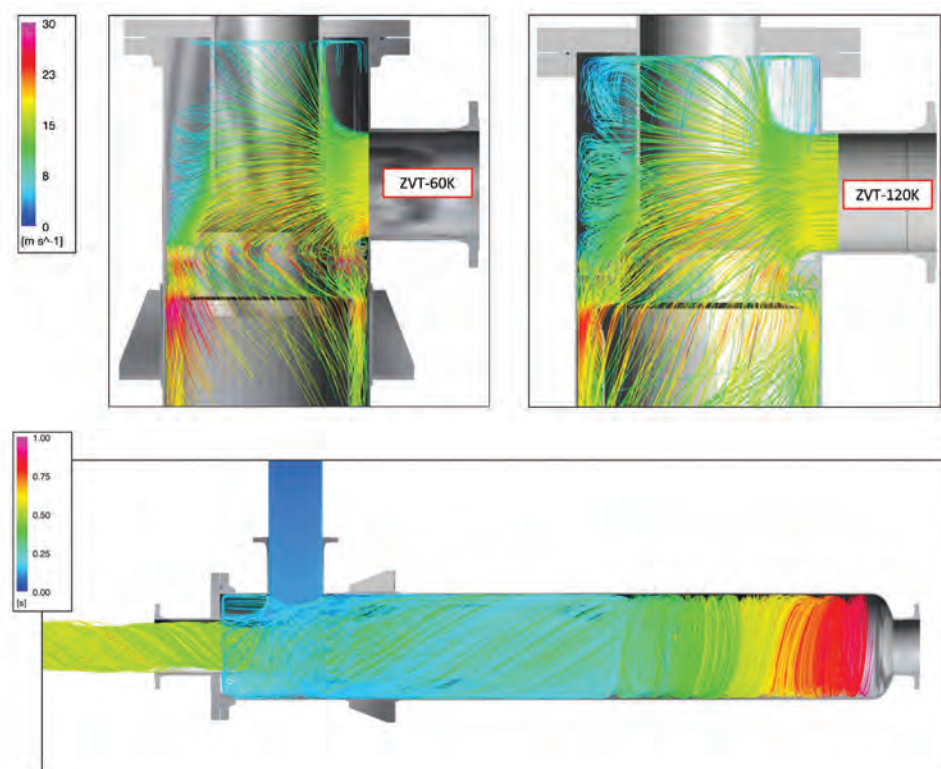
Parker sintered, and pleated steam filters are rated for removal of particulate down to 1 micron in diameter. They have been specifically developed for point of use protection of process equipment from particulate contamination.



Parker has supplied TURBOSEP™ products to the industrial fermentation market for over 40 years. Installed on the fermenter off-gas pipework TURBOSEP™ is a unique device that separates liquid aerosols and foam from the exhaust stream. TURBOSEP™ uses gas velocities, static turbine vanes and rotational forces to achieve separation and return coalesced liquids to the fermenter.

At Parker Bioscience Filtration, TURBOSEP™ and off-gas treatment expertise has been developed over 40 years, working with key players in the antibiotics and fermented ingredients markets.

A dedicated team of design engineers utilised cutting edge design software to optimise TURBOSEP™ gas flows and liquid separation efficiencies. Within specified flow limits TURBOSEP™ separates up to 99.9% of entrained aerosol from the off-gas stream and returns it to the fermenter.



TURBOSEP™ can be optimised for use across a broad range of process parameters, with the following features and benefits;

- Fabricated from 304L or 316L stainless steel.
- No moving parts make it easy to maintain and operate.
- Integrated spray nozzle cleaning for quick and effective clean in place between fermentation batches.
- Allows continuous operation of fermenter throughout foaming when used with differential pressure monitoring and antifoam injection system.
- Reduces antifoam use by up to 60%.
- Reduces make-up water consumption and loss of valuable fermented product.
- Protects off-gas filtration from blinding and damage.
- Reduces operational costs and increases productivity.

Introducing Parker’s HIGH FLOW Concept Value Proposition for Industrial Fermentation

Traditional heat exchange and direct steam injection stabilisation technologies are damaging to active ingredients, unreliable, difficult to validate, energy hungry and costly to maintain and run.

So, what is the alternative?

Parker Bioscience Filtration’s novel HIGH FLOW concept fermentation products offer many advantages.

- Offer novel solutions to specific challenges in the industrial fermentation process.
- Reduce energy consumption and resource usage.
- Are easy to validate, maintain and operate.
- Safeguard functionality of active ingredients and secure the fermentation against contamination and spoilage.
- Protect quality, reduce costs and increase yields.
- Maximise air flow, maintaining optimal conditions and minimising ingredient loss.

HIGH FLOW concept value proposition



TURBOSEP™ references

TURBOSEP™ installations are already in service, working in conjunction with HIGH FLOW concept fermentation filters and providing value in the fermented ingredients markets.

Many key players in the market have returned to Parker when planning and implementing new capital projects.

Examples include...

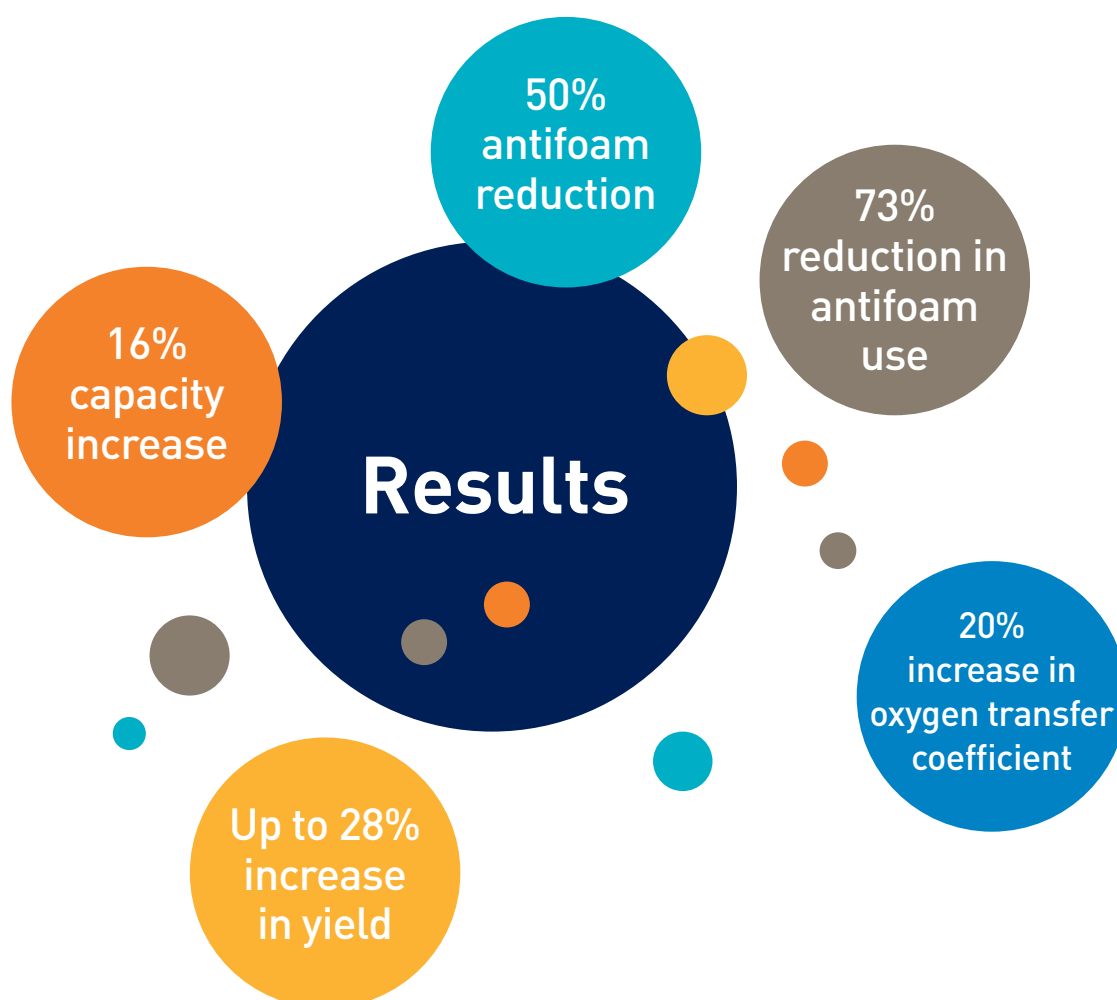
Customer	Location	TURBOSEP™ Product	Application	Driver
Eli Lilly	USA	ZVT-1K	Enzymes	Capacity expansion
Eli Lilly	USA	ZVT-40K	Enzymes	Capacity expansion
Don Biotech	Russia	ZVT-60K	Lysine	Foam control
Don Biotech	Russia	ZVT-120K	Lysine	Foam control
Evonik	USA	ZVT-20K	Lysine	Antifoam reduction
Evonik	Slovakia	ZVT-20K	Development / Biomass	Liquid aerosol reduction / foam control
Novo	Denmark	ZVT-20K	Enzymes	Liquid aerosol reduction / foam control
Evonik	Brazil	ZVT-120K	Lysine	Foam control
Evonik	Brazil	ZVT-60K	Lysine	Foam control
Evonik Gmbh	Europe	ZVT-200	Small scale	Foam control
Novozymes	USA	ZVT-12K	Enzymes	Antifoam reduction
Evonik Slovak / Slovensk	Europe	ZVT-5K	Development	Fitted to pilot plant
Evonik Degussa	USA	ZVT-90K	Lysine	Foam control
Novozymes	USA	ZVT-500	Enzymes	Antifoam reduction
Novozymes	USA	ZVT-2K	Enzymes	Antifoam reduction
Novozymes	USA	ZVT-5K	Enzymes	Antifoam reduction

Case Studies - HIGH FLOW concept

Product	Fermenter volume	TURBOSEP™	% decrease in antifoam usage	% increase in yield
BST	7500 L 2000 US gal	ZVT-10K	60	16

Product	Fermenter volume	TURBOSEP™	% decrease in antifoam usage	% increase in yield
Lysine	50 M³ 132,00 US Gal	ZVT-20K	73	16

Product	Fermenter volume	TURBOSEP™	% increase in fermenter load	% increase in yield
MSG	200 M³ 52,800 US gal	ZVT-160K	16	28



In addition to the key value proposition, Parker can provide additional value to the market with world class service and support functions.

Technical Support

Instrument Servicing and Calibration

- Dedicated team of instrument experts.
- Service and calibration laboratory.



Validation Support Services

- Dedicated validation support team.
- Filter / process compatibility testing.
- Integrity test parameters verification.



Technical Support Services

- Dedicated team of industry experts to support customer needs.
- Contract integrity testing of filters.
- Trouble shooting, fault / cause diagnosis.
- Process audits, filterability testing and filtration optimisation.



Integrity Testing Equipment

Valairdata 3

- Fully automated aerosol integrity test unit.
- Design for rapid integrity test of sterile gas filters.
- Correlated to aerosolized bacterial challenge.
- 5.7" TFT touch screen operation.
- Developed to GAMP guidelines.



Bevcheck Plus

- Fully automated pressure decay integrity test unit.
- Design for rapid integrity test of critical membrane filters.
- Programmed with connected PC and WinFilter 3.0 Software.
- IP53 splash proof protection.
- USB connectivity.



Bevcheck

- Fully automated pressure decay integrity test unit.
- Small lightweight construction.
- Design for rapid integrity test of critical membrane filters.
- Programmed with connected PC and WinFilter 3.0 Software.
- IP53 splash proof protection.
- USB connectivity & Bluetooth enabled.



The competition

When targeting the industrial fermentation market with TURBOSEP™ and HIGH FLOW concept fermentation filters, you may encounter several competitors. Pall, Merck Millipore, Sartorius and Donaldson offer sterile gas filter products with hydrophobic membranes and 0.2 micron sterilising grade liquid filters. Parker Bioscience Filtration is differentiated from the competition by being the sole provider of the TURBOSEP™ off-gas processing and fermentation foam control technology. No other competitor in this space markets a product that addresses this niche need and this provides a unique opportunity for us in this space. In addition, we can continue to compete based on the service and support options that we offer.

The sales process

TURBOSEP™ off-gas systems are typically large pieces of capital equipment and as such, there are various steps along the purchasing journey. Below is a summary of the enquiry to quote process and a list of the tools available to you in order to engage discussions, generate interest in our solutions and influence the purchasing decision in your favour.

Generating interest and lead nurturing

It is important that you engage discussions with your industrial fermentation market in order to discuss the benefits that we can provide, and position Parker at the forefront of the supplier list when the customer comes to releasing a request for quotation. The following is a list of the tools available to generate interest in our capability:

1. Data sheets (TURBOSEP™, liquid and gas filters, band heaters and controllers and housings).
2. Technical capability guide.
3. Parker.com, product, market and promotional website pages.
4. Market application notes and wins (success stories).
5. Technical application notes.
6. Capability guide.
7. Customer presentation.

As we are dealing with detailed technical arguments, we recommend that you push for meetings with your prospects where the offerings can be discussed in more detail. The Division will support you with participation and set-up of such events.

Progressing from enquiry to quotation

Where a customer is interested in receiving a budget price for a product, a questionnaire can be used to gather the base data and user requirements. Once completed, it should be forwarded to your respective Division contact. Supporting information (including the questionnaire) is available on SharePoint.



So, what's in it for us?

Based on a single ZVT-40K TURBOSEP™ with inlet and off-gas pre-filtration and sterile gas filtration, the initial TURBOSEP™ sale is worth approximately €100k.

Based on inlet air flow rate of 3142 Nm³/hr at 0.69 barg (10 psig) line pressure:

Inlet air pre-filtration consumables will total, for example, 8 x ZCPH2-1.0C filters, changed out around twice per year, which equates to €1,200 (based on an estimated unit price of €150).

Inlet air sterile filtration consumables will total, for example, 12 x ZHFT/2C filters, changed out around once per year, which equates to €9,000 (for an estimated unit price of €750).

Off-gas pre-filtration and sterile filtration will be a duplicate of inlet which equates to an annual subtotal of €10,200.

Process steam consumables will total, for example 3 x ZCHS-3-001C, changed out around once a year, which equates to €7,072 (for an estimated unit price of €2,342).

Based on an 80m³ fermenter with pre-filtration and final filtration at all liquid ingredient and addition applications:

Liquid pre-filtration consumables will total, for example, 12 x ZCPP3-.60C-S filters, changed out around twice per year, which equates to €3,264 (based on an estimated unit price of €272).

Liquid sterile filtration consumables will total, for example, 20 x ZCSG3-020C-P filters, changed out around once per year, which equates to €14,740 (based on an estimated unit price of €737).

Annual consumable potential is significant and dependent on how many applications we win in the facility.

This is a great opportunity for growing our presence and sales within the industrial fermentation market.

In summary, as the industry is growing, it is presenting more and more opportunities for sales of TURBOSEP™, filter vessels and filter cartridges. TURBOSEP™ is known in the market, offers a great value proposition to the end user and creates an opportunity to win consumables business for gas and liquid filters throughout the industrial fermentation processes.

We would love to hear your feedback about potential accounts in your area. If you require more information / support, or would like to discuss the technology in more detail, please contact;

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