

ZYMATIC PRO

Wastewater treatment for organic micropollutants

The world's most flexible water treatment
technology uses enzymes

Design an organic micropollutant treatment step
and fine-tune the treatment effect based on
the standard **zymatic sand**



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ZYMATIC PRO™

Introduction

ZYMATIC PRO™ enables WWTPs to design an optimized treatment step for the removal of organic micropollutants (OMPs). The full potential of zymatic sand is achieved by designing the installation of PRO with regards to the treatment plant's internal flow parameters and treatment requirements. The enzymes bound to the material are selected to remove common OMPs present in municipal wastewater effluents. As the world's most flexible treatment technology, our PRO customers can choose to add additional enzymes for the treatment of other plant-specific problematic organic pollutants.

95%

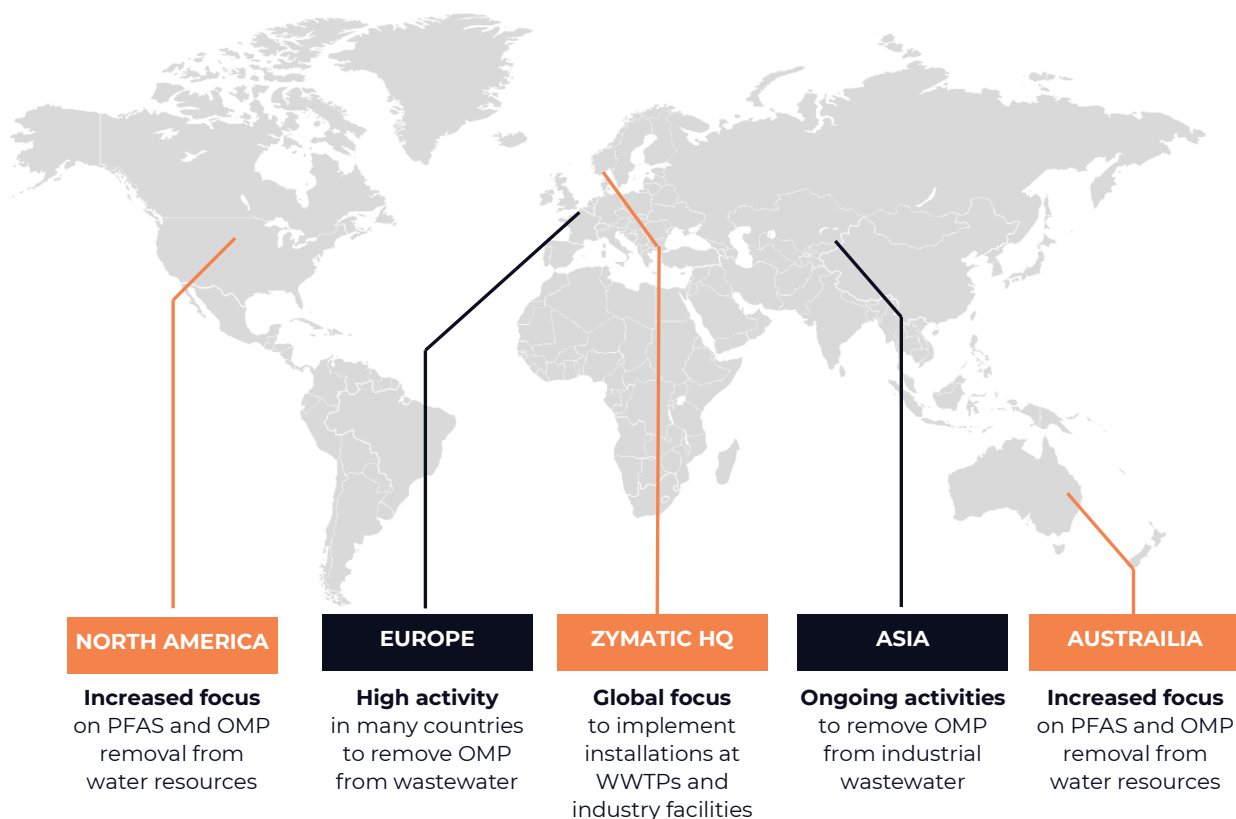
Up to 95% of removal of common OMPs

Broad effect towards OMPs and other organic pollutant compounds. Installation is easily scaled by applying standard zymatic sand parameters.

LOW COST

Very low CapEx and OpEx

Simple treatment design by applying a sand-like material. Installation to lowest possible costs and ease of use minimizes costs.



About ZYMATIC

With unbeatable low cost for water treatment, we create high efficiency treatment systems using the zymatic enzyme technology. By using a deep-tech knowledge about enzymes, we find simple solutions to your complex water treatment challenges. The use of a sand-like material, for removal of unwanted organic compounds in municipal wastewater, WWTP effluent water or industrial process waters effluents, makes ZYMATIC easy to apply and scale to any water treatment plant. Our goal is to support you as a customer to improve your water treatment by using our flexible water treatment technology.

Degradation agents

Enzymes are natural catalysts and “Nature’s own degradation agents”. Enzymes are proteins that degrades continuously and can be bound to inorganic materials for increased efficiency.

Zymatic sand

Enzymes bound to a material creates an enhanced (en)zymatic material. The water treatment technology offers continuous upgrades of the zymatic sand and high flexibility for local needs.

How the PRO™ Solution Works

The PRO™ solution is targeting the WWTPs that are building or rebuilding their facility for more efficient OMP removal. A water treatment based on zymatic sand can be installed to ensure the treatment plant meets relevant requirements. The system uses a standardised version of the zymatic sand, which is targeting a broad spectrum of OMPs. The zymatic sand is a sand-like material, which is filled into the treatment step container.

The design of the treatment step is flexible. Usually, an upwards flow is used (bottom-to-top) as it creates a great movement in the water and improves the contact between the water and the zymatic sand.

The treatment step is advantageously designed as a polishing step and could be placed after a sand- or disc-filtration treatment step. The zymatic sand requires no added energy and the treatment step is at full performance without added energy. This enables the site to design a treatment step using only inherited flow, if allowed by the existing infrastructure.

The water treatment is performed by continuously operating enzymes, which removes the target compounds by various reaction mechanisms. The use of immobilized enzymes makes the zymatic water treatment technology unique in terms of available flexible treatment mechanisms.

Collaborate with the Zymatic Team

All projects are supported by the Zymatic team and its network of experts. Dependent on need, a team is selected to guide and support the design of the treatment step. The allocated team have experience in both the use of existing infrastructure and new constructions.



Key Aspects and Benefits

The PRO™ solution offers a ready to use sand-like material, which is easy to include into an existing treatment facility. By using a standardised material, the handling is simplified and the total OpEx costs is reduced. The treatment step can be designed as a bed or column solution and is easily scaled to existing flows. PRO™ allows for short time from order to installation.

Using the standard zymatic sand, the PRO™ solution offers a water treatment technique with great impact. No additional chemicals are added to the water. Used zymatic sand are treated as normal sand from WWTPs.

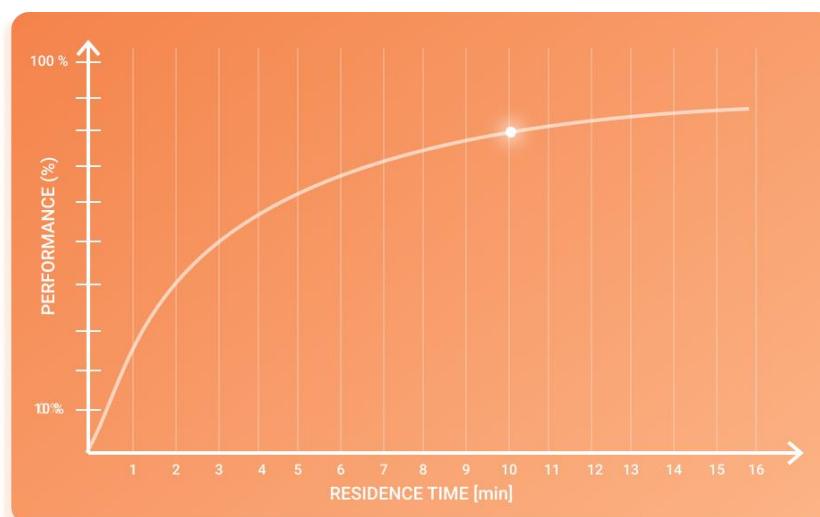
KEY FEATURES	BENEFITS
Organic Micropollutant Removal	<ul style="list-style-type: none"> • High removal effect towards pharmaceuticals normally present in municipal wastewater • The organic micropollutants are removed, degraded, deactivated, or transformed • Optimization of the removal effect is easily scaled based on water quality and water residence time • Removes organic micropollutants without the addition of other chemicals
Design and Construction	<ul style="list-style-type: none"> • Accompanied by Zymatic expert team • Established network of industry contractors • Short time from order to installation • Using sand-like material makes the design easy and fast to install • The treatment step can be manufactured in various suitable materials • The manufacturing process of the zymatic sand is standardised • The zymatic sand is easily emptied and refilled
Cleaning and Maintenance	<ul style="list-style-type: none"> • A maintenance and service plan are included • Water treatment using sand-like materials is considered easy
Environmental Impact	<ul style="list-style-type: none"> • The solution reduces the amount of organic pollutants released into aquatic environments • Can be applied without added energy • When optimized, the treatment step is relatively small and has minor effect on the local site aesthetics • Used zymatic sand is treated as normal sand from WWTPs
Verified Technology	<ul style="list-style-type: none"> • Verified by EU Horizon 2020 project 804453 at WWTPs in Sweden and the Netherlands

Performance Overview and Efficiency

The PRO™ solution facilitates the performance and physical parameters of the standardized version of the zymatic sand. The enzymes in this zymatic sand have a broad removal effect against organic micropollutants (especially pharmaceuticals). The measured removal effect of the standardised zymatic sand in a controlled environment and at various WWTP process environments is presented in technical reports (www.zymatic.com).

The removal effect of PRO™ is depending on the water quality and residence time. An initial residence time of 10 min is recommended.

The standard version of the zymatic sand is under continuous development and upgraded versions for the PRO™ solution will routinely be available to customers.



Average performance measured for standardized zymatic sand when treating disc-filtered wastewater (www.zymatic.com)

TREATMENT EFFICIENCY AT WWTPs

To determine the treatment effect of PRO™ at WWTPs, a comprehensive verification project was carried out via EU's Horizon 2020 SME Instruments programme. The treatment efficiencies from large-scale pilots, demonstrations and laboratory testing are shown in the table to the right.

Average treatment effect	Treatment step before SMART™	Relative water quality
~80%	Post-sedimentation	High
~70%	Post-sedimentation	Low
~85%	Disc-filtration	High

Key Design Parameters

The PRO™ solution allows for designing of your own treatment step using zymatic sand.

Zymatic Sand Parameters

The PRO™ solution uses a standardised version of the zymatic sand.

Version name	Void volume [%]	Average granulate diameter [mm]	Material	Bulk density [kg/m³]
Standard Zymatic Sand	~30	4.5	Silica-based	200-850

Flow and Hydraulics Design Parameters

Optimising the flow makes it possible to achieve high performance at a lower residence time. This allows for more compact installation and less total usage of material.

Residence time	Flow per m³ material*	Backwash	Recommended Hydraulic height [m]
Standard Zymatic Sand	0.3	NO	0.4

* The flow is based on 1 min residence time

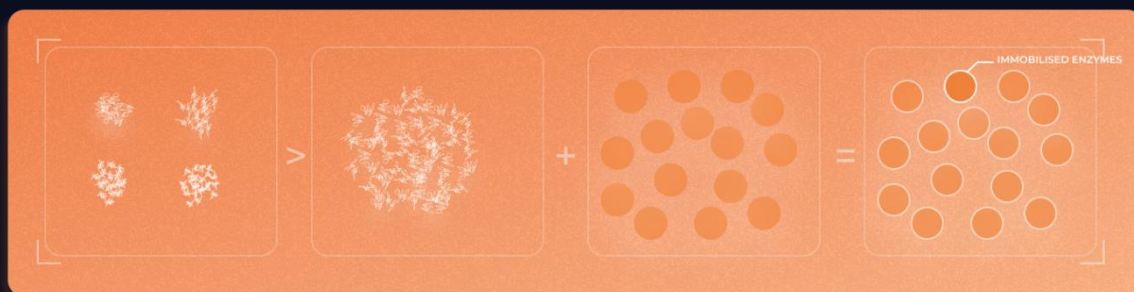
Water Quality References

A higher performance per residence time can be achieved with higher quality of the effluent water. This is normal for many technologies.

Effluent	Relative quality	SUS P	COD	BOD	TOC	PO ₄ -P	NH ₄ -N	NO ₂ -N	NO ₃ -N	T [°C]	pH	Average OMP removal [%]
Post Sedimentation	Low	22.9	-	<3	11.4	0.17	-	-	7.32	13	7.1	70
Post Sedimentation	High	-	-	-	-	-	-	-	-	20	7.2	80
Disc-filtration	High	14.4	4.7	8.0	-	0.11	2.98	1.69	6.43	16	7.1	85

Removal of Local Organic Pollutant Compounds

The standard zymatic sand have a broad effect on OMPs. Customers can also choose to remove local or site-specific problematic pollutants by adding additional enzymes. That process is described in the **INDUSTRY™** - Technology description.



Enzyme selection

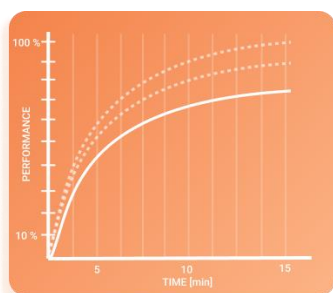
Based on your local needs, additional enzymes can be added to the enzyme mix that are used in the standard enzymatic sand.

Enzyme Immobilization

The upgraded enzyme mix is added to an already streamlined production process where the enzymes are immobilized to the material.

Adapted zymatic sand

Using the new enzyme mix, an adapted version of the zymatic sand is created.

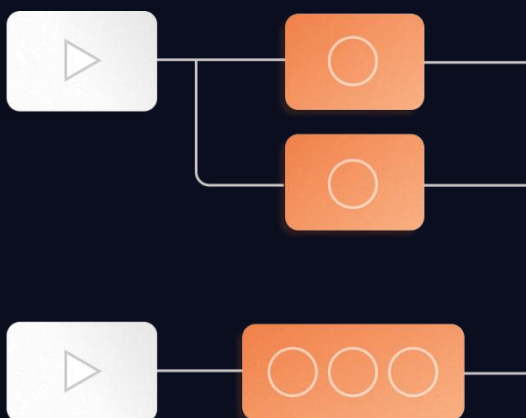


ADAPTING FOR LOCAL PERFORMANCE

Adapted zymatic sand is tested and reviewed towards the local conditions and performance parameters. The treatment effect towards the local pollutants is determined according to the local treatment profile.

Installation and Performance Scaling

The size of the PRO™ installation is scaled based on the volume of water to be treated (m^3/day). The removal effect of the PRO™ solution is depending on the residence time. The required residence time can vary from site to site depending on water quality and pre-treatment steps. The performance of the system can be scaled by adjusting the module size or use of several modules in serial/parallel connections. The standardised zymatic sand is designed and prepared for long-term stability. Measurements have shown that >95% removal effect is remained after 1 month (>90% after 3 months) of operation in a controlled environment. The life expectancy of the zymatic sand is known to depend on the local water quality. Therefore, an initial replacement frequency of 1 month is recommended for zymatic sand application under process conditions for treatment plants.



INSTALLATION

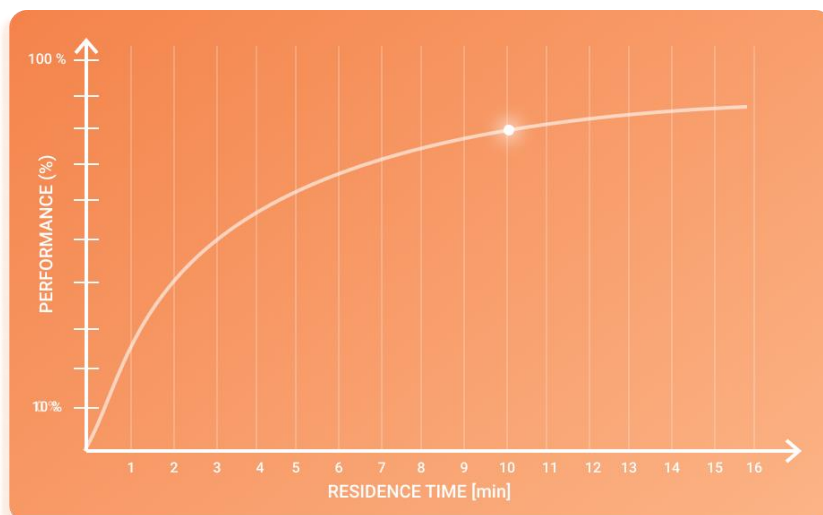
The system is advantageously installed as a final treatment step. A treatment step is designed to be easy to install and to operate.

TREATMENT STEP DESIGN

WWTPs have varying effluent water qualities and is easily scaled to using the various module sizes.

PERFORMANCE

The performance of the system (removal of OMPs) is tuned based on the WWTPs effluent water quality and applied residence time.



System performance scaling using residence time based on the effect of the standard version of the zymatic sand. (www.zymatic.com)

Warranty and Life Expectancy

The **zymatic sand** is designed and prepared for long-term stability. The life expectancy of the sand is depending on the local water quality. A normal exchange frequency of 1 month of use under process conditions are recommended.

The average operational life-length of the zymatic sand is longer than 1 month. The life-length of the material has been measured over a test period of more than 3 months in a controlled environment. After 1 month of system operation in a controlled environment more than 95% removal effect is remained.



1 MONTH

Exchange frequency

Dependent on the water quality and other important parameters the zymatic sand needs to be replaced after some use.

STABLE EFFECT

High durability

The simple system design offers high durability. The long life expectancy of a module is secured by regular quality controls.

LOW RISK

No new risks

Managing the zymatic sand is considered low risk operations.

SAFE DESIGN

Simple design

The system is designed with safety in mind. The treatment step is bringing low risks to the facility.

SIMPLE O&M

Safe & Easy

The O&M of the system is simple and can be carried out by the existing organisation.

The (en)zymatic sand

The combination of enzymes, material and enzyme immobilisation techniques have resulted in a highly flexible water treatment material, the zymatic sand. Using a sand-like material allows for easy scalability and flexibility in both design and application.

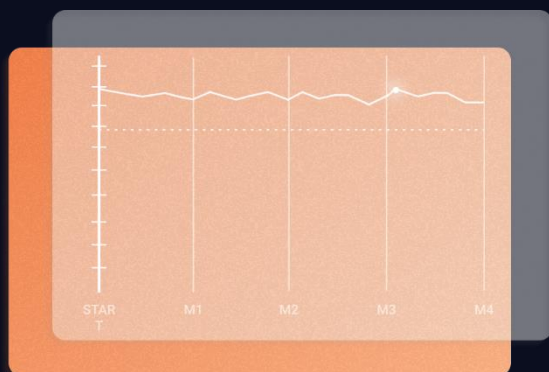
By applying different enzyme types, different chemical treatment mechanisms can be added directly to the surface of the material. This enables an adaptation of the treatment technology and chemical treatment mechanisms based on the customers' needs. In other words, with the help of the Zymatic platform technology, we can program the mechanisms of water treatment.

The Zymatic solutions provide water treatment solutions based on a mixture of different chemical reaction mechanisms. This feature offers advances over many older and conventional water treatment methods that have only one reaction mechanism. In addition, Zymatic solutions can be adapted or upgraded to future needs without adding installation changes.

Safety and Operations

A treatment step using the zymatic sand adds no new Occupational Health and Safety (OH&S) risks. The combination of a sand-like material and simple construction design enables low-risk operations.

The solution includes a full-service maintenance agreement. Within this framework, ZYMATIC partner up with local service organizations with many years' knowledge of similar operations. All installations come with a detailed O&M manual and a risk assessment.



PERFORMANCE MONITORING

The system performance is continuously monitored for best possible performance. The performance of the zymatic sand is verified before and after exchange.

WATER FLOW

Existing flow of water through the system should be monitored and controlled according to pre-set flow-specifications.

OTHER PARAMETERS

Parameters such as pH and temperature, or other controls, can be monitored for optimal controls.

Monitoring

The PRO™ solution offers different types of system parameter monitoring. The system design do not require advanced monitoring, which simplifies both operations and controls. When designing the treatment step, various monitoring parameters can be added. When the zymatic sand is exchanged, performance tests are made before and after changes to review real-time system parameters. Any additonal monitoring can be added.



Performance Monitoring

The performance of the PRO™ solution is monitored via standardised protocols.



System Monitoring

The customer decides which types of monitoring devices that is required on their system.



Maintenance Monitoring

The installation comes with a pre-defined cleaning, service, and maintenance plan.

Service, Cleaning and Maintenance

All installations are accompanied with a service organization and an established maintenance plan. The design of the PRO™ modules ensure easy and safe cleaning and maintenance.

Industry standards and commitment

Our commitment is to continuously improve and upgrade our products and services based on customer requirements, environmental requirements, and regulations. The platform technology is verified via several existing programs using third parties. All operations aim to comply with industry and international standards such as ISO 9001, ISO 14001, ISO 14034, ISO 45001 and ISO 17025. Performance testing and analysis are verified using accredited third parties.



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