ZYMATIC SMART

Plug & Play wastewater treatment for organic micropollutants

The world's most flexible water treatment technology uses enzymes

Use the standard zymatic sand in a modular setup
for simplified installation and immediate treatment
of organic micropollutants

ZYMATIC SMART™

Introduction

ZYMATIC **SMART™** is a plug-and-play module solution for removal of organic micropollutants (OMPs) from wastewater. The zymatic technology is based on the activity of enzymes incorporated in a sand-like material (zymatic sand). The enzymes bound to the material are selected to remove common OMPs present in municipal wastewater and wastewater treatment plant (WWTP) effluent water. The water is treated as the water flows through the zymatic sand (enclosed in a module/container system).

95%

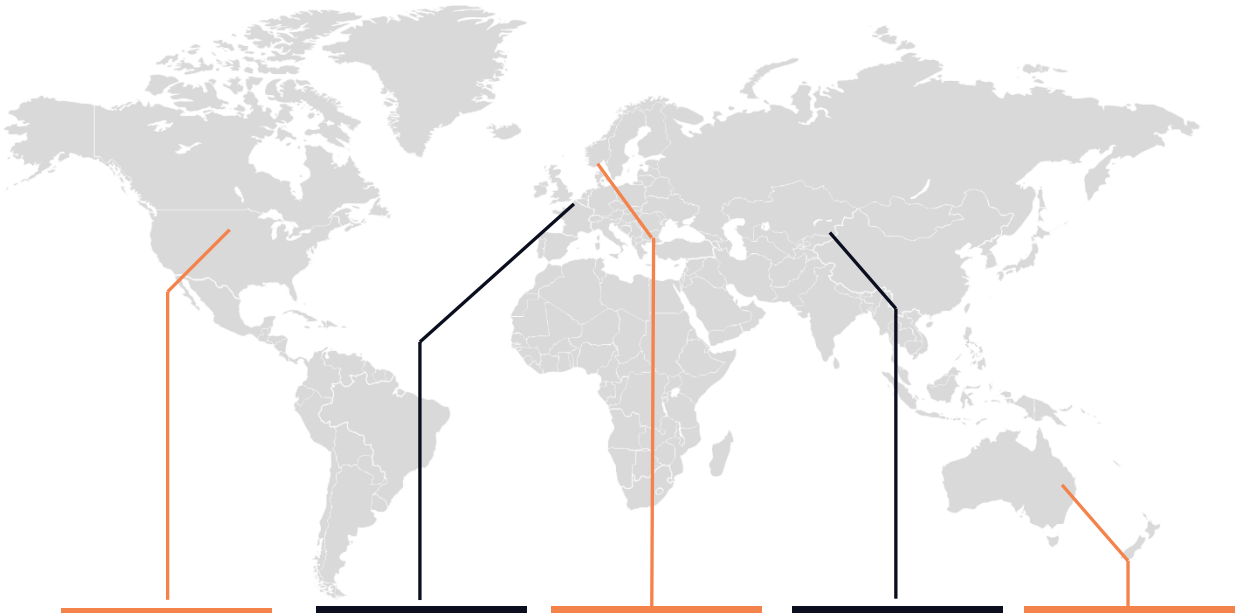
Up to 95% of removal of common OMPs

Broad effect towards OMPs and other organic pollutant compounds. Scale the installation easy using standard zymatic sand parameters.

LOW COST

Very Low CapEx and OpEx

The modular system is installed to lowest possible costs and the simple operation keeps the costs to its minimum.



Increased focus on PFAS and OMP removal from water resources

High activity in many countries to remove OMP from wastewater

Global focus to implement installations at WWTPs and industry facilities

Ongoing activities to remove OMP from industrial wastewater

Increased focus on PFAS and OMP removal from water resources

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

How the SMART™ solution works

The SMART™ solution is a multichambered treatment step designed to remove OMPs, such as pharmaceutical residues, commonly present in municipal wastewater and WWTP effluent water. SMART™ consists of a plug-and-play module (container) filled with zymatic sand.

The treatment step uses a standardized version of the zymatic sand, which is targeting a broad spectrum of OMPs. The zymatic sand is prepared and filled into the module.

The modules are designed to have an upwards flow (bottom-to-top). This creates a great movement in the water and improves the contact time between the water and the zymatic sand.

The modules are placed in the effluent of a WWTP and is fully operational using only inherited flow. The treatment can work at full performance without extra energy.

The 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.

PLUG-&-PLAY

Plug-and-play module treatment step ready to be installed after a post-sedimentation or sand-filtration step. The module is easily combined with other treatment steps.

LOW MAINTENANCE NEED

Easy to maintain and contains a defined maintenance and service plan.

HIGH DURABILITY

Water treatment with high durability, longevity as well as low cost and maintenance need.

ZYMATIC SAND

Exchange of zymatic sand according to a predefined maintenance plan. Available upgrades of the standard zymatic sand require no upgrades of the treatment step.

Note: This is a visualisation of a column design. The SMART solution is usually placed in a container

Key Aspects and Benefits

The SMART™ solution is ready to use as a plug-and-play module prefilled with the standard version of the zymatic sand. The treatment step is generally offered free of charge at an agreed OpEx cost. The modules are available in three different sizes and is easily scaled to existing flows. The treatment step is beneficially installed directly after a sand-filtration or as a final polishing treatment step at WWTP effluent. The solution enables fast installation after ordering.

The zymatic sand is an environmentally friendly water treatment technique. No additional chemicals are added to the water. Used zymatic sand are treated as normal sand from WWTPs.

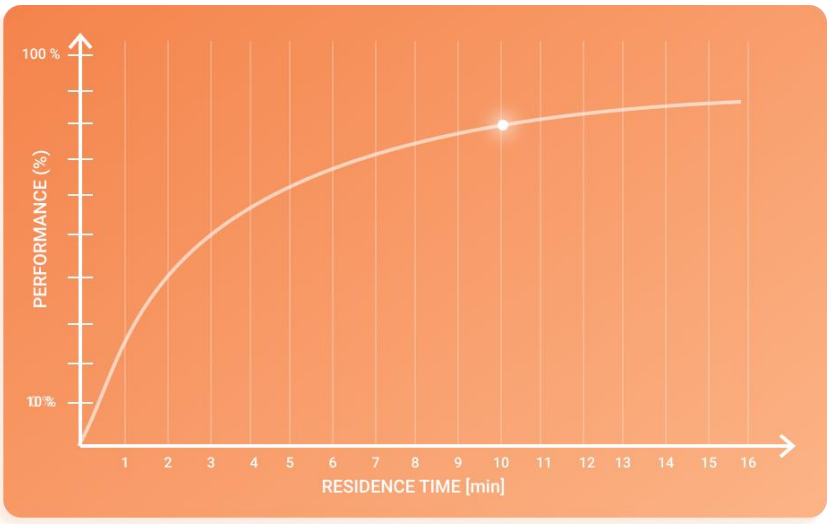
KEY FEATURES	BENEFITS
Organic Micropollutant Removal	• High removal effect towards pharmaceuticals normally present in municipal wastewater • The organic micropollutants are removed, degraded, deactivated, or transformed • The removal effect is depending on the water quality and water residence time • Removes organic micropollutants without the addition of other chemicals
Design and Construction	• Short time from order to installation • Plug-and-play systems reduce on-site installation time and cost • Simple module design to enable easy and fast installation • The sizes of the modules are compact to take up minimal space • The modules are created in non-corrosive materials • The Zymatic sand is manufactured internally and thus significantly reduces lead times • The modules are easily emptied and refilled
Cleaning and Maintenance	• A maintenance and service plan are included • Multiple access points make cleaning easy
Environmental Impact	• The solution reduces the amount of organic pollutants released into aquatic environments • Can be applied without additional electrical energy • The modules are relatively small and has little effect on the local site • aesthetics • Used zymatic sand is treated as normal sand from WWTPs
Verified Technology	• Verified by EU Horizon 2020 project 804453 at WWTPs in Sweden and the Netherlands

Performance Overview and Efficiency

The SMART™ solution contains a standardised version of the zymatic sand. The enzymes in this zymatic sand have a broad removal effect against organic micropollutants. The measured removal effect of the standardised zymatic sand in a controlled environment and at different WWTP process environments is presented in technical reports (www.zymatic.com).

The removal effect of SMART™ is depending on the water quality of the ingoing water and residence time in the modules. 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 SMART™ solution will routinely be available to customers.



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

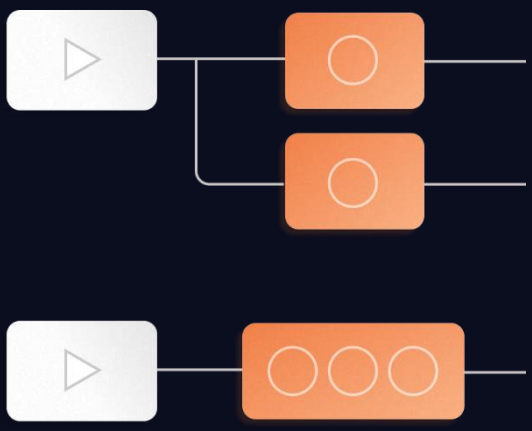
TREATMENT EFFICIENCY AT WTTPs

To determine the treatment effect of SMART™ 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

Installation and Performance scaling

The size of a SMART™ installation is scaled based on the volume of water to be treated (m^3/day). The removal effect of SMART™ depends 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 installation 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 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

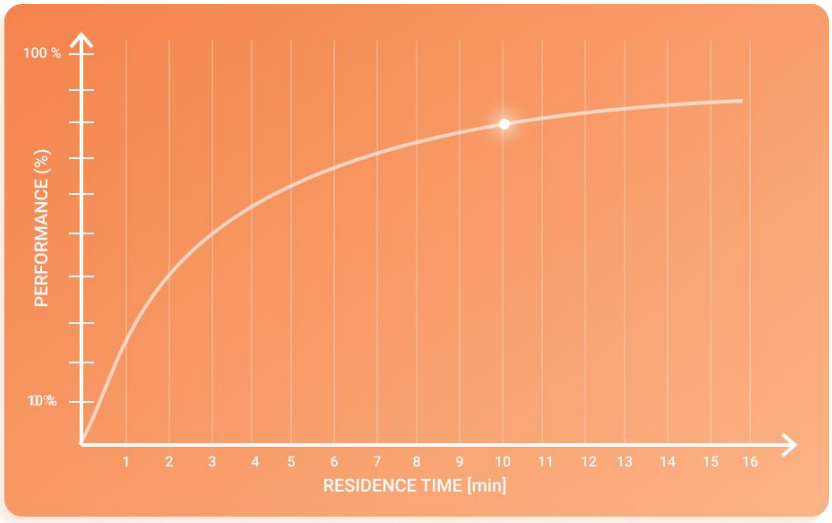
The system is advantageously installed as a final treatment step. Several modules can be connected in serial or parallel mode.

MODULE SIZE

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 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 SMART™ modules are offered free of charge. Modules that are subject to damage due to incorrect handling or vandalism are exchanged according to an established price range.

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, >95% removal effect 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

Adding the zymatic sand to a container solution is considered as a low risk operation.

SAFE DESIGN

Safe Modules

The system is designed with safety in mind. The modules are 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

The plug-and-play design of the SMART™ modules do not add new Occupational Health and Safety (OH&S) risks that is not already present on the site. The combination of a sand-like material, the plug-and-play system 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.

Key Dimensions on SMART™ Models

The SMART™ modules comes in three standard sizes (models). The various models enable each site to scale the treatment step for the best possible performance at low cost.

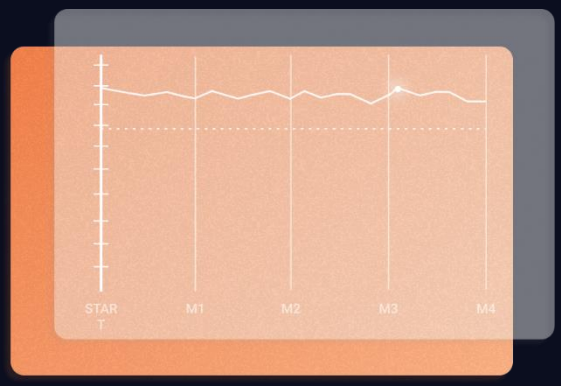
Model No	Maximum inlet pipe diameter	Approximate product dimensions (external)				Average treatable flow rate*
	[mm]	Length [m]	Width [m]	Height [m]	Approx. inlet height [m]	[m^3/min]
S10	400	2.991	2.438	2.591	1.800	0.3
S20	600	6.058	2.438	2.591	1.800	0.6
S40	600	6.058	2.438	2.591	1.800	1.2

* The average flow is based on 10 min residence time.

Zymatic sand

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

Version	Void volume [%]	Average granulate diamater [mm]	Material	Bulk density [kg/m^3]
Standard Zymatic Sand	~30	4.5	Silica-based	200-850



PERFORMANCE MONITORING

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

FLOW

Existing flow through the system is monitored and adjusted according to pre-set flow-specifications.

OTHER PARAMETERS

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

Monitoring

The SMART ™ solution offers different types of system parameter monitoring. The system design do not require advanced monitoring, which simplifies both operations and controls. The preset system setup is delivered with flow, pH and temperature monitoring. When the zymatic sand is exchanged, performance tests are maded before and after changes to review real-time system parameters. Any additonal monitoring can be added.

Performance Monitoring

The performance is regularly monitored via standardized protocols.

System Monitoring

The customer decides which types of monitoring devices that is required in their treatment step.

Maintenance Monitoring

A pre-defined cleaning, service and maintenance plan is included.

Service, Cleaning and Maintenance

All installations are accompanied with a service organization and an established maintenance plan. The design of the SMART™ 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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