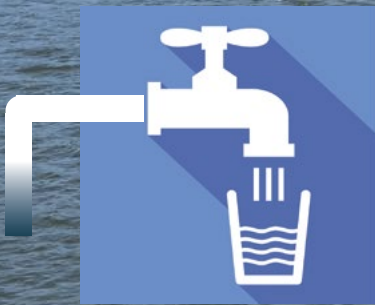


EXOCLEAN-R TRANSFORMS RIVER WATER INTO DRINKING WATER
EXOCLEAN-D PURIFIES DRINKING WATER

exomission
zero is our vision

We transform
RIVER WATER
INTO DRINKING WATER
FOR VESSELS AND VARIOUS OTHER APPLICATIONS



www.exomission.de



EXOCLEAN-R
SAFE AND CLEAN DRINKING WATER



EXOCLEAN-R SAVE AND CLEAN WATER

The rivers in Central Europe have become increasingly cleaner since the 1990s. Today, the concentrations of essential chemical constituents in the rivers are often lower than the drinking water limit values.



Surface water from rivers and lakes contain large proportions of floating and turbid substances, dissolved substances, bacteria, algae and protozoa.

With our newly developed ExoClean-R filter system we aim to generate excellent drinking water from river water.

Using our filter systems, all turbid substances are removed, chemical ingredients are reduced by over 95% and the microbiology is completely eliminated.

Investigations of different institutions have shown that, using ExoClean R, all examined water samples are clearly far below the limit values of the German Drinking Water Ordinance.

Comparison of our results with drinking water values of randomly selected German cities shows that we don't have to shy away from a comparison.

After treatment with ExoCleanR, all relevant values of the tested water samples taken from the river Rhine south of Cologne were absolutely comparable to values of drinking water of the cities of Berlin, Hamburg, Cologne and Munich.

We are confident that our small drinking water treatment plant can obtain pure drinking water from large rivers.

Of course, it is the operator's responsibility to control the operating system. We offer maximal support through permanent monitoring of the system status with our ExoControl as well as through regular maintenance.

Uwe Israel
Managing Director

Stefan Fischer
Managing Director

Investigation of different institutions ...

... have shown that, using ExoClean R, all examined water samples are clearly far below the limit values of the German Drinking Water Ordinance.

2013

As a novum, Exomission uses river water to convert it into process water on an inland vessel.

2014

Exomission receives the innovation award "European Innovation award for inland navigation" for the development of the Fuel-Water Emulsion Technology - FWE.

2014

Exomission wins the Innovation award of the Volksbank Cologne-Bonn for the application of the FWE technology.

2015

For the first time Exomission uses the sand filter technology to convert river water into process water.

2016

Due to the successful application of the FWE technology which results in extremely low emissions, the inland waterway vessel MS Empresa receives the Green Award in Gold.

2018

Exomission develops a system for water injection into the intake pipe to reduce nitrogen oxides.

2019

Exomission and the Caterpillar Importer in Switzerland, AVESCO AG, start an agreement on a partially exclusive cooperation regarding exomission's FWE technology.

2020

The MS Invontes receives the Green Award in Gold due to compliance of strictest exhaust gas values as a result of the FWE technology applied.

24/7

EXOCLEAN-R - TRANSFORMS RIVER WATER INTO DRINKING WATER

EXOCONTROL PLC-CONTROL WITH TOUCHSCREEN

ACTIVATED CARBON FILTER

DEACIDIFICATION FILTER

SEDIMENT FILTER

DOSING PUMP FOR FLOCCULANTS

REVERSE OSMOSIS MEMBRANE

UVC FILTER

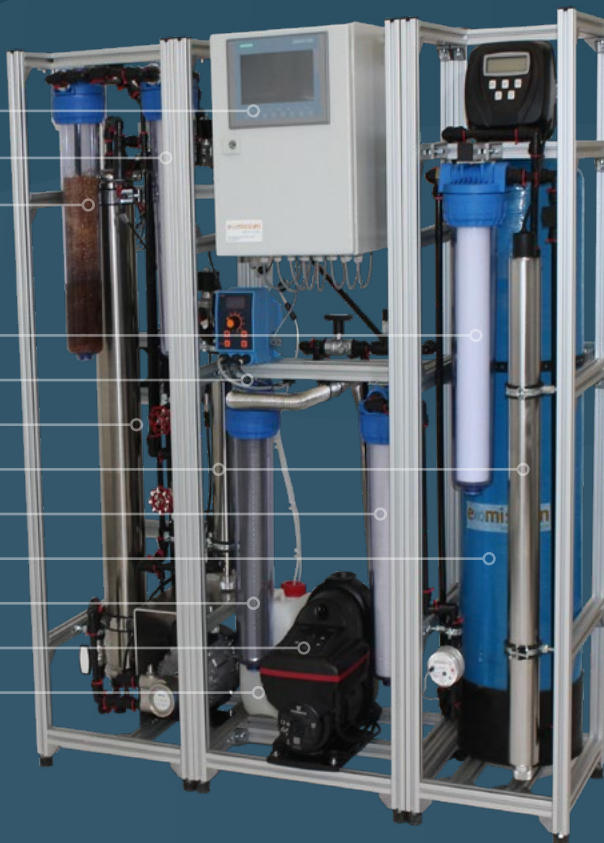
SEDIMENT FILTER

SAND FILTER

ACTIVATED CARBON FILTER

CONSTANT PRESSURE PUMP

FLOCCULANT RESERVOIR



Compact Filter System ExoClean-R

The innovative compact filter system ExoClean-R can be used to generate clean drinking water from surface water or water from other origins. Eleven different filter stages eliminate particles, suspended and turbid matter, bacteria, viruses, algae and other biology.

In parallel, all chemical ingredients such as heavy metals, pesticides and fungicides, medicines, ammonium, nitrate and hormones are usually reduced by approximately 95%, often even to a higher extent.

The illustrations and descriptions shown in this brochure are only examples of potential designs. Technical changes and errors are excepted.



EARN MORE MONEY - BY INCREASING YOUR CARGO CAPACITY

Gain space - by reducing the size of your drinking water storage tank(s)



OPTIONAL EQUIPMENT

EXOCLEAN-R

consists of the following assemblies:

- Pre-filter
- Constant pressure pump
- Flocculation system
- Sand filter
- Activated carbon filter 1
- Sediment filter 1
- UVC filter 1
- Sediment filter 2
- Sediment filter 3
- Reverse osmosis system
- Activated carbon filter 2
- Deacidification filter
- UVC filter 2
- Sensors
- Actuators
- ExoControl
- Color touchscreen

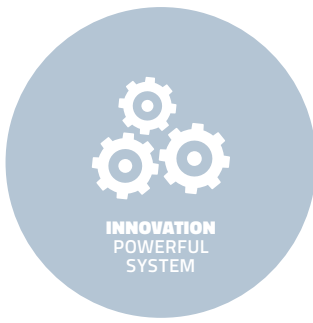
ADDITIONAL OPTIONS:

- 1+ Drip pan
- 2+ Filter drainage system
- 3+ Larger touchscreen on the control cabinet
- 4+ Additional touchscreen(s) in other rooms
- 5+ Remote diagnosis module
- 6+ Remote access via HTML / Internet in combination with 5+
- 6+ Remote access via smartphone app in combination with 5+
- 7+ SMS messages on the smartphone in combination with 5+
- 8+ Sensor packages for optimised control and diagnosis
- 9+ Solar package with 24V version and batteries for self-sufficient power supply

SUBTRACTABLE OPTIONS:

- 1- Elimination of the Simatic S7 control and various functions / sensors instead Siemens LOGO8 control
- 2- Elimination of Siemens 4 inch HMI; at place its Siemens TDE 6-line text display
- 3- Manual backwashing in combination with 1- (instead of automatic backwashing)
- 4- Manual backwashing of the deacidification filter in combination with 1- (instead of automatic backwashing)





BENEFITS OF THE EXOCLEAN-R WATER TREATMENT

Produce drinking water whenever, wherever, as often and as much as you want

- Save time - no waiting for the bunker ship
- Save money - in-house production is cheaper than many bunker stations
- Save detergent - with softer water
- Reduce the risk of legionella - with fewer deposits
- Earn more money - by increasing your loading capacity
- Gain space - by reducing the size of your drinking water tanks
- Increase your safety - no bunkering in doubtful places
- Mixing with bunkered drinking water possible

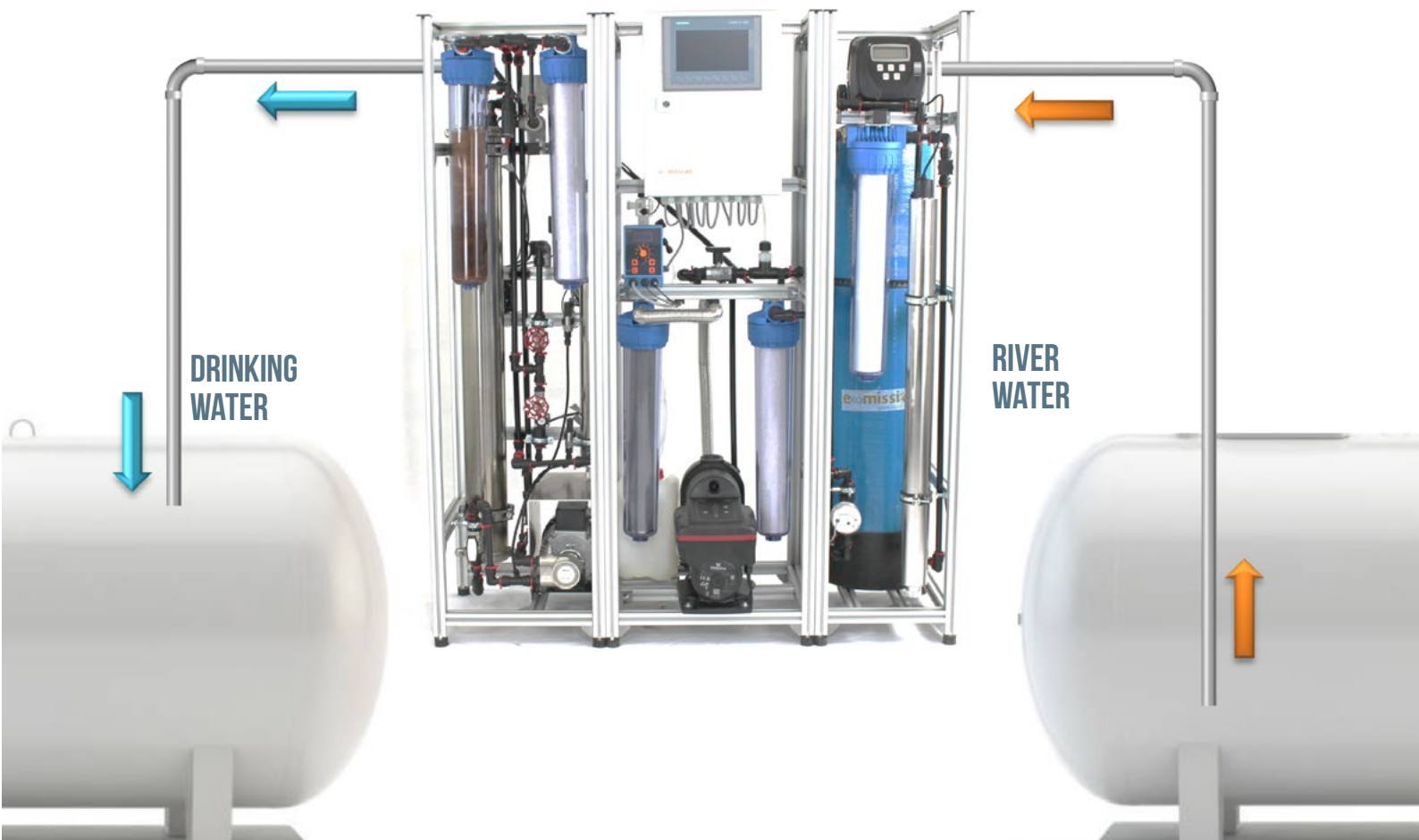


GAIN SPACE - BY REDUCING YOUR DRINKING WATER TANK(S)

Gain cargo capacity - by reducing the stored volume of drinking water

11 FILTER LEVELS
REDUCTION UP TO

99,99%



Compact filter system ExoClean-R

The ExoClean-R filter system consists of 11 entirely controlled and monitored serial purification stages in flow direction. The pump type and performance is depending on the local conditions.



1

PRE-FILTER

The ExoClean-R filter system consists of 11 entirely controlled and monitored serial purification stages in flow direction.

2

PRESSURE INCREASE

The pump type and performance is depending on local conditions.



Save time
no waiting for the bunker vessel

3 FLOCKING

Flocculants turn smallest, non-filterable suspended and turbid matter into large filterable flakes

Background

River and other surface waters contain large amounts of small and ultrasmall suspended and turbid matter. Also included are fungi, microorganisms, plankton, protozoa, bacteria and viruses.

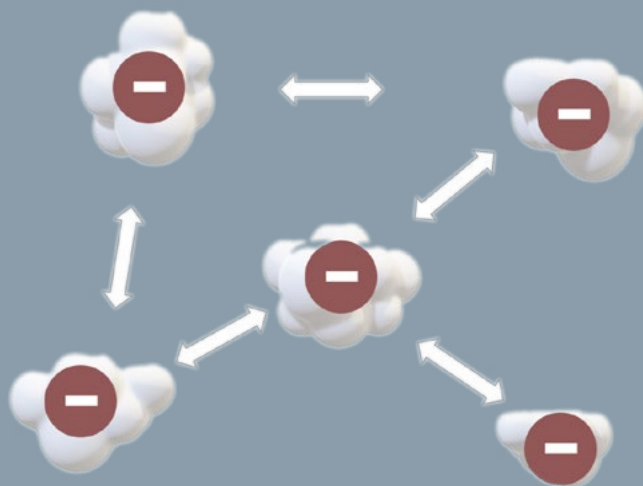
The size of the turbid and suspended matter, the so-called colloids are in a range of approximately 10 nanometers to 10 micrometers ($1 \text{ nm} = 0.001 \text{ }\mu\text{m}$).

The smallest colloids can not be filtered with sediment filters-like candle or bag filters - because the mesh sizes of even the finest sediment filters (0.2 up to $1.0 \text{ }\mu\text{m}$) are still by a factor of 20 to 100 larger than the smallest colloids.

Flocculants

In order to remove the small dirt particles, we use a trick. A flocculant approved for drinking water is applied in a very low ppm concentration.

The negative charges of the dirt particles become neutralized by the positively charged molecules of the flocculant. Subsequently, small and increasingly larger flakes in the range of micrometers to millimeters are formed, which then are big enough to be filtered. The flocculation process is completed when dirty water is successfully turned into clear water.



Left:
Negatively charged dirt particles in the water (colloids) repel each other, therefore remain small and float in the water.



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THE PROCESSES IN YOUTUBE



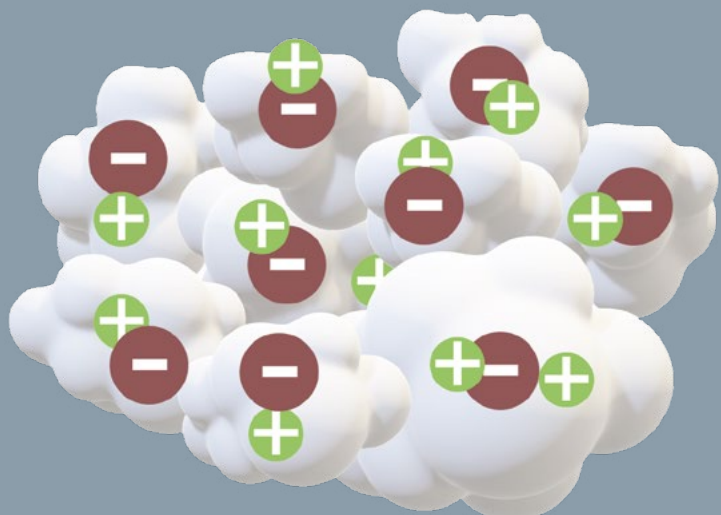
Dosing technology

The flocculant is injected from a reservoir using a high-precision special metering pump. The volume of the flocculant is proportional to the water volume flowing past and it is dynamically mixed. In the process, small microflakes are formed which then grow continuously.



Right:

The positively charged molecules of the flocculant neutralize the negative charges of the colloids and lead to small microflakes that agglomerate. The flakes continue to grow to macroflakes and can be removed in the next filter stage.



4

filter - backwash - filter
- fully automatic



MULTILAYER SANDFILTER SYSTEM

For a certain time, the water, including dirt particles agglomerated into flakes, remains in the upstream mixing section with calming zones as well as in the upper, water-filled area of the maintenance-free multilayer sand filter system.

The flakes stay on the surface and get stuck between the granules of the two- to three-stage filter material. The water, which has been cleaned of the suspended matter, continues to flow into the bottom layer filled with supportive gravel. At the exit of the sand filter the water is clear.



Different layers



River water after passing through a sand filter

Left: with the use of flocculants
Right: without the use of flocculants



THE PROCESSES
IN YOUTUBE

AUTOMATIC BACKWASH

ExoControl triggers a fully automatic backwashing of the sand filter, and controls and monitors the process. The direction of the water flow is thereby reversed and the previously filtered dirt is removed into the drain within a few minutes. After a short recovery, the filter is ready for operation again.





ACTIVATED CARBON FILTER

Activated charcoal, also called medicinal carbon, consists of porous, fine-grained carbon with an enormous inner surface.

The pores are connected to each other like in a sponge and the pore structure is so fine that the inner surface of only 4 grams activated carbon equals approximately the area of a football field!

On the surface of the activated carbon many different substances can be bound by absorption.

The clear water coming from the sand filter is flowing through a 20-inch, porous, extruded activated carbon filter element with approximately 750g weight.

In the case of radial flow from the outside inwards, a polypropylene fleece and a polyethylene outer net are responsible for clean conditions when using the filter candles.

Due to the structure of the charcoal filter, substances larger than 5 microns can be held back. Therefore, particles that are able to pass through the sand filter can be filtered by activated carbon.



Activated carbon is used as granules or as pressed / sintered activated carbon.

Retention of:

- Bacteria (conditional)
- Lead and other heavy metals
- Chlorine and its toxic derivatives
- Detergents

- Fluorides
- Odours and flavourings
- Petroleum hydrocarbons
- Organic hydrocarbons
- Pesticides
- Pharmaceutically active ingredients

- Phenols
- Plant protection products
- Viruses (conditional)
- etc.





Increase your security
no bunkering of water in doubtful places

6 DESINFECTION WITH UVC RADIATION

Surface water naturally contains microorganisms, bacteria, fungi and viruses. Much of it is harmless for humans, but there are microorganisms that multiply rapidly under certain conditions and can become a problem for human health. Therefore, it is necessary to render these substances harmless.

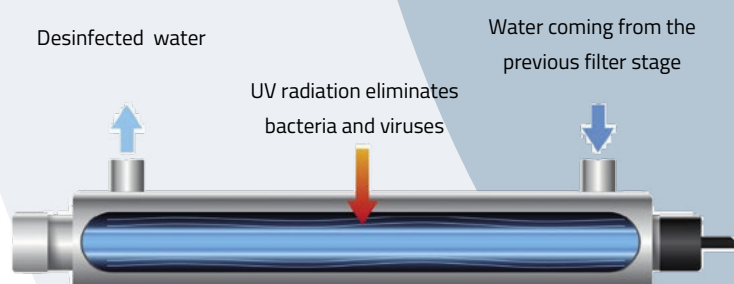


To eliminate undesirable water components, there are different options. When using ultraviolet light with a beam length of around **254 nm and a minimum intensity of 400 J/m²**, it can be assumed that **more than 99.99%** of all germs and viruses flowing past the spotlight are inactivated in an environmentally friendly and reliable manner.

A prerequisite for successful radiation of the substances contained in water is that the water used is turbid-free and clear.

After flow through the ExoClean-R activated carbon and sediment filters, the water is effectively free of turbidity, so that UVC radiation can work efficiently.

In order to maximize the efficiency, the UV light used has a powerful performance so that the required minimum radiation of the water is significantly exceeded.



7 SEDIMENT FILTERS

Multilayer Sediment Filter 1.0 µm

Multilayer Sediment Filter 0.5 µm

After the UVC clarifier, the water flows through sequential 20 inch Melt-Blown filter candles, in which 4 different spray nozzles, consisting of finer and coarser endless threads formed into a multi-layer structure, are processed. Within the respective depth filter structure, the fine 1.0 microns, or 0.5 micron layers are located inside and the coarser layers are placed outside.

Due to the four-layer gradation, the rough particles are filtered within the outer layers and the finer particles get stuck in the inner layers.

In the sediment filters, particles as well as protozoa, bacteria and large viruses are filtered out. Due to their size, they are able to penetrate the sediment filter part of the upstream activated carbon filter, however will subsequently be inactivated by UV irradiation.



The multilayer structure guarantees:

1. long service life
2. high dirt holding capacity and
3. low differential pressure

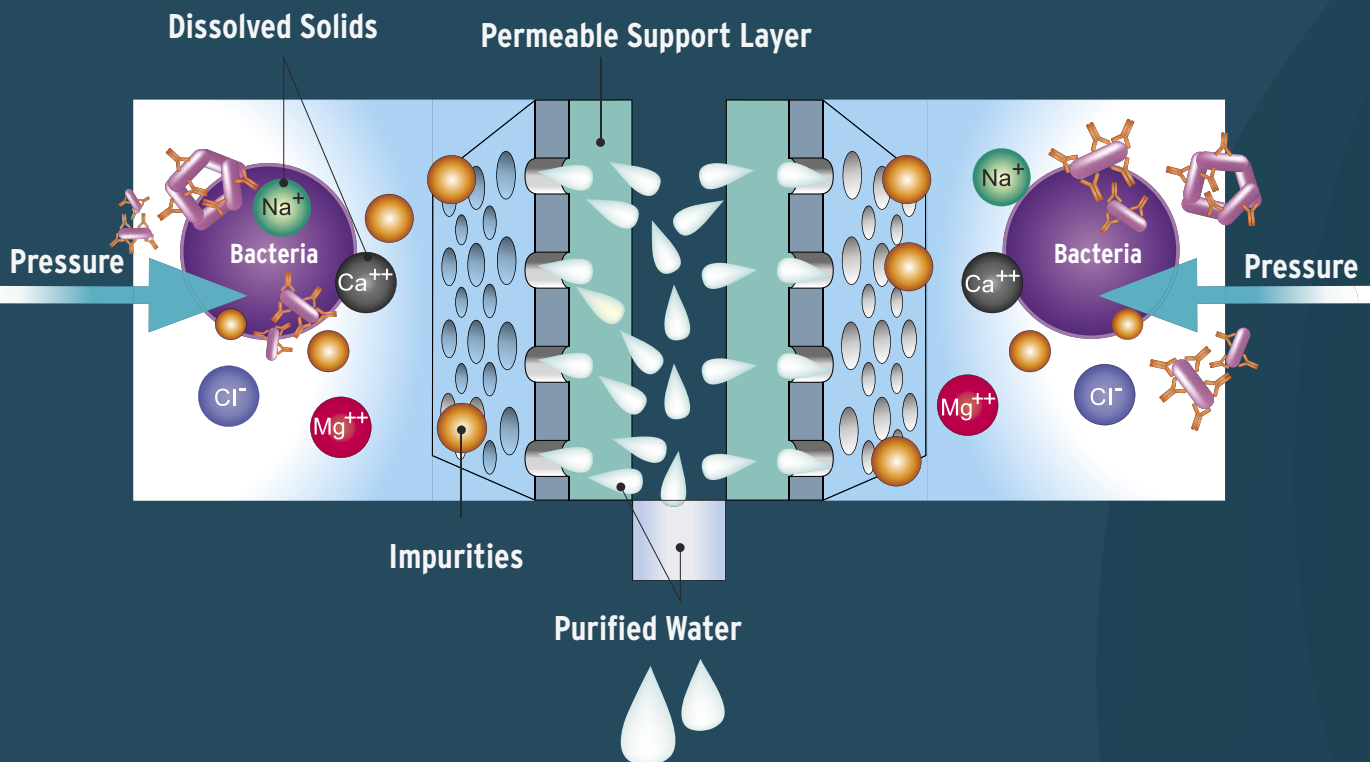
8 REVERSE OSMOSIS

In the reverse osmosis technology, a semi-permeable membrane which is permeable only in one direction, is put under pressure on the raw water side. Simplified, the membrane acts as a sieve with minimum mesh sizes. Due to this molecular filters, only molecules with a size less than approximately $0.0001 \mu\text{m} = 0.1 \text{ nm}$ penetrate the membrane. As the mesh size is so small, essentially only small water molecules can be pressed through.

Even salts dissolved in water, nitrates, silica, pesticide residues, and almost all of the other substances can not pass through the ultrafine membrane openings due to their molecular sizes and get expelled of the water or deposited. Only purest water flows through the membrane and forms the so-called permeate. However, all others - mostly undesirable substances - remain on the raw water side.

As during operation, there is continuous water flow with the contained substances retained by the membrane, concentrated substances must be continuously discharged. Therefore, a proportion of the raw water will turn into waste water.

Function of the reverse osmosis membrane



High reluctance:

- Aluminum
- Ammonium
- AOX
- Arsenic
- Bacteria
- Barium
- Benzene
- Lead
- Bromide
- Cadmium
- Chlorine
- Chrome
- DOC
- EDTA
- Iron
- FHKW
- Fungicides
- Herbicides
- Copper
- Calcium
- Magnesium
- Drugs
- Nitrate
- Nitrite
- PAH
- Pesticides
- Pharmaceuticals
- Phenol
- Protozoa
- Salts
- Sulfates
- Mercury
- Uranium
- Viruses

9 ACTIVATED CARBON FILTER

If the permeate coming from reverse osmosis still contains adsorbable substances, these will be retained in the following extruded activated carbon filter block. The water flows radially from outwards to inwards through the activated carbon block. Pollutants get adsorbed by the inner surface of the activated carbon filter.



Make more money
by increasing your cargo capacity

10

DEACIDIFICATION



Reverse osmosis removes all water constituents equally, including calcium and magnesium ions. This will release CO₂, the pH value of the water can decrease, the water gets acidic, similar to carbonated mineral water.

For humans, acidic water usually is irrelevant, but the water can be corrosive to metals in the installation.

The deacidification filter is therefore used to bind free CO₂. Our substrate consists of a natural carbonate filter granulate.

The concentration of calcium and hydrogen carbonate ions increases slightly resulting in the water not being corrosive any longer. The water is deacidified and the pH value increases back to the desired range of pH 6.5 - 9.0.

From time to time the filters require back-washes. This backwash takes place fully automatised by our ExoControl device which monitors the process.

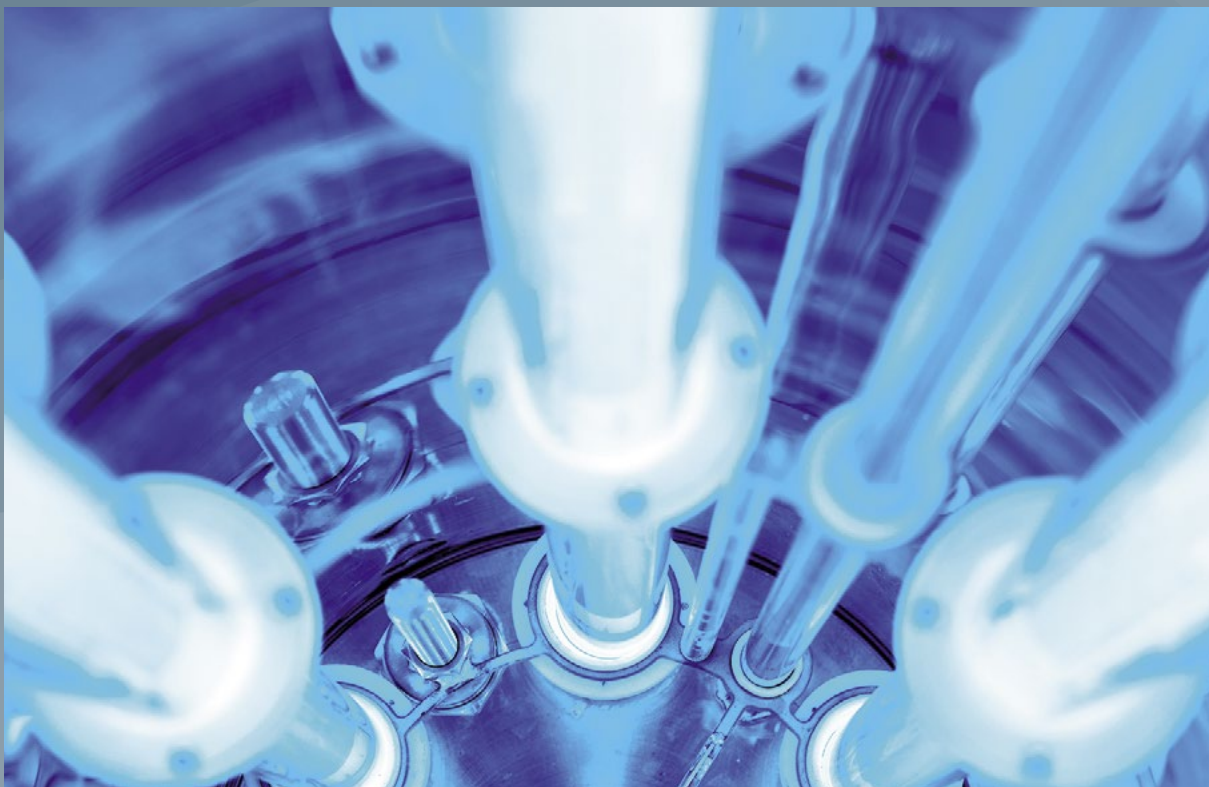
ANOTHER 11

UVC FILTER

Assuming that there are single bacteria or viruses who still manage to overcome the previous filter stages - each one also acting on the biological constituents, then at least 99.99% of these germs get inactivated by the second UVC filter.

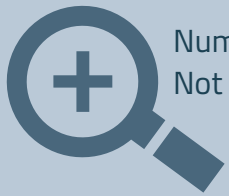
The emitter used can irradiate passing water at a flow volume of up to 1,000 liters per hour with a radiation length of 254 nm and a radiation dose of at least 400 J / m³, which is lethal for bacteria, viruses and protozoa. However,

the real water flow is significantly lower at approximately 250 l / h, so that the real radiation dose is much higher than required.

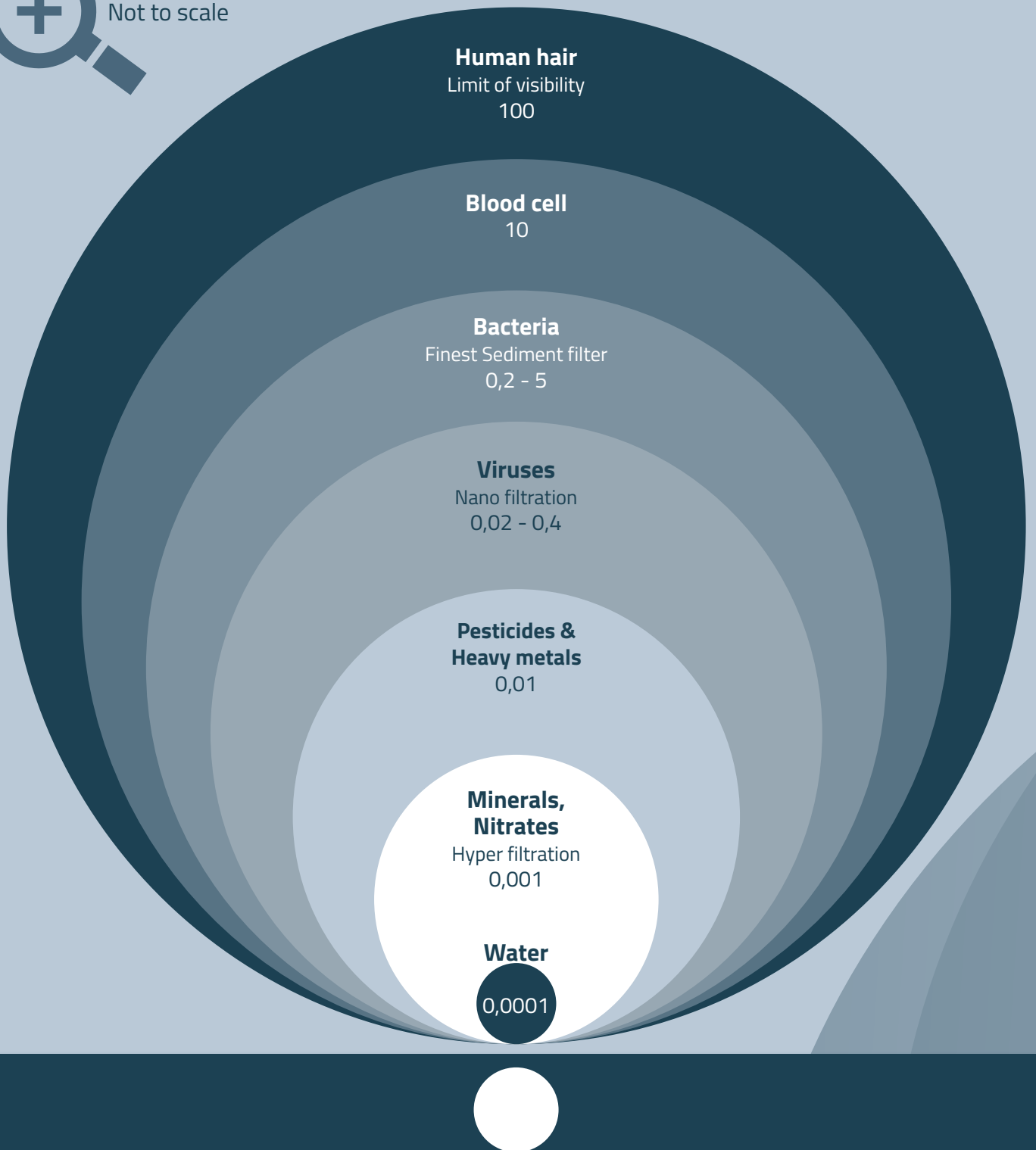


Increase your security
no bunkering of water in dubious places

No chance for pollutants, bacteria and viruses
Game over at the stage of reverse osmosis!
Only purest water can penetrate this stage



Numbers in Micrometers
Not to scale



Pore of a reverse osmosis membrane

Innovative ExoControl based on a Siemens S7 1200 PLC

The innovative control of ExoClean-R is based on a powerful and robust Siemens S7 1200 PLC. Alternatively, with significant functional restrictions, the LOGO8 control from Siemens can also be used.

In the standard version, the central operation and visualization of the system data takes place via a Siemens 4 inch TFT color Touchscreen display (HMI).

Optional and with increasing size, more comfortable 7, 9 or 12 inch versions of the Siemens TFT color touchscreen HMI are available. When using the Siemens S7 1200, the connection of further HMI incl. a mobile HMI is possible so that the operation and control can be monitored from several locations or even "location-independent".

When using the optional simplified and more cost-effective LOGO8 control, a basic LOGO TDE display (6 lines with 20 characters each) is available.

ExoControl

- compares sensor data with target values,
- controls and monitors actuators,
- informs about the current status,
- counts operating hours,
- informs about the maintenance status,
- warns if the warning thresholds are exceeded,
- sends error messages,
- stops the production of drinking water,
- triggers flushing and backwashing,
- switches the automatic pump on/off,
- controls pressure and temperatures,
- controls water flow rates,
- controls electrical conductivities
- checks the sand filter degree of soiling,
- checks the sediment filters degree of soiling,
- starts and monitors the dosing system,
- supplies the dosing pump with pulses,
- monitors the canister level,
- switches UV lamp preheating on/off
- monitors the current water flow
- monitors the UVC radiation intensity
- starts and stops reverse osmosis,
- controls the inflow
- controls waste water flow and
- controls the quality of the permeate.



Siemens S7 1200 with additional blocks.



Siemens 4 inch HMI



Logo TDE Display

EXOCLEAN-D

Would you like to take water from your drinking water tank?

Our innovative compact system ExoClean-D ensures constant pressure and further filtration steps of the drinking water immediately prior to consumption - for even more security.

Of course, ExoClean-D can also be used independently of the ExoClean-R system. It can work completely independently using a small integrated PLC control. This drinking water treatment system can completely replace an existing system with a large hydrophore (membrane pressure accumulator system).

ExoClean-D essentially consists of the following subsystems:

- a powerful and whisper-quiet electronic pressure pump for constant line pressure
- a small innovative 2 liter flowthrough diaphragm accumulator
- an combined activated carbon and sediment filter
- a powerful UVC clarifier with UV radiation monitoring
- optional: automatic water softener with hardness setting modules



Basic module without optional water softener



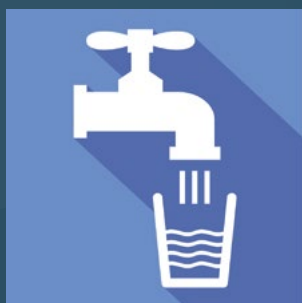
Modules placed side by side



Free up space
by downsizing your drinking water reservoir(s)

Set as an Exomission standard, ExoClean-D is manufactured using modular technology with robust aluminum profile framing. Depending on the space available, two modules can be set up side by side, installed one on top of the other or even other individual options. When difficult space conditions are given, special shapes of the modules can be created - we make it fit.

If the bunkered drinking water is “hard”, the installation of an optional water softener is recommended. The water softener not only reduces the use of detergents, but also prevents lime-scale stains on the sanitary facilities as well as blocked taps. In particular, soft water prevents the formation of deposits in the pipe system of the area to be supplied. In these deposits, Legionella and other bacteria can potentially nest and multiply.



Modules placed on top of each other

MS SCHÖNRAIN

runs since 2016 with FWE technology

Since 2016, the MS Schönrain has been running with the fuel-water-emulsion (FWE) technology developed by exomission. In brief, demineralized water and diesel fuel are mixed to form an emulsion which is injected into the engine for combustion. The results are very convincing: the machine, previously visibly sooting, becomes in fact soot-free and additionally, nitrogen oxide emissions are drastically reduced. With our FWE technology, the prime engine even meets the limit values of the CCR II exhaust regulations. In addition, the fuel consumption is reduced - in some operating points by more than 5%. The process water required is passed through several filter stages. It is taken directly from river water which was previously bunkered in a tank. We have performed several water analysis tests using water from the Rhine, Weser rivers and others and the results show that the limit values for drinking water are perfectly met.

With the new ExoClean-R water treatment system, in addition to process water, drinking water can also be produced. Compared to the tested and validated process water system, further filter stages are introduced, others massively reinforced as well as a complex control with intensive monitoring is integrated.

In addition, the system for extraction of water from the drinking water tank was newly constructed. Initially, only a large hydrophore with a pump, which was susceptible to legionella infestation was installed. The new drinking water treatment system ExoClean-D, contains additional filter levels. In addition to a powerful and whisper-quiet automatic water pumps, several sediment and activated carbon filters (an innovative pressure storage membrane working in the flow) as well as a powerful UVC filter with UV sensor is installed. That ensures maximum security.

"Environmental and climate protection are very important topics to us. Using exomission's FWE technology, we minimize soot and nitrogen oxides, which are harmful to health and the climate and fuel savings additionally reduce CO2 emissions. These effects even increase the use of GTL", says Achim Schäfer.



Achim and Christina Schäfer, the owners of the MS Schönrain, are vessel operators with heart and soul and they are convinced exomission's FWE fans. Since 2020, the Schönrain also runs with the environmentally friendly, clean fuel GTL (Gas to Liquid) obtained from natural gas.

The combination of FWE and GTL works perfectly, added Christina Schäfer. "The use of river water is a stroke of luck for us, because the capacity of the drinking water tanks on board is very limited. It is getting harder and more expensive to bunker drinking water, the taps are getting fewer and bunkering often takes too long, reports the ship owner.

"We are therefore looking forward to the new exomission system. We can then dismantle one of the tanks and use the additionally available space in a different manner. We are able to pick up a few tons of load more on average and also save time," reports Achim Schäfer.

INSTALLATION - MAINTNANCE

Installation and commissioning of ExoClean-R is performed by exomission or through an authorized partner.

Installation

Installation and commissioning of ExoClean-R is performed by exomission or through an authorized partner. ExoClean-R is constructed using an aluminum profile frame in modular construction which is typical for exomission construction plants.

Therefore, the introduction of the system in the installation room (for example engine room) is possible using 3 individual modules. When space is limited, the modules can also be separated from each other or be set up decentrally. If necessary, customized production using special modules can be applied and adapted to the installation space available.



Annual maintenance by exomission or partner. In the first year additional check after 6 months.

The installation and commissioning of the ExoClean-D modules can also be done by appropriate specialist companies.

Maintenance

Maintenance by the operator has to be carried out carefully, but essentially is limited to controls and exchanges of sediment and activated carbon filter elements.

Approximately annually (depending on water consumption) a new canister of flocculant is required and the deacidifying agent has to be refilled.

Booster pump, sand filter, dosing system and reverse osmosis are virtually maintenance-free.

The lamps in the UVC clarifiers last for more than 8,000 hours of operation and are monitored by the ExoControl monitors just like all other subsystems. If maintenance is required, the operator receives appropriate information shown on the display.

Maintenance is carried out annually by exomission or an authorized partner. After 6 months of initial operation, an additional check will be carried out by exomission.

During the first year all consumables required are included in the installation price.



MAINTENANCE CONTRACT = 3 YEAR WARRANTY

When a maintenance contract over 3 years is signed, an extended warranty is guaranteed within this time period. During the contract time of the maintenance contract, all required consumables are included.



Make drinking water whenever, wherever, as often and as much as you want

- Save time – no waiting for the bunker vessel
- Save money – in-house production is cheaper than many bunker stations
- Save detergent - with softer water
- Reduce the risk of legionella contamination – with less deposits
- Make more money – by increasing your loading capacity
- Gain space – reduce the size of your drinking water storage tank
- Gain cargo capacity – with less drinking water volume
- Increase your safety – no bunkering at doubtful places
- Mixing with bunkered drinking water possible

Layout: www.selbachdesign.com



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