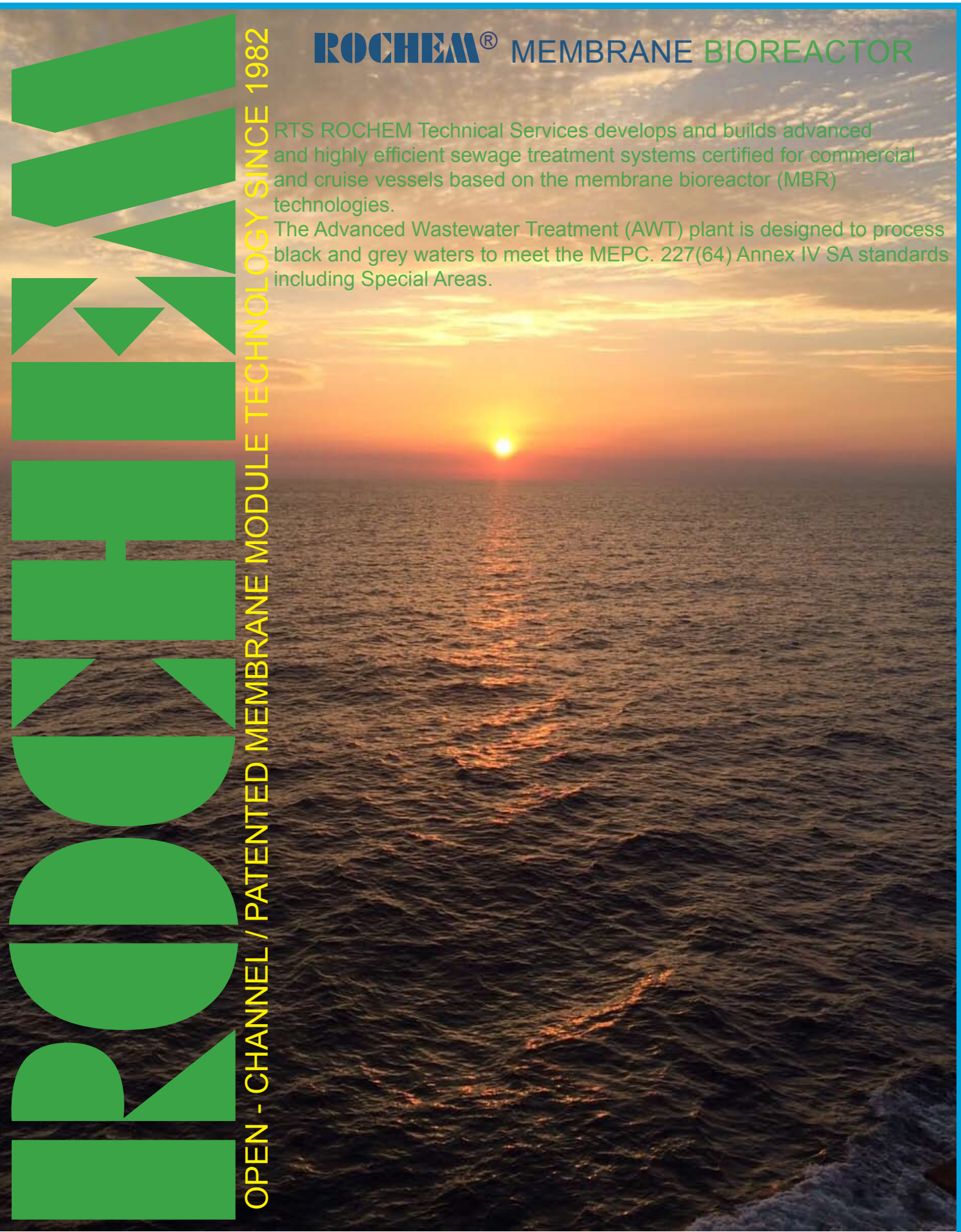
ROCHEM®
Technical Services



ROCHEM

OPEN - CHANNEL / PATENTED MEMBRANE MODULE TECHNOLOGY SINCE 1982

ROCHEM® MEMBRANE BIOREACTOR

RTS ROCHEM Technical Services develops and builds advanced and highly efficient sewage treatment systems certified for commercial and cruise vessels based on the membrane bioreactor (MBR) technologies.

The Advanced Wastewater Treatment (AWT) plant is designed to process black and grey waters to meet the MEPC. 227(64) Annex IV SA standards including Special Areas.

KEEP THE OCEAN CLEAN

ROCHEM®
Technical Services

Since 1998 on the research ship POLARSTERN
POTABLE WATER AND MBR SEWAGE TREATMENT

ROCHEM® MEMBRANE BIOREACTOR

ROCHEM MBR

Membrane Bioreactor

Turn sewage from toilets and greywaters from sinks, basins, showers, kitchen and laundry into clean enviromental-friendly water that meets the bath water quality according to EU-standards

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Improved technology for water purification with ROCHEM MBR

The combination of a high density biomass reactor with the FS module system for ultrafiltration forms the operating unit of the ROCHEM membrane bioreactor which provides many advantages for marine waste water treatment

ROCHEM SOLUTION

The high efficiency design of the membrane biological reactor purifies black water on ships to achieve a superior quality to the international limit values for contaminants imposed by MARPOL/IMO.
Therefore the environmentally sound purified waste water can be discharged overboard in any harbour or coastal area allowed by law.

since 2002 on the M/V *STAR PRIDE*,
140 m^3/day

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The main components of the RTS ROCHEM black and grey water treatment plant are the bioreactor segments and the ultrafiltration modules which form an elegant combination of the widely applied activated sludge process with the more sophisticated open-flow, ultrafiltration (UF) membrane separation process. Before entering the plant, the black and grey water influent passes a prefiltration for rejecting particles and fibres.

The filtrate is generated through pressurized cross flow on the membrane surface so that the suspended solids and bacteria are removed by the UF membrane. The continuous cross flow generate an optimized cross flow velocity on the membrane surface which scours the surface and removes deposits so that a continuously high flux rate is assured.

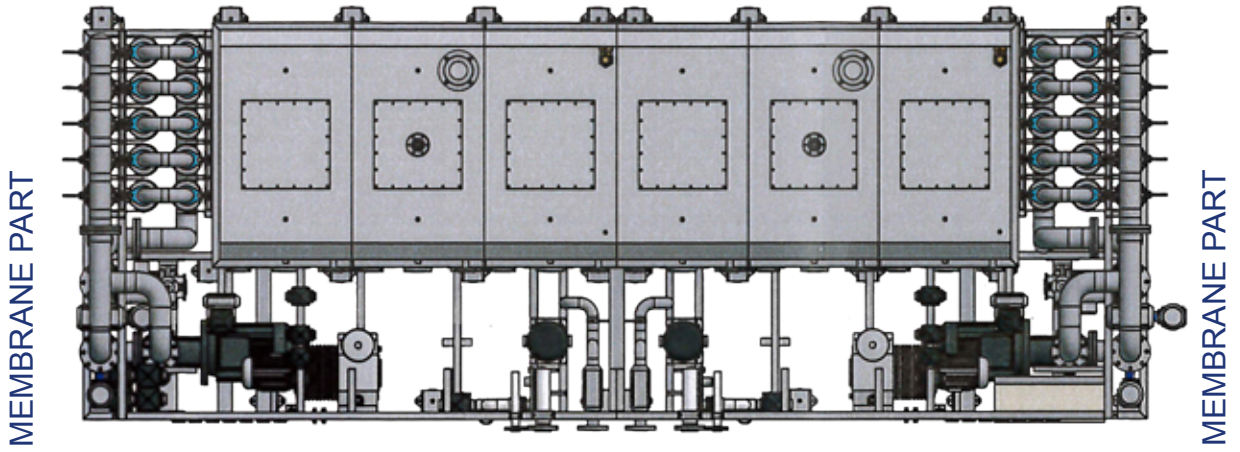
The introduction of air/oxygen through air diffusers installed at the bottom of the reactor is necessary for the aerobic biological degradation of organic wastewater contaminants.

The biowaste/excess sludge produced from the aerobic digestion of the black and grey water contaminants is collected in a sludge tank for disposal or further treatment.

The bioreactor works as aerobic stage with a high biomass density. The biomass density can be increased up to 20 g/l by recirculation of the biomass through the ROCHEM FS modules. In normal operation, a range between 14 and 16 g/l is typically sufficient for biodegradation.

The required oxygen is supplied by blowers which are connected with the fine bubble diffusers installed at the bottom of the aeration tanks. The exhaust gas is discharged into the atmosphere via an exhaust line free of back pressure.
The biomass concentration is monitored on-line with an optical sensor and kept constant by automatically controlled removal of sludge from the reactor.
The waste-sewage-water processed in the ROCHEM MBR about 94-97% can be reused as technical water or pumped over board in compliance to MEPC. 227 (64)

REACTORS



ROCHEM MBR

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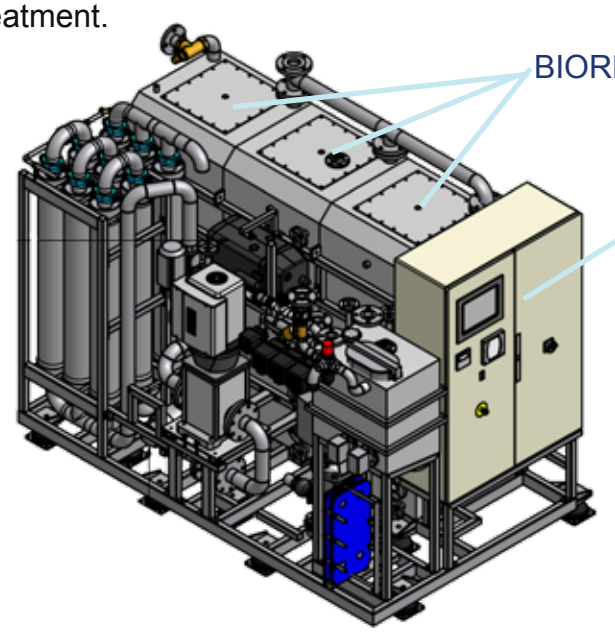
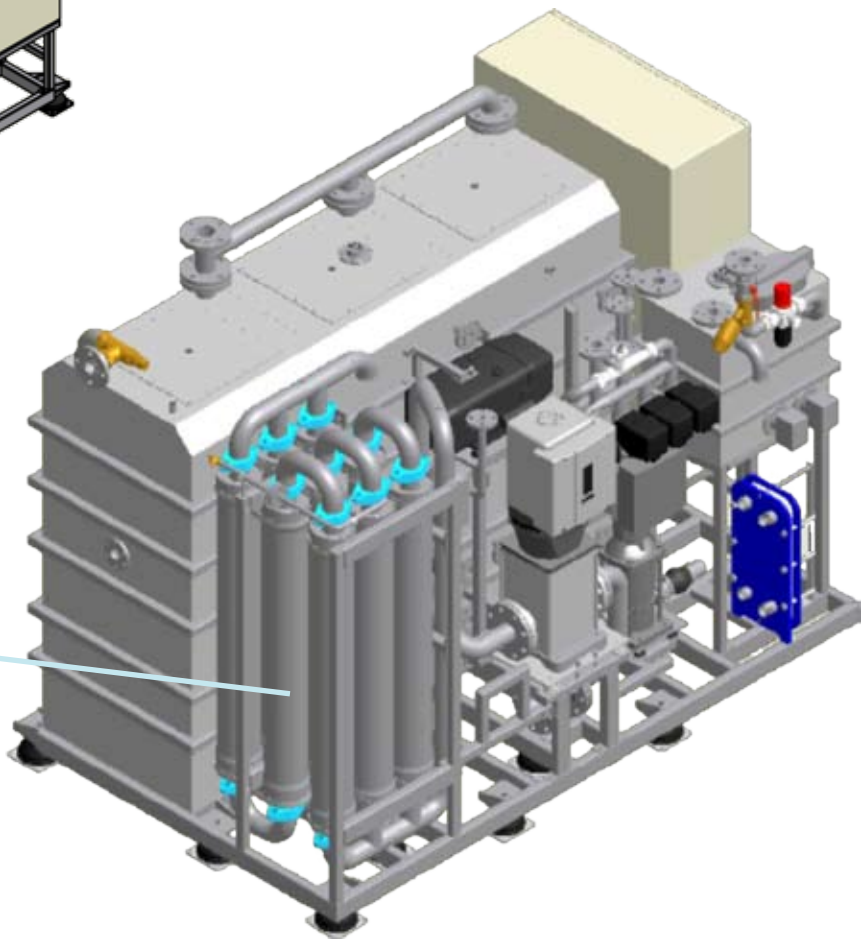
In order to protect the microorganisms from extreme pH values or high salinity, the pH and conductivity in the feed and in the FS loop have to be controlled. If one of the limit values is exceeded, the system has to be stopped and the feed water has to be discharged to the ships biowaste tank or the feed has to be adjusted to the right values.

The waste water has to be collected in an equalizing tank. From the equalization tank, waste water is mechanically cleaned by a vibrational sieve. The selfcleaning vibrational sieve separates solids bigger than 100-150 µm from the influent stream.
The prefiltration is necessary to remove high loads of solids or fibers (like hair and paper waste) which cannot be biodegraded and could block the UF modules. The prefiltered influent is pumped into the bioreactor section. The solid contaminants from the prefiltered water are collected in a small tank and mixed with excess sludge for disposal or further treatment.



ROCHEM- BioFilt 025



ROCHEM®
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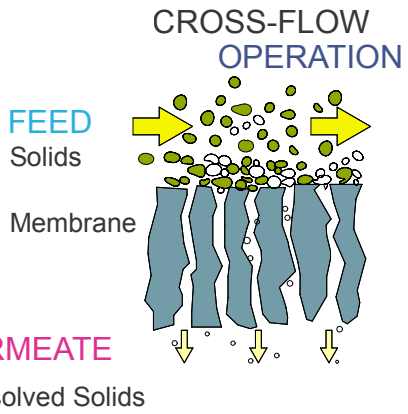
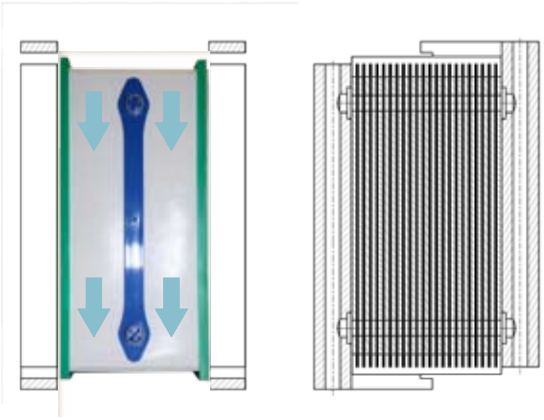


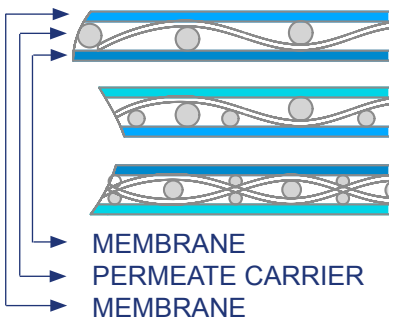


ROCHEM FS modules have been developed especially for the separation of bacteria, viruses and fine solids from water and waste water with high fouling potential. Most importantly, these modules exhibit low specific energy consumption at high and steady-state production.
Ultrafiltration is based on porous membranes.
Particles larger than the pore size of the membranes are rejected.
In practice even smaller particles are rejected because of the selectivity of the filter cake (gel layer) on the membrane surface.
Ultrafiltration membranes form an absolute barrier for bacteria and viruses.

MODULE DESIGN

The feed water is pressurized and sent to the FS module. Pure water permeates through the membrane cushion and then is directed by the drainage rod into the permeate channel of the cartridge half case. The pure water then exits the module out of the permeate hose connectors.
The typical FS module contains up to 10 membrane stacks. Each membrane stack is enclosed inside 2 cartridge half cases. The membrane cushion permeate outlets are sealed from the feed by the spacer strips.
The section drawing shows the flow through the membrane cushions.
The feed flows through the open channel created by the spacers. The feed flow is across the membrane cushions.

DIFFERENT MEMBRANE
DIFFERENT SPACER



Permeate Carrier
Different Types

IMPROVED TECHNOLOGY

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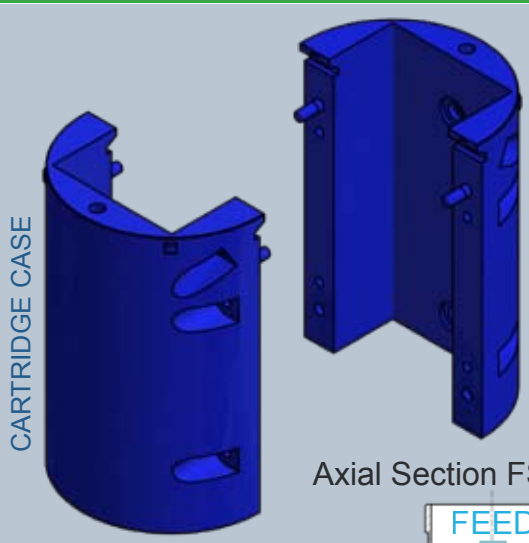
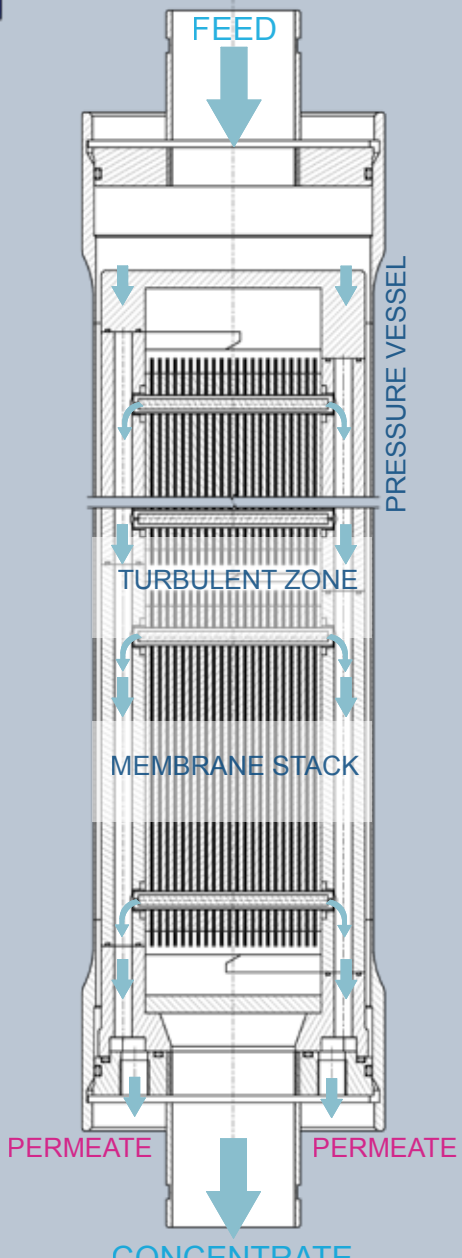
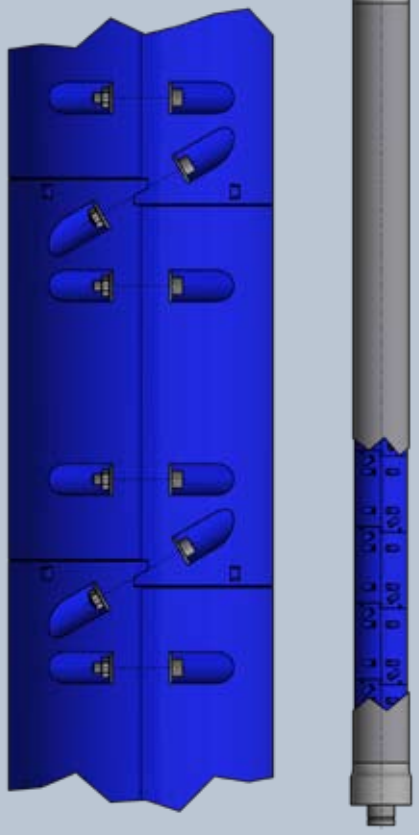
Technical Services

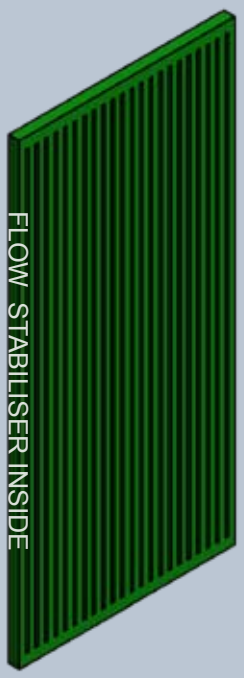
FURTHER DEVELOPMENT OF THE MEMBRANE MODULE

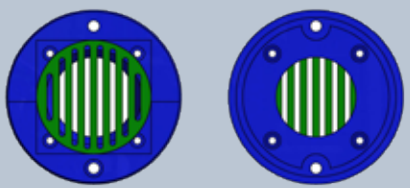


Axial Section FS Module









IMPROVED TECHNOLOGY

ROCHEM® FS-MODULE

ROCHEM®
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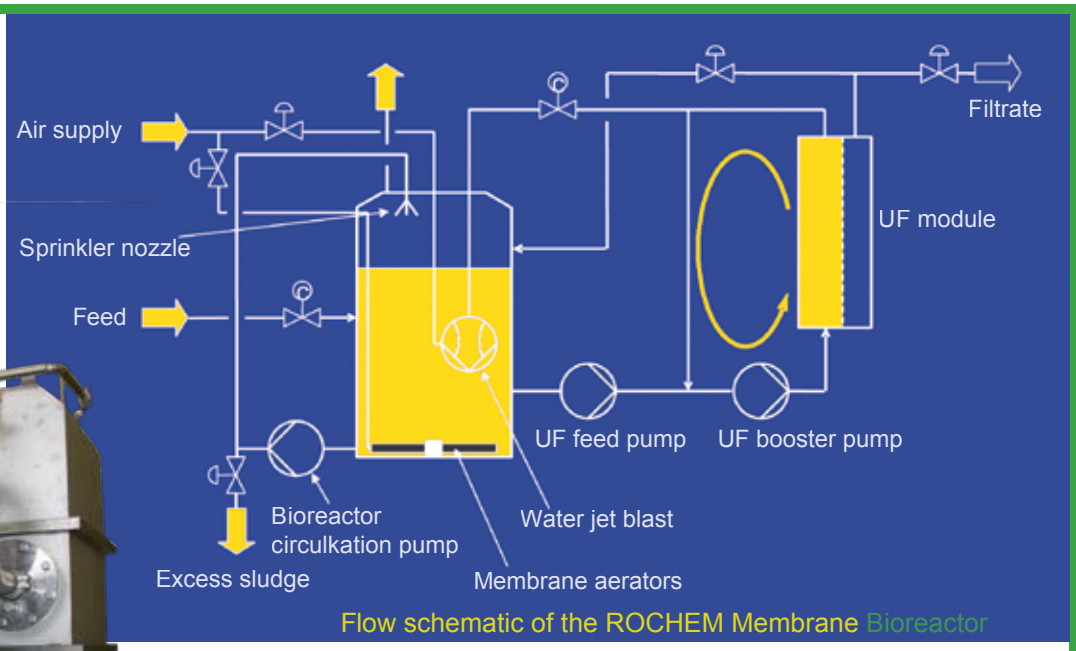

Flow schematic of the ROCHEM Membrane Bioreactor

NEW TYPE APPROVAL

ROCHEM MBR
SEWAGE WATER
Type Approval IMO
MEPC.227(64)

Use the patented Rochem FS Module that has been specially developed to treat highly polluted fluids using the open channel technology.

TEST UNIT FOR
TYPE APPROVAL

ROCHEM® Membrane Bioreactor

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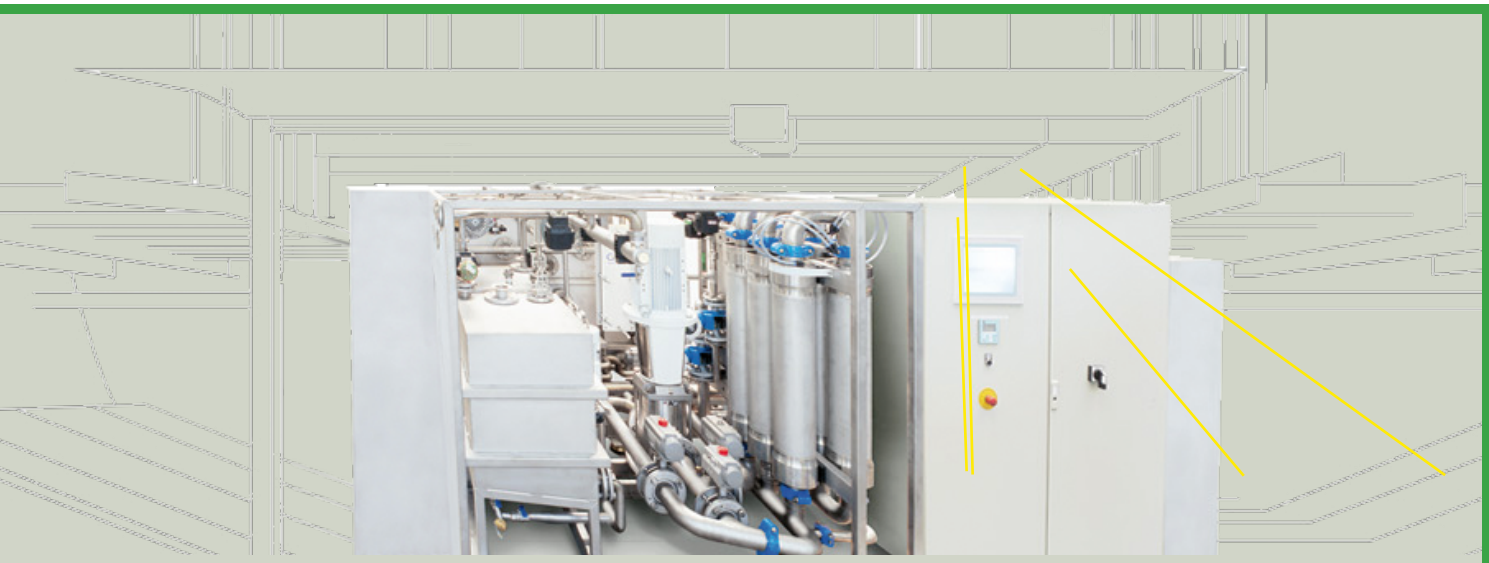
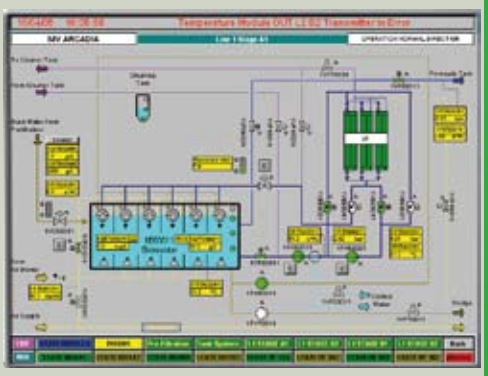


The function of the bioreactor is monitored by two parameters:



- Dissolved oxygen concentration (DO)
- Biomass dry weight (MLSS)

At start-up, the DO is in approximate equilibrium with air, at a value of 7–8 mg O_2/L. Moving towards the nominal operating mode, it decreases to 1–2 mg O_2/L, indicating the microbial oxygen consumption. The oxygen demand varies with the flow rate and composition of the sewage feed.
In order to remove nitrogen biologically through nitrification and denitrification, concentrate from the UF filtration loop is recirculated to the denitrification tank (anoxic tank).
During the anoxic period, bacteria use the oxygen from the nitrate and convert it into nitrogen gas, which will be discharged through ventilation.

$NH_3 + 2\ O_2 \Rightarrow NO_3^- + H^+ + H_2O$ (Nitrification)
$2\ NO_3^- + 2\ H^+ \Rightarrow N_2 + 5\ [O] + H_2O$ (Denitrification)

In order to remove phosphorus, chemical phosphorus removal was applied. Iron salts and aluminum salts can be used for phosphorus removal.

$Fe^{3+} + PO_4^{3+} \Rightarrow Fe(PO_4)$
or
$Al^{3+} + PO_4^{3+} \Rightarrow Al(PO_4)$

HMS Enterprise

ROCHEM®
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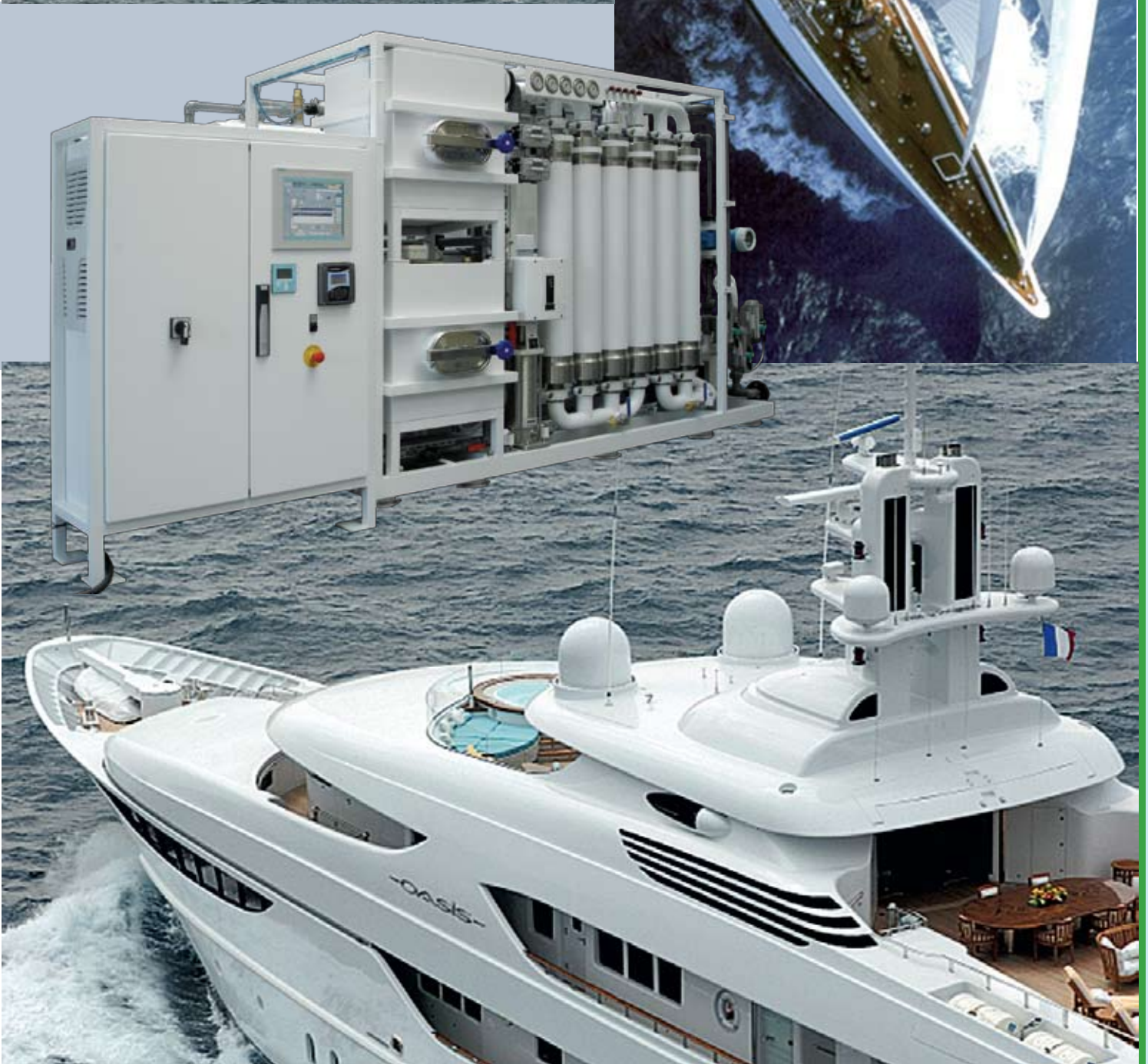

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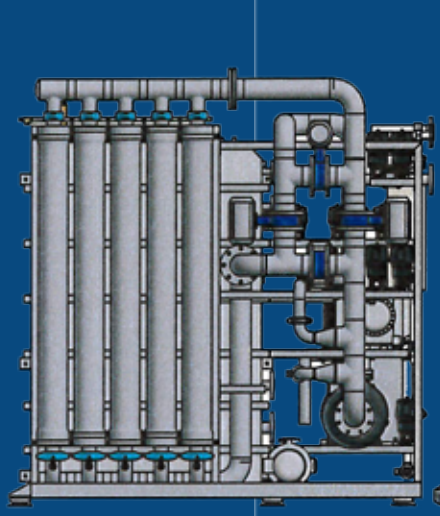
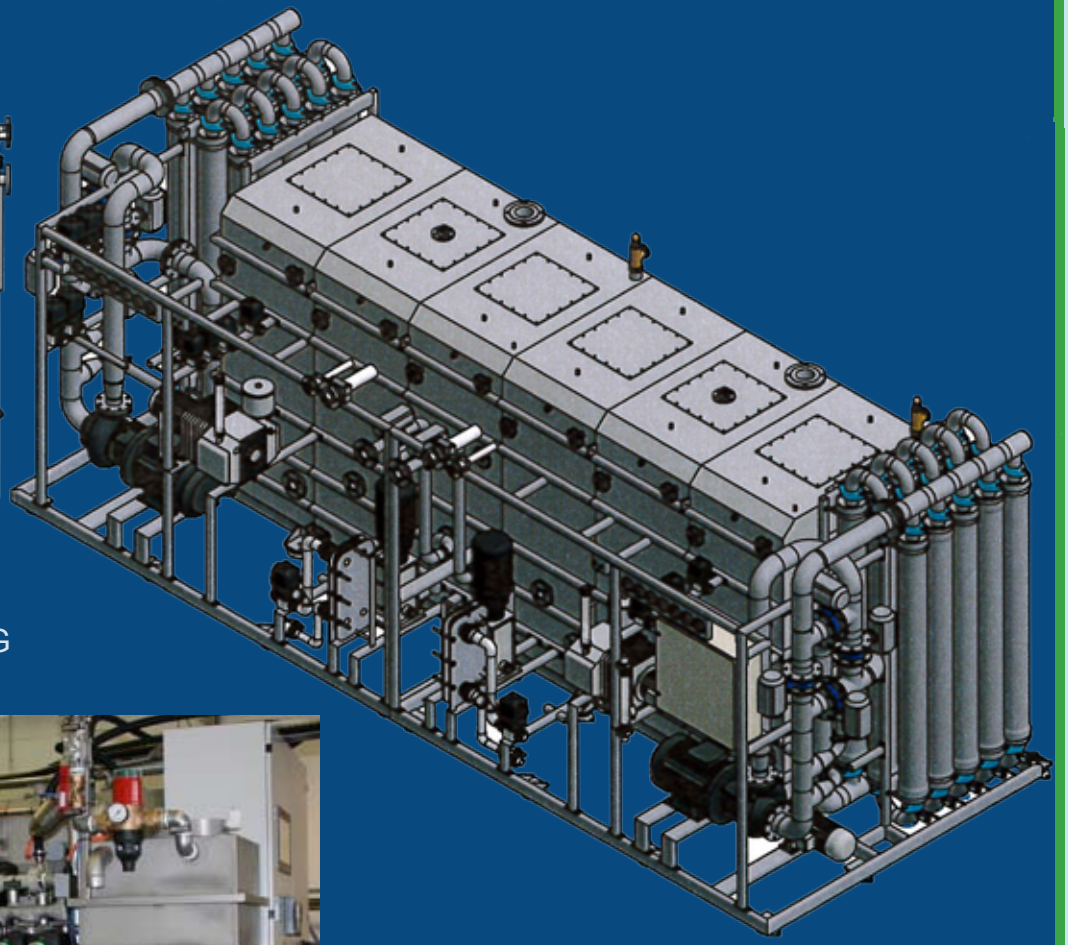
READY FOR FAT FACTORY ACCEPTANCE TEST





ALL UNITS ARE BUILT
AND TESTED IN HAMBURG

The main components of the RTS ROCHEM black and grey water treatment plant are the bioreactor segments and the ultrafiltration modules, which form an elegant combination of the well-known and widely applied activated sludge process

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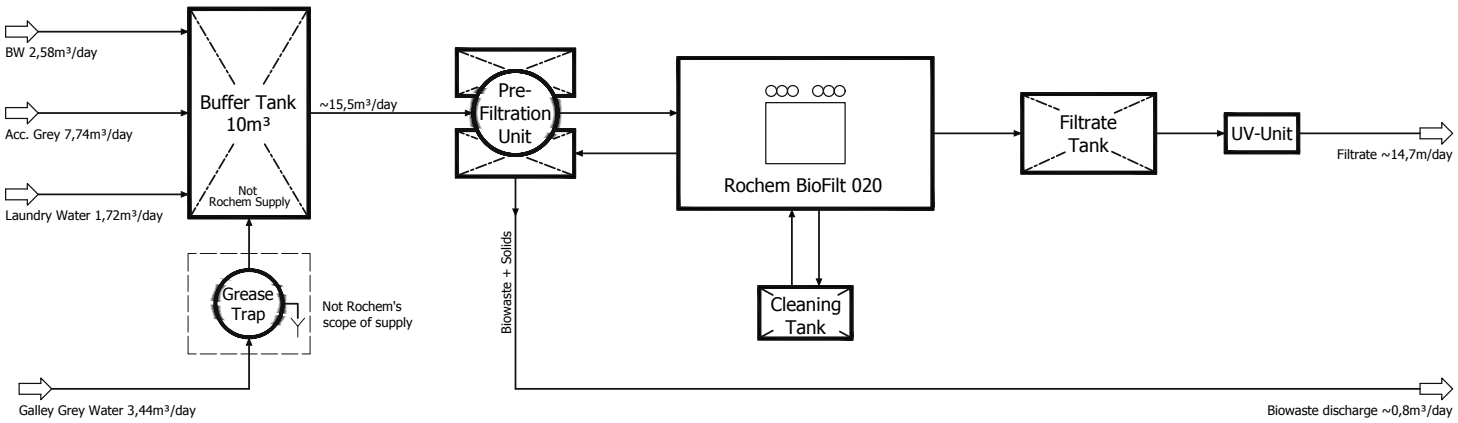
LINE DIAGRAM OF ROCHEM MBR



AVAILABLE MEMBRANES WITH ROCHEM FS MODULE:

MF MICROFILTRATION
UF ULTRAFILTRATION
NF NANOFILTRATION
RO REVERSE OSMOSIS

WITH ROCHEM MBR

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OCEAN LINE

ROCHEM®
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The Rochem MBR system has been examined and satisfactorily tested in accordance with the International Maritime Organization resolution and complied with resolution MEPC.227(64)
Analytical results achieved during type approval test run with ROCHEM MBR system

Parameters	MEPC. 227(64)	ROCHEM MBR type approval
pH	6,0 - 8,5	6,0 - 8,5
Fecal Coliform (CFU/100mL)	100	1
BOD5 (Biological Oxygen Demand)(mg/l)	25	<10
COD (Chemical Oxygen Demand) (mg/l)	125	25
TSS (Total Suspended Solid) (mg/l)	35	5
Residual Chlorine	0,5 (mg/l)	0

The Rochem MBR system has been examined and satisfactorily tested in accordance with the International Maritime Organization resolution and complied with resolution MEPC.227 (64) for special areas.
Analytical results achieved during type approval test run with ROCHEM MBR system

Parameters	MEPC. 227 (64) incl.Annex IV SA	ROCHEM MBR type approval
pH	6,0 - 8,5	6,0 - 8,5
Fecal Coliform (CFU/100mL)	100	1
BOD5 (Biological Oxygen Demand)(mg/l)	25	3
COD (Chemical Oxygen Demand) (mg/l)	125	20
TSS (Total Suspended Solid) (mg/l)	35	3
Residual Chlorine	0,5 (mg/l)	0
TN (Total Nitrogen) (mg/l)	20 or ≥ 70% reduction	12 or ≥ 80% reduction
TP (Total Phosphors) (mg/l)	1 or ≥ 80% reduction	< 0,03 or > 99% reduction

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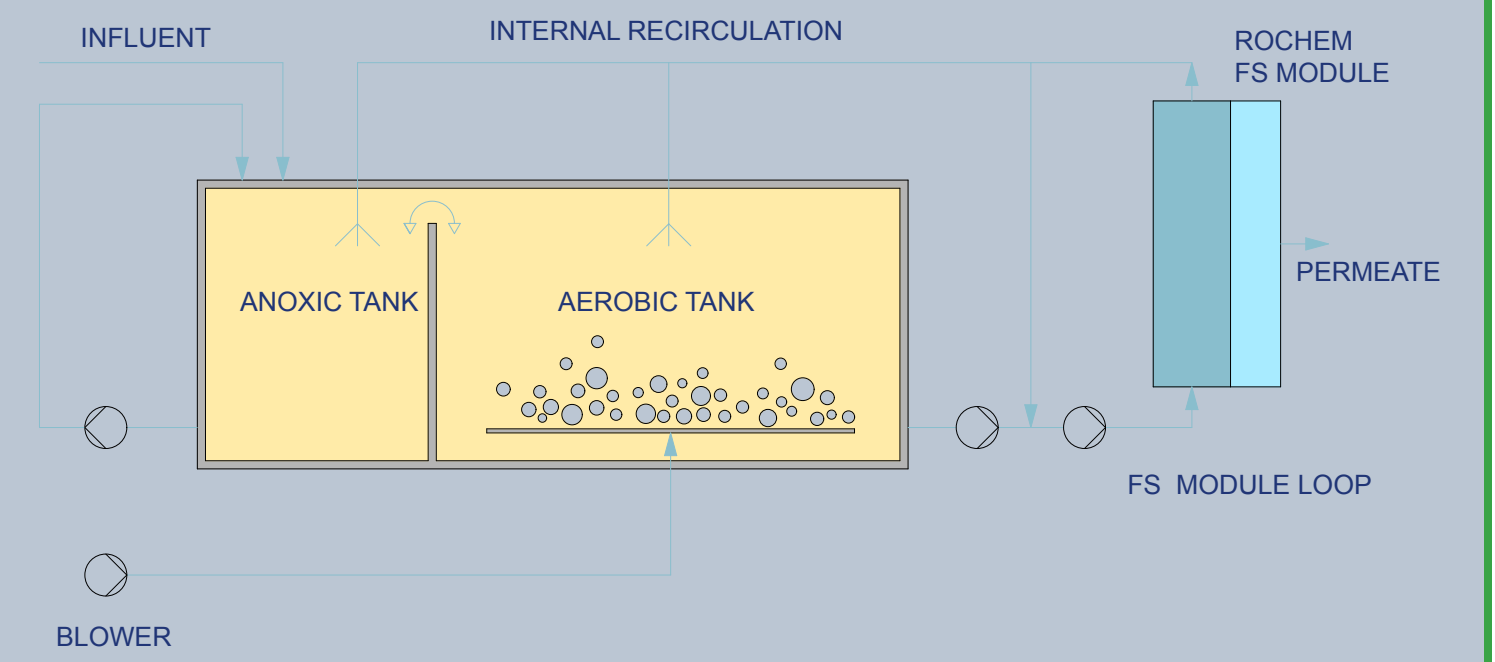

HOLLAND AMERICAN LINES

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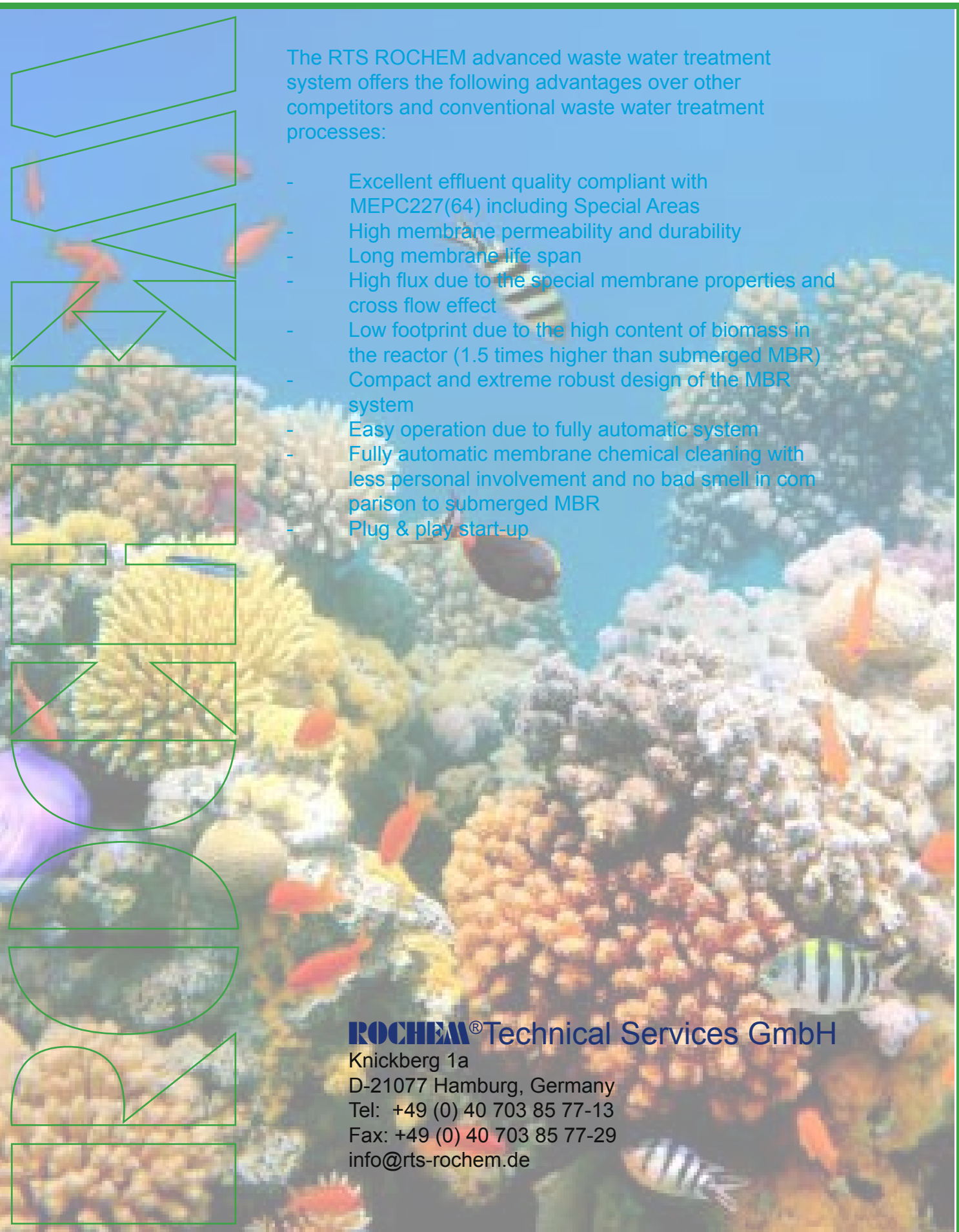
Technical Services



The RTS ROCHEM advanced waste water treatment system offers the following advantages over other competitors and conventional waste water treatment processes:

- Excellent effluent quality compliant with MEPC227(64) including Special Areas
- High membrane permeability and durability
- Long membrane life span
- High flux due to the special membrane properties and cross flow effect
- Low footprint due to the high content of biomass in the reactor (1.5 times higher than submerged MBR)
- Compact and extreme robust design of the MBR system
- Easy operation due to fully automatic system
- Fully automatic membrane chemical cleaning with less personal involvement and no bad smell in com parison to submerged MBR
- Plug & play start-up

KEEP THE OCEAN CLEAN

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