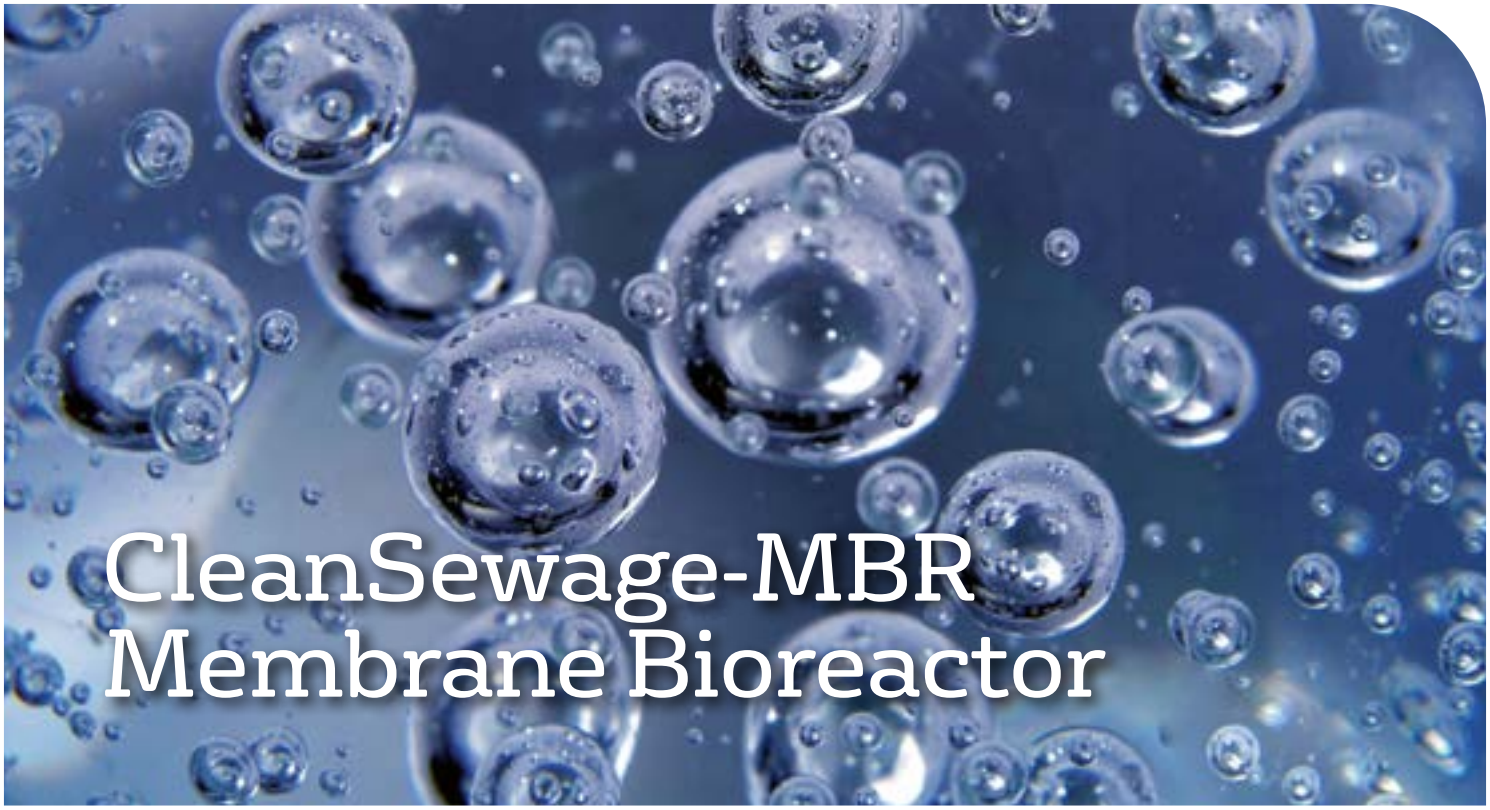


CleanSewage-MBR Membrane Bioreactor

RWO

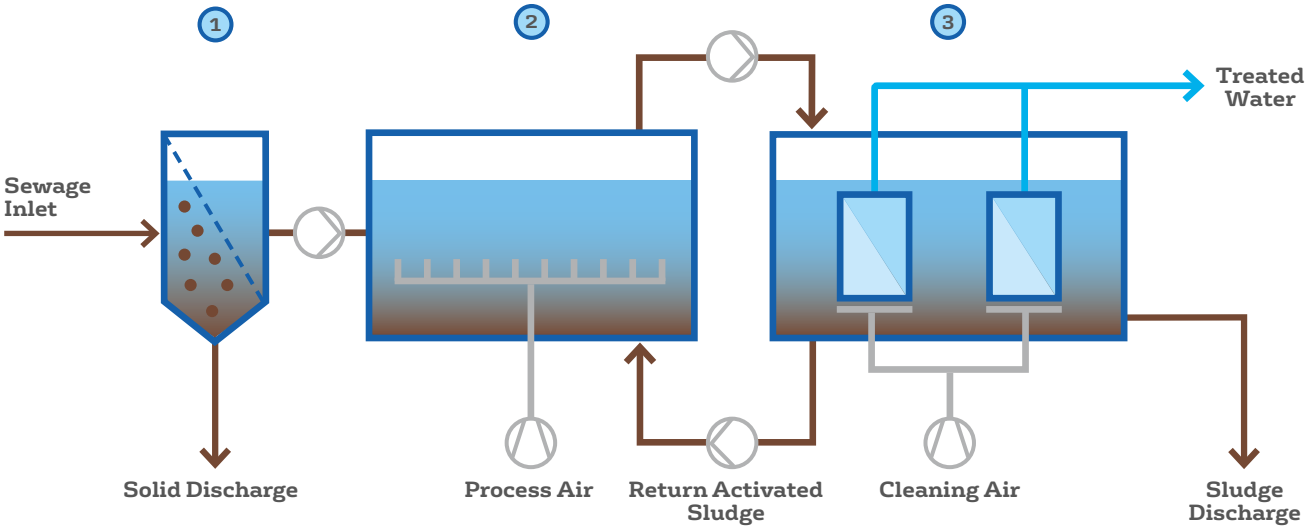
Advanced Wastewater Treatment for Passenger Ships

With the CleanSewage Membrane Bioreactor (CS-MBR) RWO has developed an advanced waste-water treatment (AWT) system fit for the requirements of sustainable passenger shipping as well as other high-standard applications. The CS-MBR is type approved according to the regulation IMO MEPC.227(64) including chapter 4.2 for nitrogen and phosphorus removal within special areas.

CleanSewage Membrane Bioreactor: Advanced Water Treatment from RWO

Sustainable Biological Treatment

CS-MBR is the successor of the MEMROD-Series, RWO's renown advanced water purification plant, with higher effluent quality and several operational advantages. The treatment process is divided into three steps: Solids are removed in the mechanical pre-treatment, pollutants are degraded in the biological stage and in a last step, a membrane barrier ensures absolutely reliable separation of solids, including microplastics. The submerged membrane system with extremely high mechanical strength and automated cleaning mechanism control make CS-MBR easy to operate and ensure long lifetime. The biological treatment process offers low OPEX due to low energy demand, low use of chemicals and thus a low production of solid byproducts/wastes.



1 = Mechanical Pre-Treatment

2 = Bioreactor

3 = Membrane Reactor

How it Works

The CS-MBR is based on a sustainable biological treatment technology that can be divided into three major process stages:

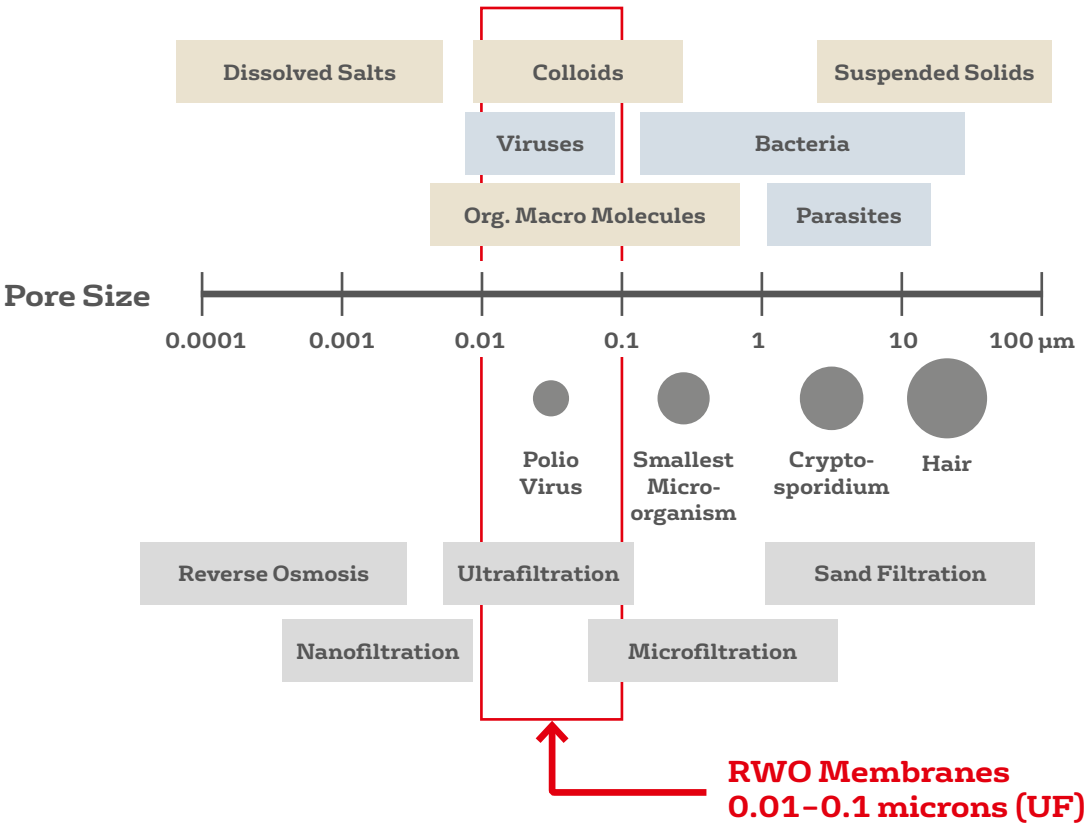
- Mechanical pre-treatment
- High Performance Activated Sludge Biological Treatment
- Submersed Ultrafiltration (UF)

These modular technologies can be combined and scaled to meet individual customer requirements.

1. In the first stage, solids are removed from all incoming waste waters (blackwater, greywater from galley, accomodation, laundry, etc.). Grease separation for the galley water treatment can be added on demand.

2. The second stage consists of a high performance activated sludge process: Controlled by intelligent aeration design, bacteria remove organic pollutants, nitrogen and phosphorus from the wastewater. To achieve minimum phosphorus concentrations in the effluent, excess phosphorus is precipitated by adding coagulant.

3. In the third stage of the process, the clean water is separated from the activated sludge via a submerged membrane. While the water can pass through the membrane, sludge, bacteria, viruses and microplastics are held back as shown below. The result in downstream water is clear, free of solids and already disinfected.



Key Features & Benefits

MEPC 227 (64) compliant including special areas

- Certificate of Type Approval for Sewage Treatment Plants according IMO MEPC.227(64) issued under the authoity of the Federal Republic of Germany by BG Verkehr

Low Footprint

- Due to high performance activated sludge process and integrated solid separation

Minimum Maintenance Work

- Automated membrane cleaning
- extremely high mechanical strength of the membranes
- Safe process design
- User-friendly and intuitive operation

Sustainability and low OPEX

- Membrane barrier removes more than 99 % of solids including microplastic
- Removal of bacteria and viruses – no chlorination needed
- No use of flocculants or chemicals for disinfection necessary
- Low energy consumption and decreased use of chemicals
- Low excess sludge production

CS-MBR is designed to minimize your vessel's impact on the marine environment. The advanced water treatment plant provides highest effluent qualities as described in table (see table) and thus exceeds the requirements of the International Marine Organization (IMO MEPC.227(64) incl. 4.2).

With our disinfection – add-on, even higher effluent standards as for example required for discharge in marine waters of the state ALASKA. Additional class notations like BV Clean, BV CleanSuper, DNV-GL CleanDesign and AWT-A/B can be issued on request.

Parameter	COD	BOD	TSS	TC	pH	TN	TP
Description	chemical oxygen demand	biological oxygen demand	total suspended solids	thermo-tolerant coliforms	–	total nitrogen	total phosphorous
Unit	mg/l	mg/l	mg/l	cfu/100 ml	–	mg/l	mg/l
Value	50	≤ 5	≤ 5	100	6.5–8.5	≤ 20	≤ 1

CS-MBR effluent quality exceeding IMO MEPC 227(64) requirements for special areas.