

## Membrane BioReactor

Grey and Black Water Treatment

# Leaders in environmental solutions for ships



Picture courtesy of P&O Princess Cruises

The increased size and number of cruise ships has led to concerns on the impact of their waste discharges on the natural environment.

Hamworthy has met the challenge of protecting the environment head-on. The Membrane BioReactor (MBR), is based on biological degradation and membrane separation. This process produces the highest quality discharge without requiring any addition or generation of chemicals that are hazardous to the environment or ship operation.

Effluent quality tests conducted by the US National Sanitary Foundation on Hamworthy's MBR produced results exceeding the most stringent future legislative pollutant standards envisaged (page 4).

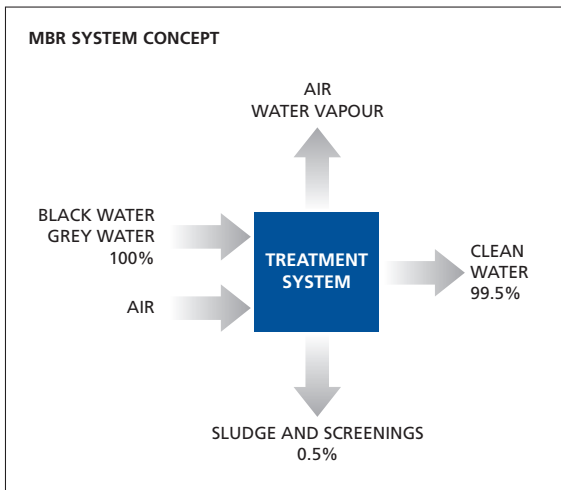
With over 30 years experience in wastewater treatment, Hamworthy is ready to serve the needs of the marine industry and the environment.



Typical MBR installation

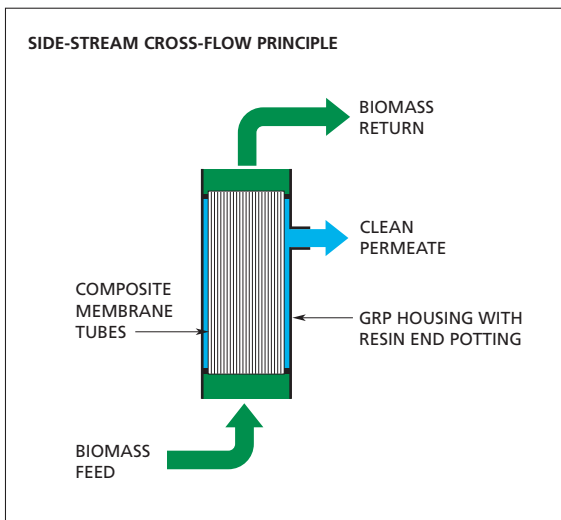
## Proven technology

Hamworthy has over 7000 conventional sewage plants in operation around the world, more than any other supplier. The innovative MBR system is an evolution of the proven sewage treatment plant technology, which allows for the treatment of grey and black water to satisfy the most stringent standards.



## MBR system benefits

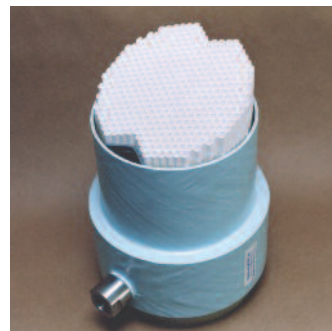
- IMO and USCG certified.
- Simple design comparing to physical chemical systems and hybrid systems.
- Simple operation requiring low skill levels.
- Safe, reliable operation with no coagulation, flocculation, chemical oxidants, or pH neutralisation.
- Compact design saving space and weight.
- Robust construction for long life and low maintenance.
- Membrane integrity is visible and secured.
- No odour emissions due to biological process.
- Complete flexibility with newbuild, conversion and retrofit options.
- One supplier, one complete system.



## Ultrafiltration membrane modules

The MBR systems utilise side-stream cross-flow membrane configuration. The membrane module has robust GRP housing perfectly suited for ship board environment.

The module contains large numbers of ultrafiltration membrane tubes designed to achieve very high permeate production under the cross-flow scouring velocity with minimum risks of any blockage.



Sectional membrane module

# Market drivers



## Regulatory

- IMO Regulations for the quality of black water discharges.
- USCG/EPA indications that grey water discharges will be regulated and monitored.
- NATO navy strategy for environmentally sound warships.
- Indication that discharge consents for offshore platforms will be aligned with marine standards.
- Other national and regional regulatory requirements.

## Customer requirements

- Meet and exceed the likely regulatory requirements for both new and existing installations.
- Maintain a more proactive public image.
- Minimisation of size and weight.
- Lowest possible cost of ownership.

## Effluent discharge quality comparisons

Independent test results recorded by the US National Sanitary Foundation show that effluent quality standards are far in excess of those required by International standards.

Item	Units	USCG 33CFR 159 PT1-300	IMO MEPC.2 (vi)	USCG/Alaska 33CFR 159.309	Hamworthy Test Results
Test Duration	-	10 days	10 days	30 days	31
Suspended Solids	mg/l	150	50 (100 at sea)	30	3.1
BOD <sub>5</sub>	mg/l	Not required	50	30	2.6
Faecal Coliform	Count/100ml	200	250	20	10.6
pH	-	Not required	Not required	6.0 - 9.0	Within limits
Chlorine	µg/l	Not required	As low as practicable	10.0	0

Hamworthy continues to optimise the MBR system design. By building on our successful experiences and working closely with customers, we have successfully rolled out the MBR Mk II and Mk III systems across wider marine and offshore sectors, with reduced energy consumption, costs and importantly, operational man-hours.

## Features of MBR performance

Hamworthy MBR technology achieved outstanding performance in Alaska under the scrutiny of the local authority, USCG and USEPA studies over the past seasons. The membrane permeate quality exceeds the most stringent coliform standards even without additional UV or chemical disinfection. According to the independent USEPA Cruise Survey in 2004, this simple system readily removed over 70% of total Nitrogen and Phosphorus. The latest system optimisation have achieved over 25% savings on energy consumption and consumables, and over 50% reduction in operational man-hours. Satellite communication allows the MBR systems to be remotely monitored by specialists as part of our fleet support program.

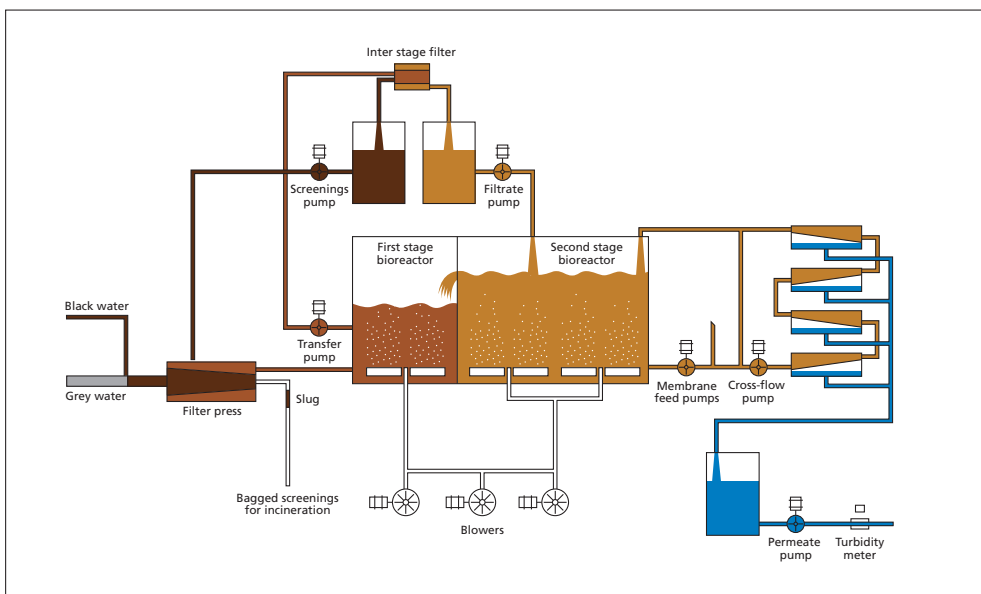
## Principles of operation

Black and grey water passes through the automatic screen press into the first stage bioreactor where the active biomass degrades organic material. The active biomass is pumped through an interstage filter fitted with fine mesh.

The filtered biomass, free of any fibrous materials, is returned into the second stage bioreactor. Biomass is circulated through membrane modules to produce a trans-membrane pressure and scouring velocity. Clean permeate is taken from the membrane modules. The concentrated biomass is returned to the second stage bioreactor for discharge. The system is automated.



MBR control panel



# Complete flexibility

Following the successful introduction of our advanced wastewater treatment technology Hamworthy has established a rapidly growing installation base all supported by our team of wastewater treatment specialists who are there to help you design your bespoke system.



P&O Princess Cruises' *'Sun Princess'*



Radissons *'Seven Seas Navigator'*



MoD Type 45 Destroyer

## Cruise Newbuilding and Conversion

A total of thirteen vessels in the *'Carnival Cruise Lines'* fleet have been converted to utilise MBR technology for black and grey water treatment.

In addition two vessels in the *'Regent Seven Seas'* fleet and one vessel in the *'Royal Caribbean International'* fleet have been retrofitted with MBR units.

The Cunard *'Queen Victoria'* and the Holland America *'Signature'* newbuilds at Fincantieri Shipyard, Italy plus the *'Aida'* newbuilds at Meyer Werft Shipyard, Germany have been fitted with Hamworthy MBR technology.

Two newbuilds for *'Seabourn Cruises'* at Mariotti Shipyard, Italy are to be fitted with Hamworthy MBR technology.

Independent testing of the effluent has enabled certification to be issued to allow overboard discharge in Alaskan waters.

## Ferries

The *'British Columbia Ferries'* newbuild at Vancouver Shipyard is currently being fitted with MBR technology.

## Offshore

The semi-submersible drilling rig *'Dada Gorgud'* operated by Caspian Drilling Company and owned by SOCAR has been retrofitted with MBR technology.

## Military Newbuild

Hamworthy has been contracted to supply advanced MBR wastewater treatment systems to the MoD for the Type 45 Destroyers being constructed at BAE Marine at Scotstoun and Vosper Thornycroft at Portsmouth. Hamworthy is among the first Tier 1 companies to be awarded contracts on all six vessels.

We have just completed final plant design and received design approval for Hamworthy MBR technology for the Royal Navy's aircraft carrier project. Should the Ministry of Defence award the contract then Hamworthy will receive these orders.

Hamworthy MBR wastewater treatment systems, which will handle both black and grey water, are being fitted in anticipation of more stringent environmental legislation during the vessels lifetime.

## Professional

# project management

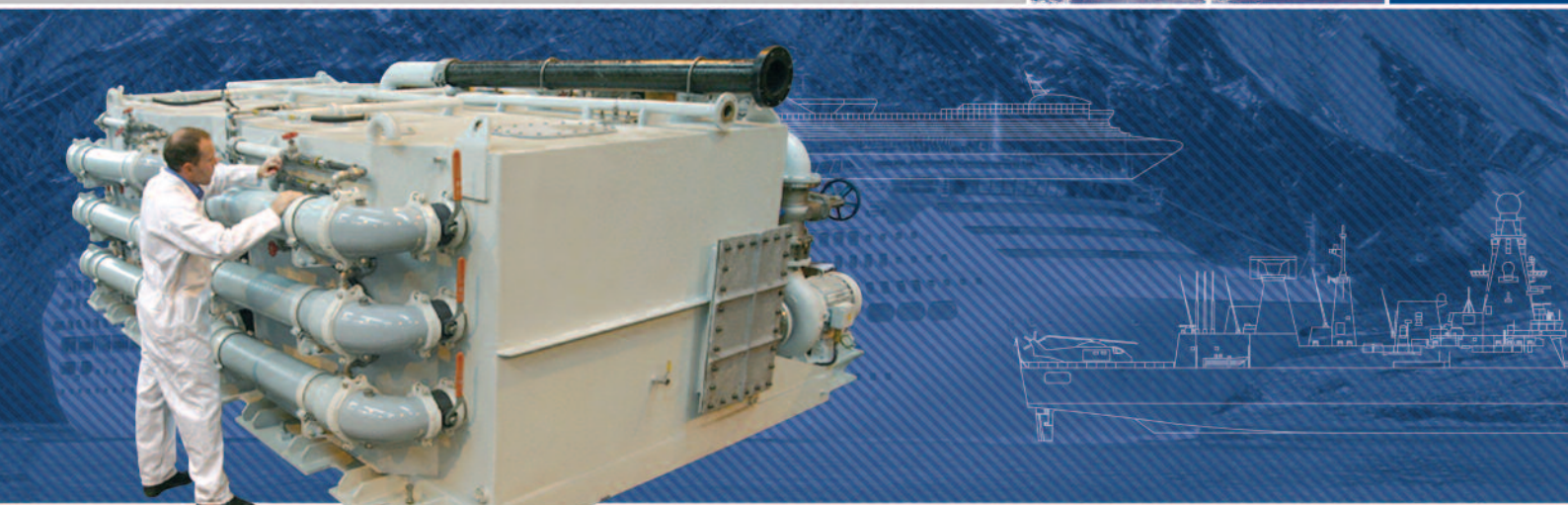
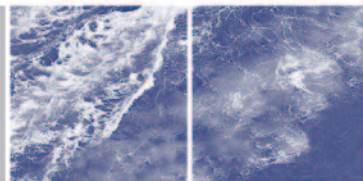
Assistance will be given to ensure complete project control from conception through to operation and service support.



- Initial installation survey
- Feasibility study to identify all options
- Replace or modify existing plant
- Supply equipment
- Provide/supervise installation
- Commissioning/IMO certification assistance
- Troubleshooting
- Spares and maintenance

## MBR Reference List

Ships Name/Hull No.	Installation Type	Complement	Capacity (m <sup>3</sup> /Day)
HMS Daring	Newbuild	235	100
HMS Dauntless	Newbuild	235	100
HMS Diamond	Newbuild	235	100
HMS Dragon	Newbuild	235	100
HMS Defender	Newbuild	235	100
HMS Duncan	Newbuild	235	100
Dada Gorgud	Conversion	120	40
Safe Astoria	Replacement	250	82
Seven Seas Navigator	Replacement	811	300
Seven Seas Mariner	Replacement	1200	480
Star Princess	Conversion	4400	960
Diamond Princess	Conversion	4400	960
Sapphire Princess	Conversion	4400	960
Coral Princess	Conversion	3500	640
Island Princess	Conversion	3500	640
Dawn Princess	Conversion	2920	720
Sun Princess	Conversion	2920	720
Pacific Princess	Replacement	1150	320
Regal Princess	Conversion	2419	400
Pacific Sky	Replacement	2200	480
Ocean Village	Replacement	2000	240
Queen Victoria	Newbuild	2200	620
Hull 681 Mega Yacht	Newbuild	120	17
Aida 1	Newbuild	3134	1200
Aida 2	Newbuild	3134	1200
Aida 3	Newbuild	3134	1200
Aida 4	Newbuild	3134	1200
Grand Princess	Conversion	4160	640
Century	Replacement	2600	960
Golden Princess	Conversion	4160	960
Eurodam	Newbuild	2800	720
BC Ferry	Newbuild	600	15
MAR 062	Newbuild	800	280
MAR 063	Newbuild	800	280
MAR 064	Newbuild	800	280
H6181	Newbuild	2800	720



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