Report
"Sewage treatment plants"

Project

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Our reference	: 461300
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Client	Contractor
Human Environment and Transport Inspectorate Ministry of infrastructure and the environment Postbus 8634 3009 AP ROTTERDAM	Hatenboer-Water b.v. Postbus 6013 3002 AA ROTTERDAM

Contact persons

Mr. M. Vink	Mr. P.W. Hatenboer Ir. C.W. Aeijelts Averink Ms. T.A. den Dunnen

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1. General

1.1. Introduction

The Netherlands Shipping Inspectorate has requested Hatenboer-Water to start a research project implementing the quality of sewage water after treatment with a sewage treatment plant.

The MARPOL IV and the appropriate resolution MEPC.159 (55) and MEPC.2 (V) are the guidelines for sewage treatment recorded. However, there is reason to believe that, despite the presence of sewage treatment plants, the quality of sewage water after treatment often does not meet the requirements described in the MARPOL IV.

1.2. Project team

The responsible persons within the project team of the contractor:

Management	Mr. Ir. C.W. Aeijelts Averink
Project leader	Miss T.A. den Dunnen
Laboratory	Mr. Ir. R. Westra
Coordination implementation	Miss M. Vis
Sample taker(s)	Mr. J. van der Vlugt and/or expert and experienced replacement(s)

1.3. Company information

Hatenboer-Water is a sister company of Hatenboer-Neptunus which supplies fresh drinking water to ships in the Port of Rotterdam since 1906. Hatenboer-Water is active since 1972 as an independent company with specialized water treatment products and equipment for the maritime sector. Our Water Quality Dept. is dedicated to ensure safe water for the (inter)national maritime industry including offshore, by performing analyses, monitoring, risk assessments and management plans, including legionella control. We are familiar with all common facilities and operational conditions and serve our customers with products, equipment and advise worldwide.

Analyses are performed for this project by our partner Aqualab. All in full compliance with the guidelines of the Accreditation Council, the so-called STERLAB criteria. The laboratory is registered in the STERLAB - register under number L081 laboratories in areas as specified in the approval. The Aqualab laboratory is state of the art, providing detailed analyses swiftly.

2. Purpose & Conditions

2.1. Goals

The Netherlands Shipping Inspectorate wishes field information of treated sewage water quality related to various types of sewage treatment systems.

2.2. Definitions

Sewage: raw sewage before treatment
Sewage water: effluent from the sewage treatment plant

2.3. Conditions

In the scope of the assignment it was decided to take water samples on board of 50 different vessels. The following objects were selected.

Table 1 Selected vessels

Type vessels	Number of vessels
Offshore Support vessels	5 vessels
General Cargo vessels	15 vessels
Tankers	10 vessels
Ferries	5 vessels
Containers vessels	15 vessels

The names of the vessels which participated in the survey are considered to be classified and therefore kept anonymous.

2.4. Actual tested objects

Of the 50 vessels selected, 32 vessels were actually tested. The test was prematurely ended because none of the 32 sewage water samples did meet the standard as mentioned in the Marpol IV.

Table 2 Tested vessels

Type vessels	Amount of vessels
Offshore support vessels	5 vessels
General Cargo vessels	7 vessels
Tankers	10 vessels
Ferries	2 vessels
Containers vessels	8 vessels

3. Analyses parameters

The sewage water samples are taken after treatment with the sewage treatment plant and the following parameters are analysed:

- Thermotolerant coliform bacteria
- Suspended solids
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- pH (acidity)
- Chlorine residue

The Marine Environment Protection Committee (MEPC) at its 55th session in October 2006 adopted revised *Guidelines on implementation of effluent standards and performance tests for sewage treatment plants* (see resolution MEPC.159(55)). The revised guidelines, which will apply to sewage treatment plants installed onboard on or after 1 January 2010, replace the *Recommendation on international effluent standards and guidelines for performance tests for sewage treatment plants* adopted by resolution MEPC.2(VI) in 1976.

3.1. Thermotolerant Coliform Bacteria

Analyses are carried out according to NEN 6570

Coliform bacteria, specially the subgroup of thermotolerant or faecal coliforms, are widely used to evaluate the effect of wastewater disinfection processes. Reduction of thermotolerant coliforms is correlated with total chlorine residual.

3.2. Total Suspended Solids

Analyses are carried out according to NEN EN 872

Domestic wastewater usually contains large quantities of suspended solids that are organic and inorganic in nature. These solids are measured as **Total Suspended Solids or TSS** and are expressed as mg TSS/ litre of water. There are several ways to reduce TSS in wastewater. The simplest is the use of a septic tank effluent filter. The filter prevents passage of floating matter out of the septic tank and, as effluent filters through the slots, fine particles are also caught. Many types of alternative systems are also able to reduce TSS, usually by the use of settling compartments and/or filters using sand or other media.

3.3. Biological Oxygen Demand

Analyses are carried out according to NEN –EN 1899-1 (equal ISO 5815:1989 MOD)

Biochemical oxygen demand or BOD is a procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at a certain temperature over a specific time period. It is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. It is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water.

BOD can be used as a gauge of the effectiveness of wastewater treatment plants.

BOD has traditionally been used to measure the strength of effluent released from conventional sewage treatment plants to surface waters or streams. This is because sewage water high in BOD can deplete oxygen in receiving waters, causing fish kills and ecosystem changes.

Because BOD serves as a food source for microbes, BOD supports the growth of the microbial biomat. A healthy biomat is desirable because it is capable of removing many of the bacteria and viruses in the sewage water. The bacteria in a healthy biomat also digest most of the remaining BOD in the sewage. Too much BOD however, may cause excessive growth of bacteria in the biomat.

3.4. Chemical Oxygen Demand

Analyses are carried out according to NEN 6633

Chemical Oxygen Demand (COD) is the amount of oxygen required to oxidize the organic carbon completely to CO2 and H2O. Some organic chemicals are not completely oxidized.

A COD value greatly exceeding the BOD value indicates that the sample contains large amounts of organic compounds that are not easily biodegraded.

3.5. pH

Analyses are carried out according to NEN 6411 (equal NEN-ISO 10523)

Generally, wastewater organisms in biological treatment systems function best at pH values ranging from 6.5 to 8.0. Chlorination is most effective at low pH, and wastewater in sewage collection systems should be maintained at a value close to 7.0.

3.6. Chlorine residu

Remaining concentrations of oxidizing hypochlorous acid and hypochlorite ions may be measured as chlorine residual to estimate effectiveness of disinfection or to demonstrate safety for discharge to aquatic ecosystems.

4. Description sewage treatment systems

4.1. General information

Ships produce waste water in two categories: grey wastewater from sinks, laundries, and showers, and black wastewater containing sewage. International maritime laws require black waste water to be treated before discharge overboard into the sea is allowed. Treatment of waste water can be carried out separately for grey and black waste water, or both streams can be processed by a shared system. There are several modern types of equipment for treating the wastewater, and these are supplied as a complete unit, ready for installation in the engine room.

Formerly all wastewater was collected in a tank and pumped overboard if the vessel was outside the stipulated 12 mile distance from any coastline.

The discharge of sewage into the sea can create a health hazard, while in coastal areas, sewage can also lead to oxygen depletion and an obvious visual pollution - a major problem for countries with large seashore-based tourist industries.

4.2. The (health) risks of untreated sewage entering the environment

Sewage may affect the marine environment in three main ways; through oxygen depletion, by causing disease and by nutrient enrichment

- Oxygen depletion: When sewage decomposes it uses up oxygen from the surrounding water and if the discharged concentration is to high, the amount of oxygen available for fish and other aquatic animals and plants will be insufficient and leading to morbidity.
- Disease: Sewage contains pathogenic bacteria and viruses which pose a risk to public health for swimmers and those eating contaminated shellfish.
- Nutrient enrichment: Sewage discharges contain nutrients which will increase algae and plant growth under certain background conditions. For example, when present in high concentrations, nutrients can be responsible for the formation of algal blooms which reduce light penetration through the water column. These algae may produce toxins and can cause oxygen depletion when decomposition takes place.

4.3. Regulations

4.3.1. Annex IV of MARPOL

Annex IV contains regulations regarding the discharge of sewage into the sea, ships equipment and systems for the control of sewage discharge, the provision of facilities at ports and terminals for the reception of sewage, and requirements for survey and certification. It also includes a model International Sewage Pollution Prevention Certificate to be issued by national shipping administrations to ships under their jurisdiction.

It is generally considered that on the high seas, the oceans are capable of assimilating and dealing with sewage through natural bacterial action. Therefore, the regulations in Annex IV of MARPOL prohibit ships from discharging sewage within a specified distance of the nearest land, unless they have an approved treatment plant in operation.

Annex IV entered into force on 27 September 2003. A revised Annex was adopted on 1 April 2004, with an entry into force date of 1 August 2005. The Annex requires ships to be equipped with either a sewage treatment plant or a sewage comminuting and disinfecting system or a sewage holding tank.

The discharge of sewage into the sea is prohibited, except when the ship has an approved sewage treatment plant in operation, or is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; or is discharging sewage which is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land.

Governments are required to ensure the provision of adequate reception facilities at ports and terminals for the reception of sewage.

4.3.2. Amendments to the revised MARPOL Annex IV: Port State Control

Regulation 13 – Port State control on operational requirements

1. A ship when in a port or an offshore terminal of another Party is subject to inspection by officers duly authorized by such Party concerning operational requirements under this Annex, where there are clear grounds for believing that the master or crew are not familiar with essential shipboard procedures relating to the prevention of pollution by sewage.
2. In the circumstances given in paragraph 1 of this regulation, the Party shall take such steps as will ensure that the ship shall not sail until the situation has been brought to order in accordance with the requirements of this Annex.

4.3.3. Revised sewage standards

The Marine Environment Protection Committee (MEPC) at its 55th session in October 2006 adopted revised *Guidelines on implementation of effluent standards and performance tests for sewage treatment plants* (see resolution MEPC.159(55)). The revised guidelines, which will apply to sewage treatment plants installed onboard on or after 1 January 2010, replace the *Recommendation on international effluent standards and guidelines for performance tests for sewage treatment plants* adopted by resolution MEPC.2(VI) in 1976.

The MEPC also adopted a standard for the maximum rate of discharge of untreated sewage from holding tanks when at a distance equal or greater than 12 nautical miles from the nearest land (see resolution MEPC.157(55)).

4.3.4. Special area's

In Annex IV *Prevention of pollution by sewage from ships*, MARPOL defines the Baltic sea as **"special area"** in which, for technical reasons relating to their oceanographical and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required. Under the Convention, these special areas are provided with a higher level of protection than other areas of the sea.

4.4. Ships waste water categories

Categories of Ships Waste water

The two basic categories of waste water are grey and black, which come from several different sources.

Grey water is generated from domestic activities such as laundry, dishwashing, and bathing.
Grey Wastewater Sources:

- Sinks – from galley sinks and sinks in crews cabins and toilets
- Showers – from showers in crews accommodation
- Laundry – from washing clothes

Wastewater containing fecal matter and urine is called black water or sewage water.
Black Wastewater Source:

- Sewage – from crews accommodation
- Medical – from ships hospital

4.5. Sewage treatment plant on ships

4.5.1. Introduction

Sewage in water needs oxygen to break down naturally. This sewage, when disposed to the sea, absorbs excessive oxygen, hence reducing the requisite amount of oxygen needed by fishes and marine plants. Bacteria present in the sewage produces hydrogen sulphide gas which produces acrid smell. Human waste contains E. coli bacteria which are found in the intestines. The amount of E.coli bacteria in a water sample indicates the sewage content of that sample.

The protection of marine environment from sewage discharges from ships has been on the environmental agenda for implementation in the marine industry since 1970’s. IMO MARPOL Annex IV governs the sewage treatment and discharge requirements for shipboard sewage treatment plants.

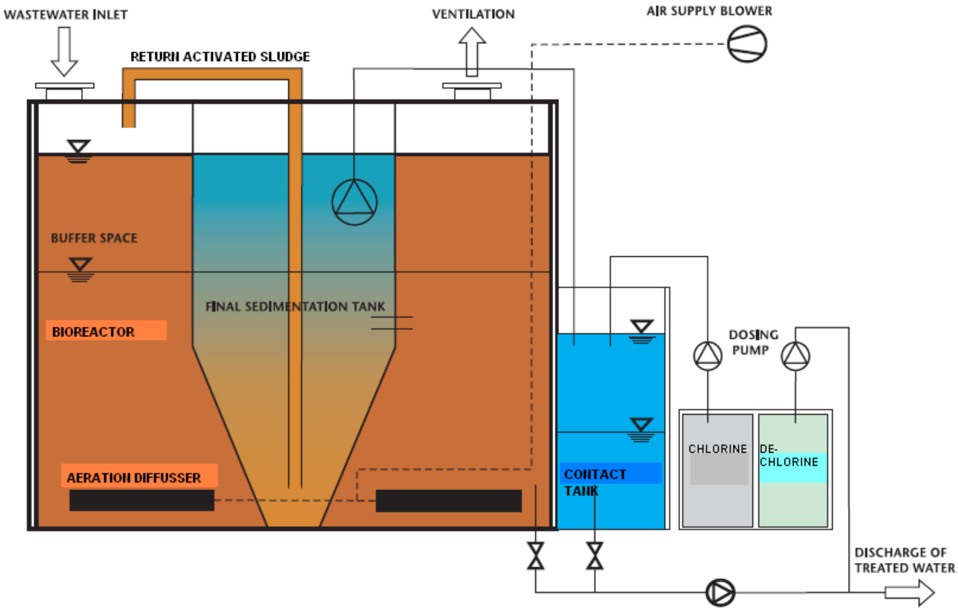
At present, there are over 30 sewage treatment systems type-approved to MEPC2(VI) and the latest MEPC159(55). The technologies adopted by these systems can be categorized in three groups:
1) conventional biological treatment systems;
2) physical-chemical treatment systems;
3) advanced wastewater treatment (AWT) systems.

4.5.2. Conventional biological treatment systems

Biological sewage treatment plants use bacteria to facilitate the process of breaking down of solid constituents. This type of plant generates an oxygen-rich atmosphere that aerobic bacteria utilize to multiply and disintegrate the sewage waste to convert it into sludge. The treated sewage thus generated can be disposed off to any water. The process that takes place inside the plant is known as the aeration process.

The whole plant is divided into three compartments, being:

- aeration compartment;
- settling compartment;
- treatment compartment.



A typical conventional biological treatment system with chlorination disinfection.

Sewage enters the sewage treatment plant first through the aeration compartment. Aerobic bacteria digest the sewage waste and reduce it to small particles. A continuous supply of atmospheric oxygen is provided to increase the rate of the digestion process. The degradation process is environmental friendly because the same process occurs in the natural environment. It is important to have sufficient amount of bacteria kept in the system and to provide them with sufficient dissolved oxygen in order to treat organic pollutants.

The disintegrated solid waste is then transferred to the settling compartment where the solid constituents settle down under the effect of gravity. The liquid at the top is then passed to the treatment compartment and the rest is returned back into the aeration compartment as "return activated sludge" (RAS). The settlement tank is critical in a conventional biological treatment system to ensure compliance performance. It is also important to have correct RAS flow, as too much or too little RAS will cause poor settlement performance.

In the treatment compartment, the liquid water is treated with chlorine or UV to kill any surviving bacteria. Chlorination is well-proven and effective, providing a sufficient chlorine concentration and contact time within the contact tank. After chlorination, the water is then discharged into the sea. The process of chlorination is often performed with chlorine tablets.

The sludge that settles down in the settling compartment is removed and stored in a storage tank. It can be discharged to shore facilities or decontrolled areas.

4.5.3. Pysical - Chemical Sewage Treatment plant

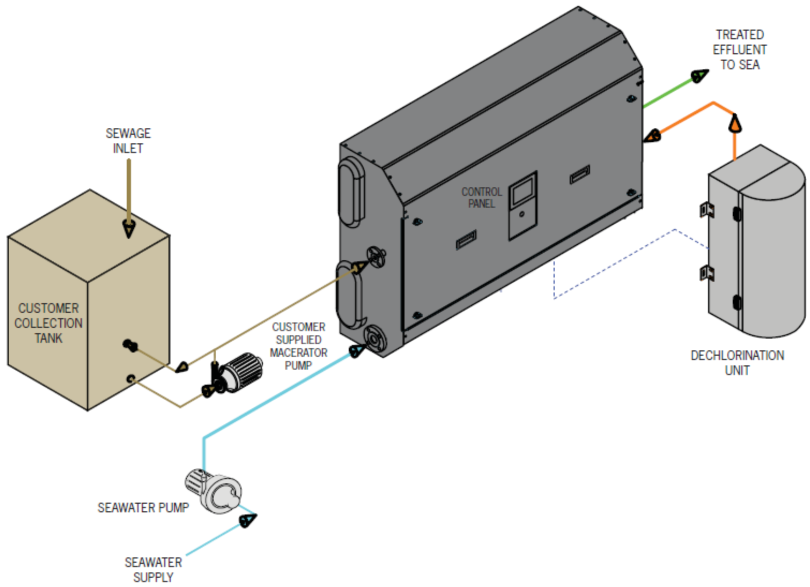
Physical-chemical treatment technologies can be divided into two categories:

- electro-chlorination;
- coagulation/flocculation.

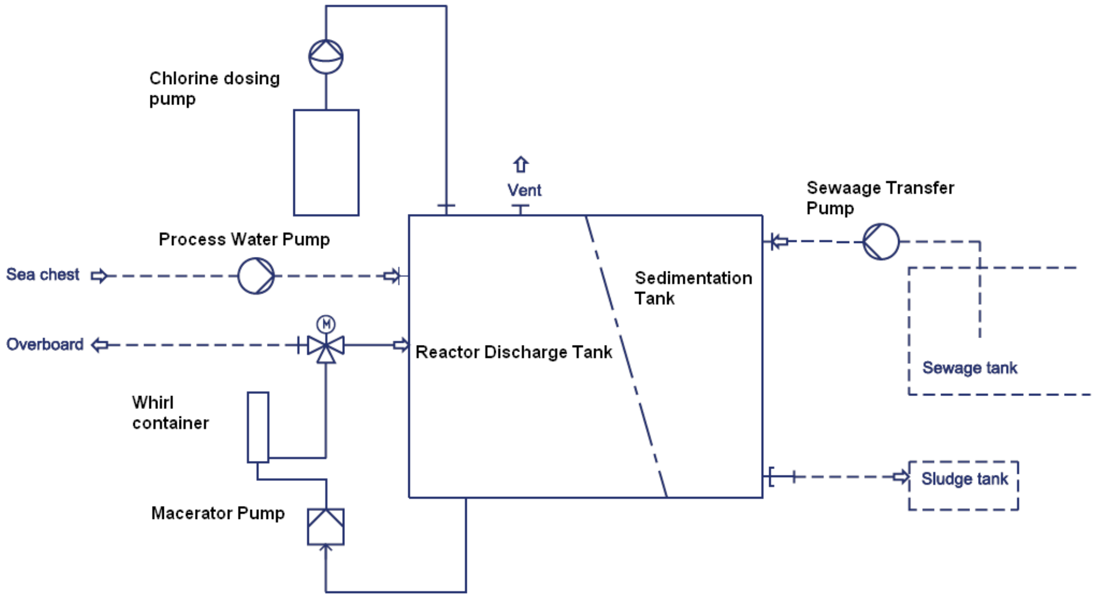
These systems are often much smaller than the equivalent biological treatment systems.

A physical-chemical sewage treatment system using coagulation and dissolved air flotation technologies

Electro-chlorination is a traditional technology, whereby chlorine is generated from sea water or a salt solution to disinfect the sewage. The technology requires high (and stable) salinity to work effectively. Electro-chlorination is suitable for gravity flushing toilet systems that use sea water. With fresh water vacuum toilet systems, a sea water flow of multiple quantity of the sewage flow is often introduced. Some of these systems are type approved to MEPC159(55) by adding a dechlorination stage.

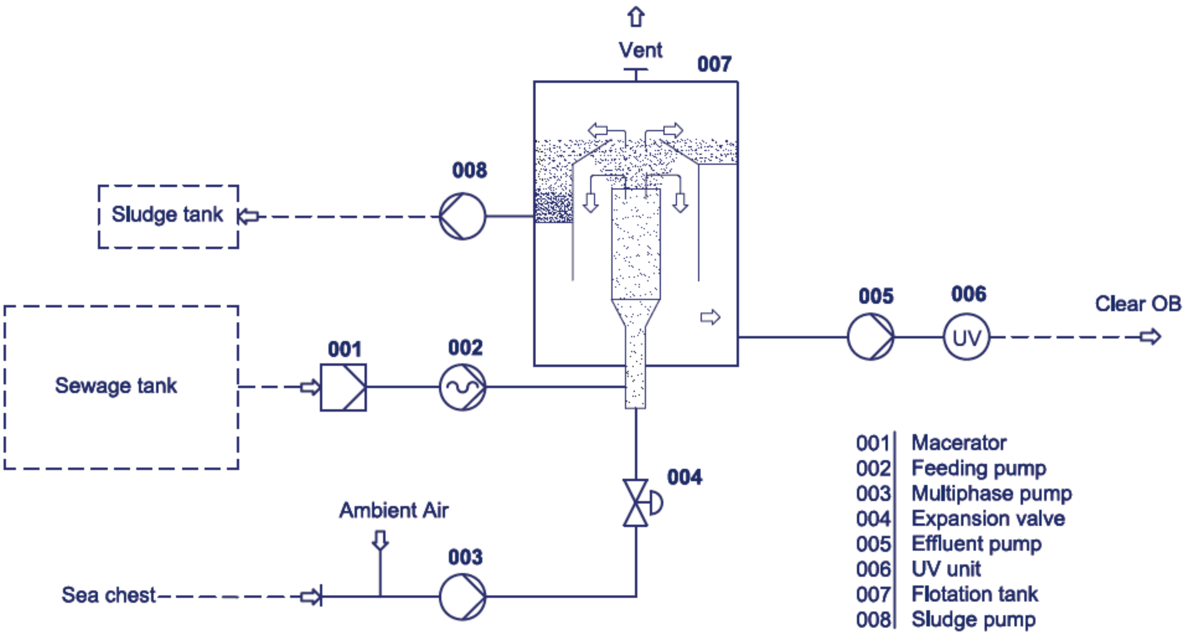


An electro-chlorination sewage treatment systems with de-chlorination, type approved to MEPC159(55).



A chlorination sewage treatment system without dechlorination, type approved to MEPC159(55)

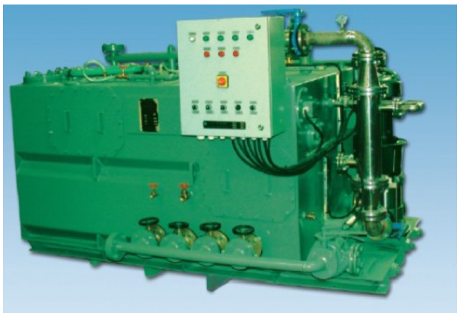
Coagulation/flocculation technology is also used for shipboard sewage treatment. It utilizes chemicals to destabilize the colloidal materials, which are then separated from treated sewage by dissolved air flotation. Therefore, it is essential to have a suitable chemical dosing as correction conditions within the dissolved air flotation chamber at all time, in order to ensure compliant performance. However some systems use flotation technology without the aid of any coagulant or flocculent. Instead, sea water is used to assist the treatment process.



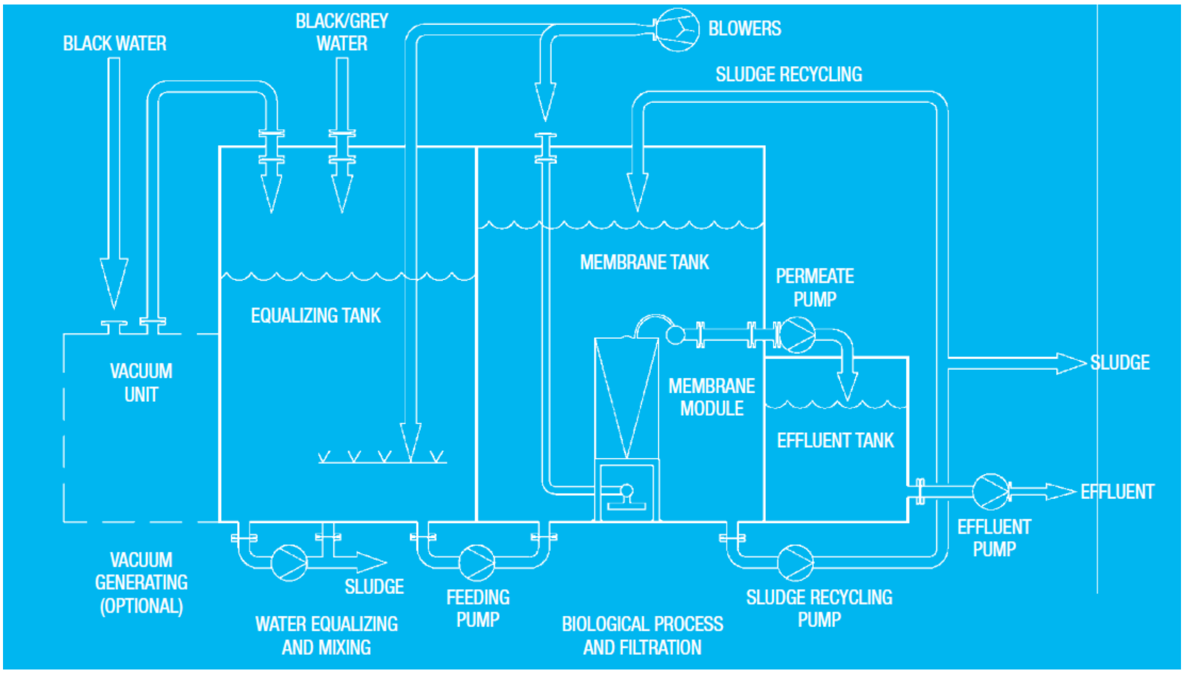
A physical sewage treatment system that is chemical free, type approved to MEPC159(55).

4.5.4. Advanced waste water treatment (AWT) systems





The AWT technology used onboard of ships is best represented by Membrane BioReactor (MBR) systems. Like conventional biological treatment systems, MBR also uses the 'activated sludge' biological treatment process to remove dissolved and particulate organic pollutants. However, instead of a settlement stage to separate the bacteria from treated wastewater, MBR utilizes a physical barrier such as microfiltration and ultrafiltration membrane technology (Figure 7). The performance is therefore more robust and reliable, provided a MBR system is appropriately designed and operated. Specifically, measures must be taken to prevent the membranes from blocking or fouling to ensure continuous membrane filtration performance. The need to have a disinfection stage depends on the specifications and qualities of the membrane materials, as well as the integrity of the membrane element assemblies.



Process diagram of a typical submerged MBR technology

5. Results of the analyses

5.1. Thermotolerant coliforms

According to regulations, the geometric mean of the thermotolerant coliform count of the samples of effluent shall not exceed 250 (new regulation 100) thermotolerant coliforms/100 ml.

Only three (3) out of 32 samples comply with the "test" regulations of max. 250 cfu/100 ml.

The other samples exceed the level of bacteria with high concentrations of thermotolerant coliforms/100 ml and did not come close to the standards. The highest concentration found was 231,000,000 cfu/100ml.

5.2. Suspended solids

The geometric mean of the total suspended solids content of the samples of effluent shall not exceed 50 mg/ltr (new regulation 35).

Six (6) out of 32 samples show concentrations of suspended solids within the limits of the regulations. Twenty-two (22) of the samples even exceed 100 mg/ltr of suspended solids. The highest concentration found is 2.200 mg/ltr.

5.3. Biological Oxygen Demand (BOD)

The geometric mean of 5-day Biochemical Oxygen demand of the samples of effluent shall not exceed 50 mg/ltr. (new regulation 25)

Six (6) out of 36 samples show concentrations of BOD below 50 mg/ltr.

Twenty-six (26) of the samples do exceed the test limits and eight (8) of the samples even exceed a concentration of 500 mg/ltr.

5.4. Chemical Oxygen Demand (COD)

The geometric mean of 5-day Chemical Oxygen demand of the samples of effluent shall not exceed 125 mg/ltr.

One (1) out of 36 samples has a concentration COD within the limits.
Just one (1) of the units is installed after 2010 when regulations for COD came in force. In this particular sample, the COD is 127 mg/ltr.

Six (6) samples show values over 1000 mg/ltr.

5.5. pH (acidity)

The pH of the samples of effluent shall be in the range of 6 to 8.5.

Only eight (8) out of 36 samples do not meet the standards.
Seven (7) of the samples have a pH > 8.5 but remain < 9.
Just one (1) sample has a low pH of 5.12.

5.6. Chlorine Residue

As low as practical possible

Eight (8) out of 36 samples contain residue chlorine. In all other samples residue chlorine was not detected.
One (1) vessel operates an MBR and does not use chlorine but ozone instead.

One (1) of the treatment plants has double disinfection and uses both UV and chlorine.

The chlorine residue was tested in the laboratory and will be lower than measured on site.

5.7. Nitrite

The Nitrite content is not to exceed 10 mg/ltr NO_2.

The content of Nitrite is not limited according to Dutch or Marpol regulations. During the project, IVW requested to analyse also for Nitrite, just as additional information. The results are not evaluated in the report.

5.8. Results of the Questionnaire

During visits to the sites for sample taking, the sampler or a member of our project team asked a number of questions, according to MEPC 55/23 annex 26:

- Type of sewage system
- Manufacturer
- Design capacity
- Type of disinfection
- Number of crew / passengers
- Use of seawater or freshwater (gravity or vacuum system)

Appendix 1 "sample questionnaire" is an example of this form.

All vessels tested for this project had a valid test certificate regarding the sewage plant. The sewage plants are tested and considered to be appropriate.

At least twenty seven (27) of the sewage treatment systems use chlorine as disinfection method. One (1) system is using a combination of UV disinfection and chlorine disinfection.

One (1) unit is using ozone as disinfection method.

5.9. Visit Vessel for inspection sewage treatment system

In order to investigate the source of the poor analyses results, one of the vessels was visited a second time for further inspection of the sewage water treatment system. According to the crew, the installation was working properly and no malfunction was mentioned. The unit was running during the visit and the compressor was on.

This unit has a grey water supply directly connected to the treatment disinfection tank of the unit. The supply of grey water can influence the suspended solids level of the sample.

The aeration valves on the unit seemed to be closed. Without proper aeration in the tank, the bacteriological content will be influenced. There was no return of the activated sludge visible.

This second visit clearly showed that specific operational conditions have significant impact on compliance performance.

5.10. Field experience according to a supplier of sewage treatment units

Field experience, according to one of the suppliers of sewage treatment units, show that there are several possible causes resulting in poor performance of the installations in practice f.e.:

- When the installation is taken into operation, it will take approximately 10 days before the bacterial growth in the first compartment is stable. In these 10 days the installation will not perform sufficiently. Sometimes the installation is shut down when the vessel is outside the 12 mile area. The time for starting up the installation is not considered.
- The shelf life of the chlorine used for disinfection can be expired so no sufficient disinfection is available. Sometimes even the chlorine tablets are not present.
- Cleaning toilets with chemicals containing chlorine. If these kind of chemicals are used this will have a strong negative effect on the biomass in the first compartment of the sewage treatment unit.
- Maintenance like cleaning the sediment tank, checking chlorine tablets, checking aeration, is insufficient.

6. Conclusion & Evaluation

6.1. Explanation of Analyses results

All plants on board of the tested vessels are approved by the IMO standards, but none of the analyses results comply with the "discharge limits during test" as described in the regulations.
Regulations provide for sewage to be discharged to the sea water under condition of operating an approved sewage treatment plant. On the other hand, there are no discharge limitations regarding the sewage water quality pumped overboard.

- Some of the results could be traced back to lack of maintenance :
  - High colony count in combination with high suspended solids could be caused by lack of maintenance of the sediment tanks.
  - Low concentration suspended solids in combination with high colony count could be caused by lack of chlorination / disinfection.

- The design capacity of 13 of the sewage water treatment unit mis-matches the number of crew members on board.

- The only advanced biological treatment system (MBR) included in the investigation is the only system to show a high concentration of Nitrite. The reason for this is not evaluated in this report.

- Only one of the plants has double disinfection by UV and chlorine. The results of the bacteriological analyses of this specific plant are close to the required test results. However, since only one (1) unit with double disinfection was tested, this is regarded as insufficient data to draw a solid conclusion.

- The MBR installation which uses ozone shows good results. Only the thermo-tolerant bacteria count is too high, which indicates the ozone had not sufficient disinfection capacity at that moment. All other results are close to, or within, the test limits.

- In two (2) samples the BOD is higher than the COD. As this is not possible, this indicates that errors have occurred. The COD analyses are carried out in duple, and no significant differences occurred. The BOD samples needed to be diluted before analyses.

6.2. Remarks and Comments

The administration seems to be aware of the fact that the water treated by the sewage treatment plants onboard often differs from test results:

Resolution MEPC159 (55) Guidelines on implementation of effluent standards and performance tests for sewage treatment plants.
It is acknowledged that the performance of sewage treatment plants may vary considerably when the system is tested ashore under simulated shipboard conditions or on board a ship under actual operating conditions. Where testing ashore demonstrates that a system complies with the standards, but subsequent onboard testing does not meet the standards, the administration should determine the reason and take it into account when deciding whether to type approve the plant.

A first step to increase awareness and environmental impact would be to start sampling of the sewage water and reporting the results to an organisation for database entry. If the samples do not meet test standards within certain limits than re-sampling needs to be carried out.

7. Appendixes

Appendix 1 : example of letter to clients
Appendix 2 : Example questionnaire
Appendix 3 : Sample procedure
Appendix 4 : Sewage Marpol IV
Appendix 5 : Results questionnaire & analyses

Example of letter to clients

January 2011

Subject: Project sewage treatment plants

Dear,

Hatenboer-Water has been requested by the Dutch "scheepvaartinspectie" to carry out a project concerning sewage treatment plants on board of ships. Hatenboer-Water would lie to ask your cooperation for this project. In this letter we shall explain more about this project.

General
The discharge of raw sewage into the sea can create a health hazard, while in coastal areas, sewage can also lead to oxygen depletion and visual pollution. Annex IVof Marpol contains a set of regulations regarding the discharge of sewage into the sea, ships equipment and system for the control of sewage discharge.

Goal
In spite of the sewage treatment systems on board of the ships still, in many cases, the quality of the sewage water does not comply with the MARPOL Annex IV. This project investigtes the quality of the sewage water after treatment in combination with the details of the sewage water treatment system present on board. The main goal is to investigate the relation between different techniques and the quality results.

Project
Hatenboer-Water will visit 50 ships to take samples of the sewage water. The samples will be tested according MARPOL on the following parameters:

- Coliform bacteria
- Suspended solids
- Biological oxygen demand
- Chemical oxygen demand
- pH
- Chlorine residue

In addition to the sampling a questionnaire shall be filled in regarding the sewage treatment plant on board of the vessel.

The individual test results will be reported to the ship (owner). The overall results will be combined in a report which will be presented to the Dutch scheepvaart inspectie. The vessels remain strictly anonymous in the report.

Benefits
Hatenboer-Water BV request if you will participate in this research project. You will receive a complete sewage water analyses report according to MARPOL IV free of charge.

Contact details
For more information about this project please contact:

Hatenboer-Water BV
Tjarda den Dunnen
Phone : 0031 10 409 1200
E-mail : tdd@hatenboer-water.com

If you, after reading this letter, would like to be informed further or would like to participate in this project, we will gladly make an appointment.

Please do not hesitate to contact us and we will be at your service or supply further information should you require it.

Trusted to have informed you well, we remain,

Kind regards,

Tjarda den Dunnen
Sr. consultant (drinking) water quality

Questionnaire

Name vessel : ....
IMO number : ....
Contact details : ....
....
....

Number of crew/passengers : ....

Type of sewage installation : ....
Manufacturer : ....

Design capacity : ....
Type of disinfection : ....
Seawater or fresh water system : ....
Production date : ....

Copy of approval certificate available? YES / NO

Remarks :
....

Sampling Procedure

1. Shut down discharge pump
2. Check the compartments of the sewage treatment plant and define these compartments and there discharge connections.
3. Samples can be taken from the sample point on the 3rd compartment tank.
4. Clean the sample point and flush it before taking the samples
5. Fill the bottles.
6. Note the following information on the bottles:
   - Name vessel
   - Date
   - Time
   - Type water: sewage
   - Type of analyses

Sewage - MARPOL Annex IV

Vessel/Voyage type/Area	*Sub-Category*	*Discharge Conditions*
Vessels on international voyages	Comminuted and disinfected sewage using an approved system	• > 3 nm from nearest land.
Vessels on international voyages	Sewage stored in holding tanks (untreated and treated sewage)	• > 12 nm from nearest land; and • discharged at a moderate rate*; and • ship proceeding en route at a speed of at least 4 knots. * The rate of discharge must be approved by the Administration.
Vessels on international voyages	Treated sewage effluent discharged through an IMO approved sewage treatment plant (STP) Also integrated system where the STP includes • grey water input • food processing input.	• Effluent not to produce visible floating solids nor cause discolouration of the surrounding water. • When within port limits, check with port authority as permission may be required • All vessels should ensure that the STP is operating at optimum performance when in Australian waters • Food or biological waste removed from filtration unit is prohibited from discharge within 12nm from land (Australian Quarantine requirements)
Vessels on domestic voyages (all sizes)		• Recommended to comply with MARPOL Annex IV • Local laws may prohibit discharges in ports
Great Barrier Reef Marine Park Vessels on **International voyages** to and continuing in Australian waters	All sewage discharges	• In accordance with Annex IV requirements and where applicable with any additional restrictions imposed as conditions of a GBRMP permit
Great Barrier Reef Marine Park Vessels on domestic voyages	All sewage discharges	• Recommended to comply with MARPOL Annex IV • Or In accordance with requirements of Part 3A of the GBRMPA Regulations (93A-93G) for both treated and untreated sewage • AND, where applicable, in accordance with any additional restrictions imposed as conditions

		of a GBRMP permit
Queensland State Waters (small vessels/State registered and recreational)	If vessel does not have a sewage treatment system on board, options include: • using onshore toilet facilities whenever possible • using a portable toilet to be later emptied to a sewerage/septic system • retain sewage in onboard holding tank for pumping out to shore facilities.	• If a vessel has 16 or more persons on board, no discharge of untreated sewage is permitted anywhere in Queensland waters. • If a vessel has 7 to 15 persons on board, no discharge of untreated sewage is permitted within 1 nautical mile (1852 m) of a reef or the mean low water mark of an island or the mainland.

HATENBOERWATER

Appendix 5

	Number of crew / passengers	Fresh Water/ seawater	Chemical / biological	Type plant	design capacity m3/day	type of desinfection	production date	free chlorine mg/l	pH	suspended Solids mg/l	Biological Oxygen Demand mg/l O2	Chemical Oxygen Demand mg/l O2	thermotolerant bacteria / ml	chloride	nitrite mg/l NO2
Offshore support Vessels															
1	40	fresh	biological	EVAC STP 40C 1122	4	chlorine	2009	< 0,03	7,17	1100	< 3	925	900.000		
2	24	fresh	biological	JETS vacuum AS 30 MB-D	13,9	chlorine	2009	0,1	8,08	190	170	675	77.000	33,7	
3	13	fresh	biological	Biocompact KSA-S-15 +30 MB-D	3,75	chlorine	2007	< 0,05	8,63	940	2800	4970	90	881	
4	48	fresh	biological	Hamworthy ST3A super trident	4,66	chlorine	2001	< 0,05	8,31	180	580	610	10	178	
5						chlorine		0,3	7,19	210	4	860	300		< 0,01
General Cargo vessels															
6								< 0,05	7,73	52	230	430	44	74,6	
7	25	fresh	biological	Aquamar MSP 25				<0,05	6,52	240	470	515	3.300		
8	23	fresh	biological	Hamworthy ST2A super trident	3,12	chlorine		< 0,05	7,12	110	390	860	34.000	5,8	
9	13	fresh	biological	Triton format GmbH	1,26	chlorine	2004	< 0,05	8,95	440	920	1290	31.000.000		
10	16	fresh	Chemical	Format chemie / mstd1	10,5	chlorine		< 0,05	7,49	240	260	725	24.000.000		
11	11	both	biological	KP ocean clean 15	2,77	chlorine	2004	< 0,05	8,86	100	280	515	231.000.000		0,049
12	25	fresh	biological	SBT 25	1,5	chlorine	2006	0,08	7,74	110	89	315	250.000		1.581
Tankers															
13	25	fresh	biological	BIO ECO 450 DOS 985 LI	x	x	1994	< 0,05	7,92	43	270	535	5.600		
14	27	fresh	biological	Facet iberica RF750M	3	chlorine	1996	< 0,05	5,12	100	400	460	680.000	224	
15	22	fresh	biological	ISS-25 /IL seung Co, ltd	1,5	chlorine	2007	0,09	8,63	75	640	215	585.000		
16	30	fresh	biological	Facet iberica RF750M	2/hr	chlorine	1995	< 0,05	7,32	300	950	1.000	3.950.000		
17	31	fresh	biological	Hamworthy ST3A super trident	4,66	chlorine		< 0,05	8,8	130	140	295	7.880.000		< 0,01
18	25	sea	MBR	wcmbr membrane sewage	30 persons	ozone	2010	< 0,05	7,32	44	16	127	270.000		466
19	23	sea	biological	biomaster DV2-SKA-20	3,7	chlorine	2004	x	8,52	< 2	1.800	3.350	32.900.000		0,09
20	19	fresh	biological	Hamworthy ST3A Super trident	9,22	chlorine	1989	< 0,05	7,09	110	400	495	143.000.000		< 0,01
21	24	fresh	biological	SBT 25	1,5	chlorine	2003	0,06	8,59	160	200	1.990	600.000		< 0,01
22	14	fresh	biological	MSD-11/20 CSTM-VAC	4	chlorine	2006	< 0,05	8,28	1.800	260	590	30.000		0,016
Ferries															
23	36	fresh	Biological	DVZ SKA 30 Biomaster	5,5	chlorine	23-3-2009	< 0,05	6,62	220	600	415	6.900.000	112	
24	90/1200	fresh	biological	evac / msp VIII	2 x 105	chlorine	2008	< 0,05	7,06	310	470	700	100.000		
Container vessels															
25	14	fresh	biological	KSA-S15	3,75	UV & chlorine	2005	0,06	8	370	160	510	279		
26	25	fresh	biologcal	Hamworthy ST4A super trident	6	chlorine		< 0,05	7,47	1.200	420	650	71.000.000		
27								0,08	8,26	150	76	360	9.900	92,1	
28	11	fresh	biological	RWO wwt type 3	4,63	chlorine	2006	< 0,05	7,1	2.200	560	3.060	96.000		
29	23	fresh	biological	taiko kikai submerged bio filter treatment	4	chlorine		< 0,05	7,14	13	16	75	5.000	632	
30	23	fresh	biological	Evac 40C	4,38	chlorine	2007	0,06	7,39	73	50	210	970.000		< 0,01
31	28	fresh	biological	SBT-40	2,4	chlorine	2008	< 0,05	7,59	44	18	140	3.300		77
32	14	fresh	biological	Hamworthy ST2A Super trident	3,12	chlorine	2009	0,06	6,86	74	150	385	14.000.000	57,4	0,01