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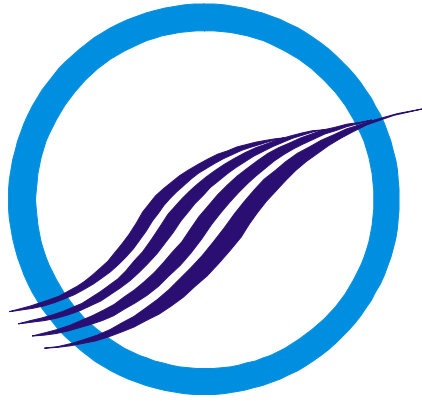
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WATER 2021

Conference Proceedings



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SHIP WASTEWATER MANAGEMENT

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ABSTRACT

Increasingly intensive water transport has pointed to the need to address the problem of wastewater from ships. The paper shows the wastewater that can be found on board. Analytically shows an adequate wastewater treatment plant before discharge into the sea. Scheme showing the method of wastewater disposal on board. Provides recommendations that can contribute to more efficient wastewater disposal on board. The International Law on the Prevention of Marine Pollution (annex 4, MARPOL) was presented, which defines the legal obligations for the removal of wastewater from ships.

KEY WORDS: Wastewater, Sea, Ship, MARPOL, Annex (IV)

SHIP WASTEWATER MANAGEMENT

REZIME

Sve intenzivniji vodeni transport ukazao je na potrebu rešavanja problema otpadnih voda sa brodova. U radu su prikazane otpadne vode koje se mogu pronaći na brodu. Analitički je prikazano odgovarajuće postrojenje za prečišćavanje otpadnih voda pre ispuštanja u more. Šema koja prikazuje način odlaganja otpadnih voda na brodu Pruža preporuke koje mogu doprineti efikasnijem odlaganju otpadnih voda sa brodova. Predstavljen je Međunarodni zakon o sprečavanju zagađenja mora (aneks 4, MARPOL) koji definiše zakonske obaveze za uklanjanje otpadnih voda sa brodova.

KLJUČNE REČI: Otpadne vode, more, brod, MARPOL, Aneks (IV)

INTRODUCTION

At the International Conference on Marine Pollution, held in London in 1973, the International Maritime Organization adopted MARPOL (International Convention for the Prevention of Pollution from Ships). The name MARPOL (derived from the English words Maritime pollution). MARPOL includes six specific regulations, each of which considers a specific type of pollution as set out below and depending on the MARPOL Annex[1]:

1. Annex I Regulations for the Prevention of Oil Pollution (Fuels) - (entered into force on 2 October 1983).
2. Annex II Regulations for the control of pollution by harmful substances in bulk - (entered into force on 6 April 1987).
3. Annex III Regulations for the prevention of pollution from harmful substances floating on the surface of the Sea - (entered into force on 1 July 1992).

4. Annex IV Regulations for the Prevention of Pollution from Wastewater from Ships (Prevention of Wastewater Pollution from Ships) - (entered into force 27 September 2003).
5. Annex V Regulations for the Prevention of Pollution by Ship Waste - (entered into force on 31 December 1988)
6. Annex VI Regulations for the Prevention of Air Pollution from Ships - (entered into force on 19 May 2005).

Bearing in mind that these are violations of the global system and other sources of harmful effects on the environment, MARPOL is also working on new requirements related to the protection of the environment from the following sources:

7. International Convention for the Prevention of Pollution from Ships by Ballast Water.
8. Regulations for the prevention of "antifouling" paint pollution from ships.
9. Regulations for the prevention of "pollution" by noise from the ship.
10. Regulations to prevent "pollution" from vibrations from the ship.

ANNEX IV - REGULATIONS FOR PROTECTION AGAINST WASTEWATER POLLUTION FROM SHIPS

MARPOL wastewater is divided into: Black wastewater - Collected due to leaks of water, oil, and fuel from the main and auxiliary engines, as well as other equipment on ships in the engine room. Such waters are treated with special devices required by MARPOL, bilge water separators (Waste / oily water purifier), which must provide purity of 15 ppm[2,9].

Separators work on the principle of separation, ie filtration of wastewater so that heavier fractions are separated and collected at the bottom, from where they are transferred back to the collection tank, from where they are transferred by a special transfer pump via the International Deck, to collection facilities onshore, tankers or ships. The following figure shows a ship's compact Black Water Separator (figure 1)(OWS).



Figure 1. ship treatment / sewerage separator from machine area (marine oil water separator)

In January 2005, many states and ship owners ordered new ships, so the old models of wastewater separators (all ships over 400 GT) were inevitably replaced in order to meet the requirements of IMO MEPC 107 (49) regulations. These, Ship Oil Separators (OWS) are designed to operate in automatic mode and to adapt to the conditions of work onboard. Automatic cleaning/draining of water or diversion of oily water through a three-way valve implies simplicity in operation without any problems. The American manufacturer BRUTE guarantees that their oil separator (OWS) works normally at an angle of 30° "stumble" of the ship (the case when the ship sails at an angle of 90° to the waves), and the ship is in motion.

GRAY SEWAGE WATER

Collected from toilets, showers, kitchens, and cabins, which are stored in special collection tanks. According to the requirements of MARPOL, they must be treated in special devices (separators) and after treatment, clean water can be discharged into the sea, and the waste residue must be burned in special devices, called incinerators. The special treatment of these waters is regulated by the requirements in Annex IV, and I will return to that in a special part of this Seminar Paper, with a comment on how I personally experienced it on ships.

MARPOL has prescribed in its Annex (IV) how Gray wastewater can be discharged directly into the Sea and at what distances from the shore as well as at what speeds, for example, a minimum of 12 nautical miles from the shore at a ship speed of not less than 4 knots, 4 km / h) In practice, this is usually done without taking into account the requirements of MARPOL, but according to the condition and contents of the tank when it comes to overflowing and unpleasant odor. The following figure shows the ship's Wastewater Treatment Plant (figure 2).

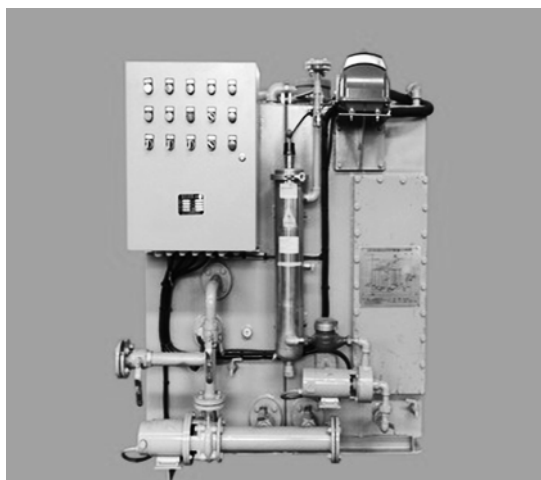


Figure 2. Ship's device for wastewater treatment

The device is manufactured in China by Dongtai City Dongfang Marine Fitting Co., LTD. Several main data on the device related to the technology of treatment of Gray wastewater are presented as follows:

Ship Wastewater Treatment Plant - Model SWCM, Marine Sewage Treatment Plant (table 1).

Table 1. Technical data of the ship's device for waste treatment

Product Name	Sewage Treatment Plant
Model	SWCM-10
Brand	YEAN
Average treatment Load (L/d)	840
Rated Number of Persons	10
Max number of persons	12
Voltage	AC380V, 50Hz/AC440V,60Hz
Power(KW)	5.5
Outline Dimention(L*W*H)	1160*1150*1350 (mm)
Emission Index	TSS>=35mg/l, BOD5>=25 mg/l, COD>=125 mg/l, Coliform>=100/100ml, pH=6~8.5

BOD - Biochemical Oxygen Demand, COD - Chemical Oxygen Demand

PURPOSE OF THE DEVICE

This device works on the principle of activated sludge, in contact with the oxidation and membrane bioreactor (MCR) in order to dissolve organic pollutants in wastewater. This process / treatment, wastewater treatment efficiently and completely, so that the quality of water coming out of the device meets the IMO standard and other local regulations of countries that issue their additional regulations, to improve and protect the environment and their territorial waters.

Several MARPOL regulations related to wastewater discharge are listed below:

Regulation 11 - Wastewater disposal.

The subject of Regulation 3 of this Annex is that the discharge of wastewater into the sea is generally prohibited, except the following cases:

- when treated and disinfected wastewater is discharged from the ship using a system approved by the Administration following the relevant paragraph (requirement 9.1.2) of this Annex at a distance of more than 3 nautical miles from the shore, or wastewater which are not frozen or disinfected at 12 nm (nautical miles) from the shore, the condition that in any case the wastewater stored in the collecting tank must not be discharged at once but at a moderate rate and at a reduced speed, but not less than 4 knots; the amount of wastewater from the ship discharged into the sea will be defined by the Administration (flag carried by the ship), all related to the standard prescribed by MARPOL; or
- the ship is approved by the Administration, the Wastewater Treatment Plant in accordance with the requirements specified in the rules of this Annex, and
 - the details of the testing of the device installed onboard shall be in accordance with the Wastewater Pollution Protection Certificate;

- it is additionally required that wastewater shall not contain solids floating on the surface or cause discoloration on the surface of the sea.

The compliance with paragraph 1 shall not apply to ships navigating the territorial waters of the flag State, or to ships visiting the said territorial waters discharging wastewater in accordance with a lower level of requirements than MARPOL, which may be required / permitted by the Administration and Countries, and for its territorial waters.

- Where sewage water also contains some other wastewater (for example wastewater containing kitchen dishwashing detergents), or waste considered in Annex MARPOL 73/78, the requirements of these Annexes shall be in accordance with the requirements of this Annex.

MARPOL CONVENTION SHIP CERTIFICATES

In order to ensure that the ships comply with the technical standards prescribed by the MARPOL Convention, the flag state, ie. The administration must, based on them, perform inspection supervision and issue the necessary certificates. Certificates issued by one State Party shall be valid in the territory of the other State Party. In addition to the Administration (the flag State), the Port State also has the right to inspect when a foreign ship enters its port. The Port State has the right to initiate proceedings in case of derogation from the provisions of the Convention that may occur in the area of its coastal waters.

OIL RECORD BOOK

Each ship over 150 GRT must have an Oil Book onboard maintained by the Chief Engineer once a week, and in which he enters data on the condition of oily waters and sludge in the Machine Space, their transfer and quantity in storage tanks with the date and time of start and end of operation depending on whether a pump was used or manually. If the mentioned waste is delivered to the port, the quantity delivered to the receiving plant or vehicle / barge, start and end time shall be entered. In the end, a receipt is issued certified by the recipient, which is kept in the documentation on the ship. The said book shall be issued by the Administration (whose flag the ship carries) or by the classification society on behalf of the Administration, in accordance with Rule 20 of Annex I to the MARPOL Convention. Each page is stamped by the Administration. In addition to the operation with oily water and sludge, other data are entered in this document, such as fuel intake, operations with ballasting in tanks other than those specified in the construction documents. The form of the Book of Oil in English is attached.

INTERNATIONAL CERTIFICATE FOR THE PREVENTION OF OIL POLLUTION - IOPP CERTIFICATE

This Certificate certifies that the ship has been inspected by an Administration Inspector or a Classification Company following the Rule 4 of Annex (Annex) I to the MARPOL Convention and that the inspection has established that the structure, equipment, systems, installed parts and arrangement of equipment and devices in each meets the requirements of Annex I. In the Appendix, which accompanies the IOPP Certificate, there is a detailed description of pollution prevention equipment and devices. The data refer to the type of oil filter device with a signaling device and automatic stop device if the device does not operate

at 15 ppm (15 parts per million). The validity of this Certificate is 5 (five) years, and the entire system is subject to an annual inspection by the Administration Officer or the Classification Society. At the end of the Seminar paper, an example of the IOPP Certificate with the Appendix is attached in the appendices, in English.

SOPEP - SHIP OIL POLLUTION EMERGENCY PLAN

All ships with 400 GT (Gross Registered Tonnes) and over, in accordance with the MARPOL 73/78 requirements of Annex I, must have an “Emergency Oil Spill Protection Plan” following the standards and instructions written in the IMO (International Maritime Organization) and under MEPC (Marine Environmental Protection Committee) International Committee for Environmental Protection.

Requirements for tankers, according to the MARPOL Convention, have been reduced to 150 GRT since oil is the only type of cargo, which doubles the risk of oil pollution.

The ship's captain is generally responsible for monitoring SOPEP, along with the Chief Officer who is responsible for implementing SOPEP on board. SOPEP includes a plan and duties for the captain, officers, and crew of the ship in relation to the manner of resolving various scenarios of oil and fuel spills into the sea that may occur onboard. In the case of Fuel Tankers, the plan differs in terms of cargo handling and the fact that tankers can transport significant amounts of cargo in storage.

During the first acquaintance of the crew with the ship, (Familiarization Training) one of the important moments is the acquaintance with the SOPEP “locker”, a yellow container, which contains handy means for immediate prevention of the spread of environmental pollution in case of fuel spills or black waste.

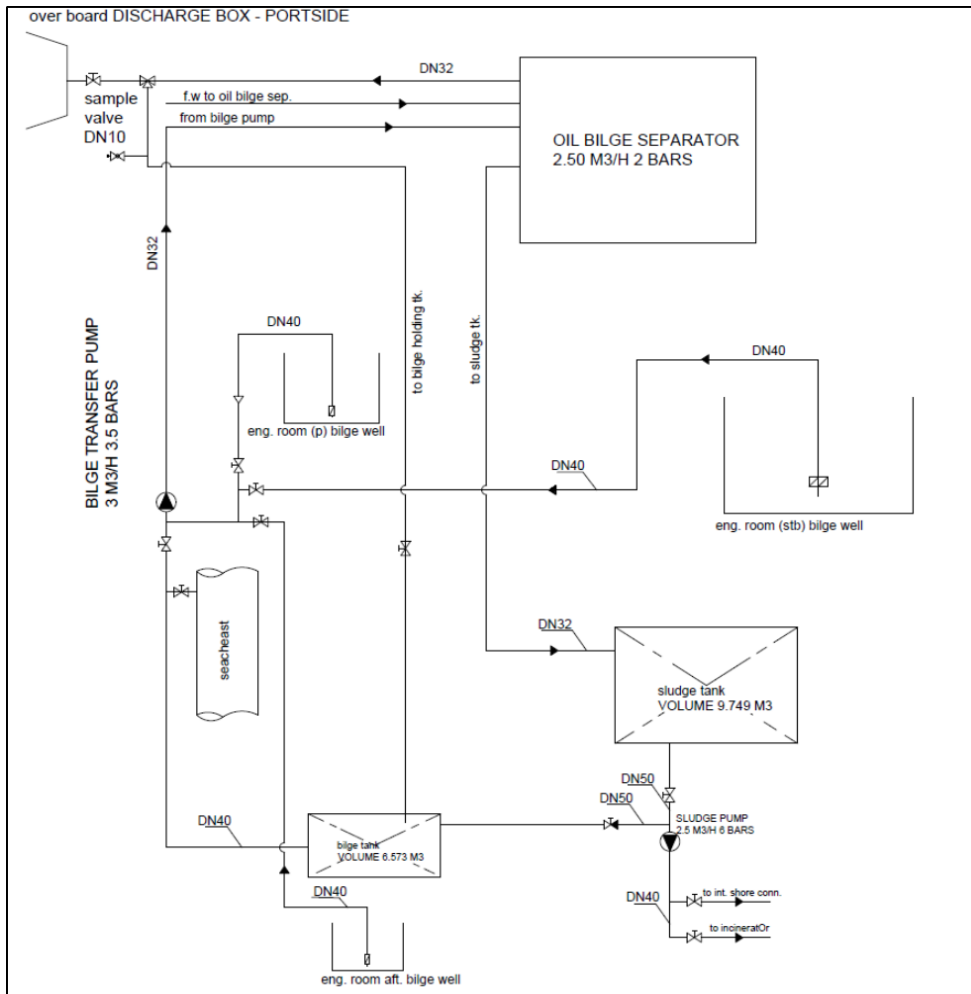


Figure 3. Example schematic representation of wastewater from ships

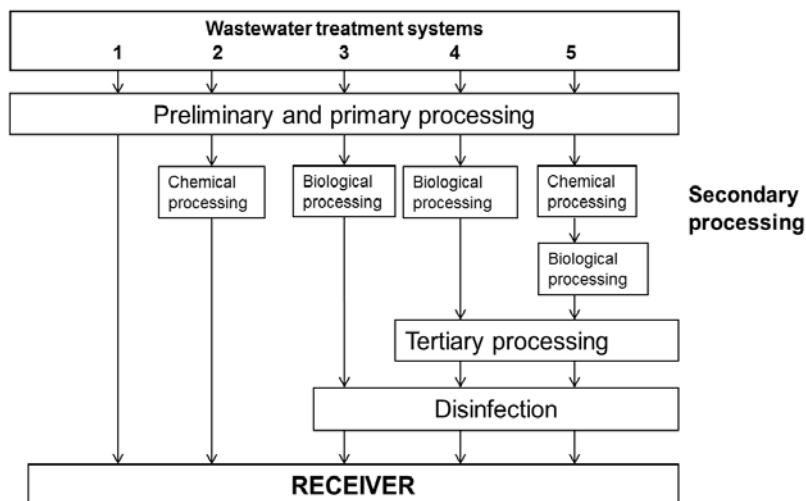


Figure 4. Schematic representation of wastewater treatment depending on the type of pollution

The goal of processing is complete release from the present pollution. There is no single procedure. Types of wastewater treatment processes, procedures are divided into : mechanical, chemical and biological[3,4,8]. According to the quality of the processed water, the processing can be: preliminary, primary, secondary and tertiary (figure 4). MEPC.227(64) requires sewage treatment plant influent to represent raw sewage and prohibits recirculates generated from the sewage treatment plant to be returned to its influent. Otherwise, the influent no longer represents raw sewage, and the plant's capacity would be overrated. Yet, some conformity assessment bodies have approved precisely these plants. As of now, one market surveillance administration has mobilised its internal procedures to review one possible candidate.

CHLORINATION DISINFECTION WITHOUT DE-CHLORINATION

Chlorination relies on a time-concentration relationship, which has for decades been well understood and documented. With a typical contact time of 30 minutes, a chlorine dose of 5-15 mg/l can effectively disinfect biologically treated effluent (Wastewater Engineering Treatment and Reuse, 4th edition, Metcalf & Eddy). For this concentration to be reduced to below the 0.5 mg/l limit, a de-chlorination step is a must. Yet, the de-chlorination step is absent in some chlorine-based sewage treatment plants. Considering that almost all chlorine-based ballast water treatment plants incorporate a de-chlorination step for less arduous disinfection duty, the inconsistencies between approvals for sewage treatment plants and ballast water treatment systems are beyond comprehension[10].

“NO-SLUDGE” PRODUCTION

Some sewage treatment plants do not have provisions to discharge sewage sludge. Such no-sludge claims do not conform to environmental science, and are simply untrue. One such sewage treatment plant was even certified to remove Total Phosphorus, in which case the “removed” Total Phosphorus has to disappear into nowhere. Recently, one Notified Body announced suspension of the MED approval certificate of a sewage treatment plant, subject to further reviews. Despite this development, there are still other magic boxes with no-sludge claims, approved by other Notified Bodies, and the issue may still persist beyond the European efforts[10].

These non-conformities and magic boxes have been finding their ways into new ships in their hundreds. Ship yards and owners are entitled to gain further insights to these issues. The credibility and accountability of the approval regime is at stake.

SILVER LINING

Having seen the realities, Alaska regulators took actions starting in the early 2000s. They introduced new rules and the Commercial Passenger Vessel Environmental Compliance (CPVEC) program to the large cruise ships trading in Alaska water each year. Gray water, being more polluted than sewage, was also brought under the same rules.

Some vendors, including Wärtsilä Water Systems Ltd, developed a new generation of technologies known as Advanced Wastewater Treatment Systems (AWTS). AWTS carry the same certificates as sewage treatment plants and marine sanitation devices do, but differ from them in that the ships’ discharges are sampled and monitored under CPVEC, with the results published in the public domain. The success of this program has been praised by all stakeholders, in particular by the cruise industry[10].

CONCLUSION

Based on experience, the recommendations are: to tighten controls in the Ports on all ships, especially those older than 15 to 20 years. A detailed review of documentation and facilities in the Machinery Area should be performed every month by Port Inspectors (so far this has been done every 3 months). Audits conducted by Administration Officers or Classification Company Inspectors should be at least every 6 months and not annually.

Ongoing training and exercises should be maintained in accordance with the Management Plan with the full responsibility of the Captain and other Officers. All other crew members would have to undergo onshore training and obtain appropriate Certificates of Competence for future shipboard operations. If the checks show that the documents are "fake", they are automatically unloaded with all the consequences, of which they are aware by signing the acts and statements that they are qualified for certain duties. Such books should be confiscated and registered in Global system available to Ship-owners or Managers, so as not to take them back on ships. Certainly, the Officer Personnel who acquaints the crew after boarding, with the ship and the equipment, must bear full responsibility for the correctness of their work and appropriate punitive measures must be taken against them in order to eliminate all irregularities in the work of the crew. The problem is very big in the impossibility of communication since a large number of sailors and machine operators do not have adequate knowledge of English, so insurmountable problems arise. Constant work and

practice will certainly lead to results, but the problem created by Ship-owners with reducing the crew and duplicating their duties.

REFERENCES

1. [http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx)
2. Ketin, S., Antanaskovic, D., Jovanovic, Z., Lukic, V., Andrejic, M. (2020) Technologies collecting free oil and its derivatives in the Sea. Fresen. Environ. Bull., Vol 29, No. x/2020 p.
3. Biocanin, R., Sacirovic, S., Ketin, S., Canak, S., Vignjevic Djordjevic, N., Plojovic, S., Neskovic, S. (2015) Chemical process decontamination in the treatment of hazardous substances. Polish Journal of Environmental Studies. 24(1), 427-432.
4. Ketin, S., Dasic, P., Neskovic, S., Kostic, B. (2016) The technological process of solidification for the treatment of hazardous waste. Fresen. Environ. Bull. 25, 1877-1882.
5. Andrejic, M., Ketin, S., Ilic, Dj. (2019) Contribution to the advancement of the brokerage and logistics of commercial ships in Serbia. Vojno delo. 4/2019, 359-384.
6. Elezovic, N., Ilic Komatina, D., Dervisevic, I., Ketin, S., Dasic, P. (2018) Analysis of SWQI index of the River Ibar (Serbia). Fresen. Environ. Bull. 27, 2502-251
7. Sacirovic, S., Ketin, S., Vignjevic Djordjevic, N. (2019) Eco-industrial zones in the context of sustainability development of urban areas. Environmental Science and Pollution Research. 25, p. 1-11
8. Srbinoski, S., Tomic, S., Bulajic, S., Lutovac, M., Lutovac, B., Ketin, S. (2019) Results and experience of the new test working of the station for the purification of the fecal waste water in Volkovo, Fresen. Environ. Bull. , 28, No. 12A/2019 p. 9724-9730
9. http://www.marpoltraining.com/MMSKOREAN/MARPOL/Annex_IV/index.htm
10. Wei Chen, Sewage from Ships – Rules and Realities, The Maritime Executive, October 2020