

# Ship Domestic Sewage and Treatment Strategy

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## Abstract

**With the improvement of people's living standards, the problem of domestic sewage from ships in China has attracted the attention of relevant people. This paper analyzes the pollution of domestic sewage from ships and its treatment plan, starts with the connotation and pollution hazards of domestic sewage from ships, understands the existing problems of domestic sewage from ships at this stage, and further explains the treatment plan of domestic sewage from ships. The analysis of the treatment plan of ship sewage pollution is conducive to improving people's awareness of ecological concept and promoting the reasonable discharge of ship sewage in China.**

## Keywords

**Ship domestic sewage; Treatment strategy; Membrane bioreactor.**

## 1. Introduction

With the development of shipping and modern marine technology, more ship domestic sewage is discharged into rivers and oceans, which is threatening the marine biological environment and human health. The ship domestic sewage comes from the daily water used by the crew (crew and passengers), such as from drainage from toilet, kitchen, dining room, and so on. The ship domestic sewage brings many hazards and can conclude as follow: (1) influencing the hygienic indicators of water bodies and leading to the spread and epidemic of diseases. (2) affecting the quality of the water environment and causing oxygen-consumption organic pollution of the water bodies. (3) promoting the formation of eutrophication and destroying the self-purification balance of water bodies, thereby deteriorating the quality of regional water environment.

## 2. The Current Ship Domestic Sewage Treatment

At present, the existing problems of ship domestic sewage in China mainly appear in the port area and ship navigation area. For the port area, the problems of domestic sewage are reflected in the low treatment rate of domestic sewage and the inadequate facilities for receiving and treating domestic sewage. As for the navigation area, the problems of domestic sewage mainly lie in the inadequacy of sewage treatment by the specialized receiving units of ship pollutants, the improper use and supervision of domestic sewage treatment devices on ships, and the difficulty of installing domestic sewage treatment devices on large ships [1].

### 2.1. Ship Port Area

A. The domestic sewage treatment rate is not high

With the poor of construction of domestic sewage pipeline facilities in Chinese port cities, a lot of domestic sewage without treatment was discharged into rivers or oceans. The discharge of domestic sewage from ships is less than that from Chinese port cities due to the population living and working on ships are less than shores. In addition, the treatment rate of domestic sewage is not high, which seriously affects the water quality of port, threatens the health of the surrounding environment of port residents.

#### B. Inadequate facilities for receiving and treating domestic sewage

When building ship ports and terminals, the related construction standards must be followed to equip corresponding facilities for ship pollutants including oil, water, domestic sewage and garbage. However, for the Chinese ship ports, the terminal operators and managers never consider investment and construction of domestic sewage facilities, which cause the lack of domestic sewage facilities [2].

### 2.2. Ship Navigation Area

#### A. Inadequate sewage treatment by professional receiving units of marine pollutants

The treatment of sewage is completely cost-efficient including labors, equipment, transportation, etc. due to the difference of substances from domestic sewage and oil pollution. The ship receiving facilities of ports port mainly receive the oily sewage rather than the domestic sewage. Currently, the ship domestic sewage receiving service projects are missing due to the lack of charging standards. Due to the unwillingness of the relevant receiving units to provide free sewage receiving services and increase of treatment costs, shipowners will refuse to accept the relevant domestic sewage treatment measures.

#### B. Improper use and supervision of ship domestic sewage treatment plant

With the inefficiency of domestic sewage treatment plant, the unskillful of operators of domestic sewage treatment plant and the unperfect of domestic sewage detection methods, the treatment rate is difficult to reach the national standards. In addition, due to the negligence of duties and improper supervision of supervisors of the ship sewage department, the environment of rivers and ocean has heavily polluted [3].

#### C. Small ships lack on-board sewage treatment equipment

Different types of ships emit different types of pollutants. For Chinese small ships, especially with the large number and limitation of structural space of transportation ships and fuel tankers, which cause difficulty in arranging domestic sewage equipment. Hence, the discharge of domestic water consumption increases. Due to the concentration of sewage discharge and the inefficiency of operation, the operating cost will increase if install the sewage treatment plant.

## 3. Treatment Strategy from Management

For preventing environmental pollution resulting from ship sewage, MARPOL convention bylaw IV express strict rules for the prevention of sewage pollution from ship structure and equipment.

### 3.1. Domestic Sewage System and Standard Discharge Head

For preventing damage of maritime environment causing by ship sewage discharge, the vessel should be equipped with meet the requirements of the MARPOL convention supplement IV domestic sewage system and standard discharge connection.

#### A. Domestic sewage systems

For the annex IV, the ship should be equipped with one of the following domestic sewage systems:

- (1) Domestic sewage treatment plant, which should be approved by the competent authority in accordance with IMO standards and test methods;
- (2) Domestic sewage crushing and disinfection system approved by the competent authority should be equipped with the facilities that have been qualified for the purpose of temporarily storing domestic sewage in the situation that the ship is less than 3 nautical miles from the nearest land.

(3) The collection tank should be manufactured in accordance with the requirements that the ship was confirmed with sufficient capacity to store all domestic sewage for considering key factors including ship operation performance, number of people on board, etc.

#### B. Standard discharge connector

In order to connect the receiving pipeline to the ship discharge pipeline, both pipelines should be installed with standard discharge joints as required. For ships navigating on fixed routes (e.g., passenger ferries), the discharge lines on board may be equipped with discharge fittings acceptable to the competent authority, such as quick docking sleeves.

### 3.2. Domestic Sewage Discharge Requirements

Domestic sewage discharge regulations vary according to the ship type (i.e., passenger and other ship) and area (i.e., inside and outside of special areas). Bylaw IV special area for supplement I defined in the Baltic sea region and IMO specified in prevention of sewage pollution caused by the specific area of the standards and procedures specify any other waters.

#### A. Passenger ships discharge domestic sewage in all areas

(1) The ship should discharge the crushed and disinfected domestic sewage to the competent authority in accordance with the approved equipment in 3 nautical miles from the nearest land.

(2) Discharge untreated or undisinfected sewage, or sewage from places where animals are stored, within 12 nautical miles from the nearest land.

(3) However, the domestic sewage in the storage tank should not be discharged immediately under any circumstances and the ship should be discharged at an appropriate when sail at a speed not less than 4 knots. Emission rate standards should be developed by the competent authority according to IMO.

#### B. Passenger ships discharge domestic sewage in special areas

(1) Except for the exceptions specified in this Supplementary Provision, passenger ships should be prohibited from discharging domestic sewage in special areas. For new passenger ships, domestic sewage should be prohibited from discharging domestic sewage in special areas on or after January 1, 2016.

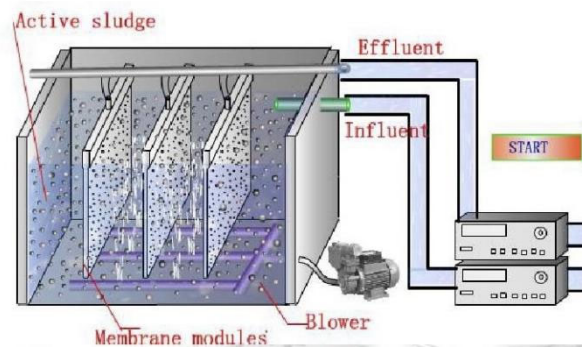
(2) However, the premise is that the ship has an approved domestic sewage treatment plant in operation, which has been verified by the competent authority and can meet the operational requirements described in the annex, and the wastewater must not produce visible floating solids in the surrounding water or change color.

## 4. Treatment Strategy from Technology

With the increasing awareness of marine protection, the requirements for ships to export wastewater are becoming stricter. One of the main causes of marine pollution is the export of wastewater. Therefore, many researchers have invented many tools that can help treat wastewater to meet the standards set by the International Maritime Organization (IMO) or other countries. At present, the mainstream methods of wastewater treatment include physicochemical method [4], Biochemical process, electrochemical process, membrane bioreactors (MBRs) [5], using the tank collecting sewage and vacuum distillation treatment (VDT).

Now, the membrane bioreactor (MBRs) is the most commonly used technology due to the advantages of MBRs are superior to the other methods. (1) effluent coped by MBRs is cleaner. In the MBRs reactor, activated sludge and the attached microorganisms and bacteria absorb and decompose soluble organic matter in wastewater. The secondary sedimentation tank achieves the effect of sludge-water separation, and the solid-liquid separation efficiency is higher. And then ensuring that the effluent is good and stable, and little affected by the quality of the influent water. (2) the advantage in denitrification capacity of MBRs is more prominent.

With the interception of the MBRs reactor, the slowly growing nitrifying bacteria gradually become the most beneficial bacteria via frequent interception, thereby improving the nitrification efficiency of the entire system. Hence, the efficiency of nitrogen removal of the whole reactor and the difficulty of degradation are improved. (3) it is easy to implement automatic control due to its small footprint. Since the membrane module realizes the separation of mud and water, the organisms in the reactor are improved. The reduction in load can make the MBRs process equipment compact and occupy a small area. Time-integrated equipment is easy to implement automatic control and operate [6].



**Figure 1.** The principle of membrane bioreactors

MBRs is a technology that uses a membrane with selective permeability to separate different substances (e.g., molecules, ions and particles) through a chemical potential gradient. MBRs is increasingly becoming the technology of choice for high-quality water treatment or space-limited water and wastewater treatment. MBRs must be pre-treated to protect them from mechanical damage by sharp or abrasive particles, and to prevent clogging or scaling of hair and other fibrous materials [7]. Pretreatment screening is the primary task of facility managers and engineers responsible for the efficient operation of MBRs. MBRs require some type of fine screening to function properly and limit the possibility of clogging or excessive maintenance. JWC provides a variety of fine screening solutions for MBRs [8].

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