

Using Inert Gas to Treat Aquatic Organisms in Ballast Water of the Ships

Pham Huu Tan

*Faculty of Marine Engineering, Vietnam Maritime University
phamhuutan@vimaru.edu.vn*

Tran Hong Ha

*Faculty of Marine Engineering, Vietnam Maritime University
tranhongha@vimaru.edu.vn*

Abstract: The ballast water and sediments carried by ships have been identified as a major pathway for the transport of harmful invasive aquatic organisms and pathogens. Ships often take on ballast water in one port and carry such ballast to other ports where it is discharged. The ballast water and sediments contain living organisms which, despite the harsh conditions in the ballast tanks and piping systems, survive to compete with native species in the port of discharge. If the non-native organisms have few natural predators or other natural controls they may become invasive and change the local ecosystems, sometimes dramatically. Ballast Water Management Convention was adopted 2/13/2004 stated: beforeThe ship ballast pumped out the ship ballast water must be treatment. This paper presents a method of ballast water treatment with inert gas. When aeration tanks inert inert gas into the air will push out the inert form of air and water environment of the bunker, so the organisms in water and ballast will be destroyed. Safe environment with an inert atmosphere of goods will also reduce the possibility of causing corrosion of oxygen tanks leaked items.

Keyword: inert gas, ballast water, organisms

1. INSTRUCTIONS

Ballast water is the source of the spread of certain harmful organisms from place to place around the world [1] like: Zebra mussel spread from Europe to the Great Lakes between the USA and Canada, causing great damage to the water projects, spending billions of U.S dollar. Cholera income derived from ballast water spread to many parts of South America, Gulf of Mexico and elsewhere. Disease in sea water fleas black water (water Cladoceran flea) spread to the Baltic Sea and development of very powerful, destroying creatures, indigenous phytoplankton, trapped fishing nets, gill nets, influence to the region's indigenous economy. Because of the impact of infectious diseases brought by ballast water is huge, Ballast Water Management Convention was adopted 2/13/2004 stated: The ship

ballast pumped out before the ship ballast water must be treatment. Currently the ballast water treatment is done by changing the ballast water. Regulation B-4 of the BWM Convention to make the request on the exchange of ballast water. Ballast water exchange can be done through one of three methods [2]:

Sequential method: Domestic ballast water tanks or pits are pumped out at least 95% by volume, and then, new ballast water is getting into alternative ballast water was pumped out.

Flow through method: new ballast water is pumped into underground tanks or ballast water is to push the boat out through the hole opened on the open deck. When applying this method, the volume of water is pumped through the ballast water tanks or pits must be at least equal to three times the volume of the bunker or tunnel.

Dilution method: new ballast water pumping from the top of the ballast water tanks or silos, and ballast water is pumped from the bottom of the bunker or tunnel discharge with a flow equivalent to ballast water discharge are received in order to maintain the water level in the bunker or tunnel has not changed. Similar to flow through method, the method of dilution, the volume of water is pumped through the ballast water tanks or pits must be at least three times the volume of the bunker or tunnel there.

When conventions WBM effect for different-sized ships, the ballast water exchange methods mentioned above will be phased out and eventually removed altogether and replaced by ballast water treatment measures. Ballast water treatment measures are applied to meet the criteria specified in Regulation D-2 of the BWM Convention. Systems and ballast water treatment equipment must be approved in accordance with Guide G-8 and / or process BWN G9 of the Convention (see Resolution MEPC.174 (58) and MEPC.126 (53)). Table 1 below presents a number of treatment systems.

Table 1. The ballast water treatment system has been type approved [3]

System Name	Maritime authorities approved	Guidelines and procedures apply
PureBallast-Alfa Laval	DNV on behalf of the Norwegian government	G8 & G9
OceanSaver®-OceanSaver	DNV on behalf of the Norwegian government	G8 & G9
Sedna®-Hamann AG	Germany	G8 & G9
Electro-Clean™- Techcross	Korea	G8 & G9
NEI Treatment Systems	Liberia and Marshall Islands	G8
Hyde Marine BWTS	LR behalf of UK Government	G8

However, these methods are very high cost. Method inert atmosphere of the aeration tank by inert ballast water into the tank to bring high-performance processors. This method has two main uses is to kill the organisms carrying the pathogen by means of inert chemicals in the water tank, to prevent oxidation corrosion of ballast tank leak caused Safe section.

2. TREATMENT METHOD

Ballast water treatment method on board inert gas is shown in Figure 1 below.

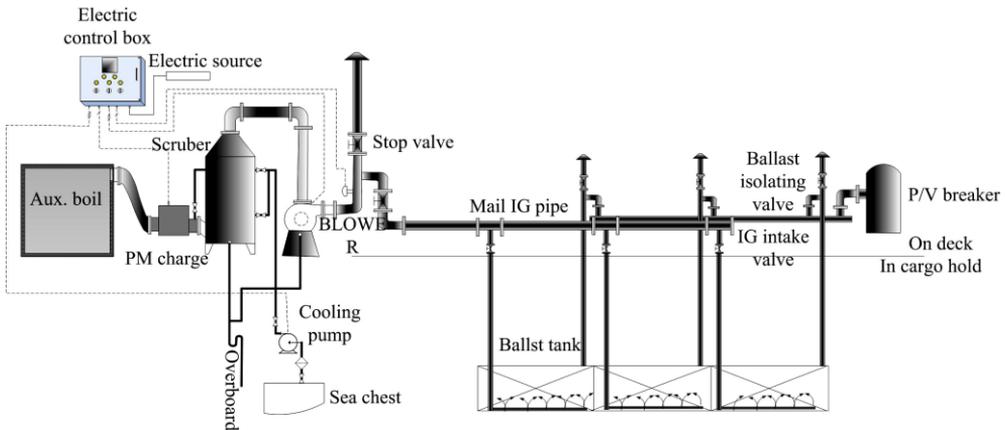


Figure 1. Ballast water treatment system using inert gas

Boiler exhaust gas is drawn through an electrostatic filter tower use sea water to filter exhaust gas and other impurities in Figure 2. Seawater cool down temperature of the exhaust gas from above 135°C to 10°C - 20°C . Electrostatic towers are steel cylinders containing a trap which has many doors. Each trap has been slotted cap taken on the door of "The Trap.". The sea water enter the tower from the top and flows through each trap. A series of walls are arranged to ensure that a trap was about 20mm deep in water. The "trap" at the bottom are arranged so that water is directed from the class "trap" to trap the other next. The exhaust gas before enter the tower it is charged by electrostatic charger. Where exhaust gas were positively charged, leading to the tower is then filtered through the water at the bottom cushion, going up over her husband "trap" it will in turn pass through the water layer in the "trap", through the slot of the slot cap which will distribute gas through the surface of the water system on the "trap.". Water will attract positively charged soot particles, virtually soot particles trapped in the trap. At the top of the cage "trap" people arranged a water separator and the waste gas. To remove the SO_2 in the exhaust gas the exhaust gas is discharged to the $\text{Ca}(\text{OH})_2$.

The exhaust gas after the filtration tower just left of CO_2 , N_2 inert gas, then a fan will be pushed into the inert gas system. Inert gas will be supplied in the space of ballast tanks. Inert in the process of aeration into the water, inert gas will gradually dilute O_2 concentration in the water and air space of the bunker. Normal levels of O_2 in seawater containing 5-6% range. From experimental results shown that when we went into the aeration tank of water to dilute it in water 2.5-3.5% depending on the O_2 in inert gas. However, when O_2 concentrations in water decreased to 2.5 to 3.5%, most organisms can not survive. Inert gas into the bunker should Jacuzzi filled with water to O_2 concentrations in water decreased to 2.5 to 3.5%, the amount of exhaust gas from the jacuzzi on the right by 0.5 to 1 times the tank volume and even can even larger. Aeration time should range from 4-6 hours. After scouring inert gas into the ballast tanks, the tanks must be isolated

from outer space. To solve this problem is on the front of the tank vent pipe to locate the valve. However, when the vent pipe is closed phenomenon will happen to change the pressure in the ballast tank when the tank temperature changes or when the waves. To overcome this, the vents will be connected to normal pressure regulation. This structure shown in Figure 3.

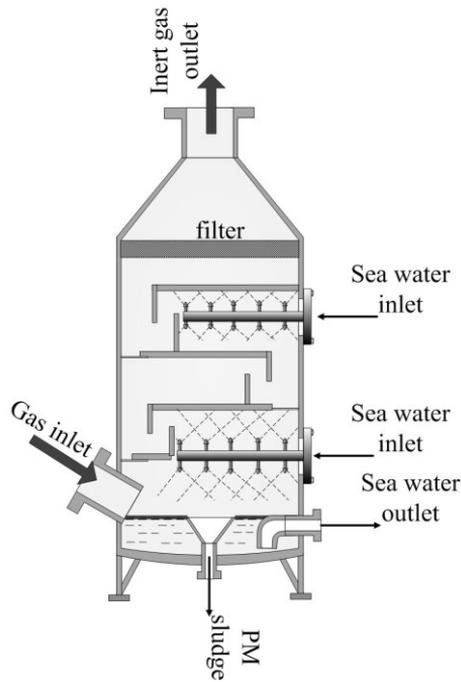


Figure 2. Electrostatic filter water tower

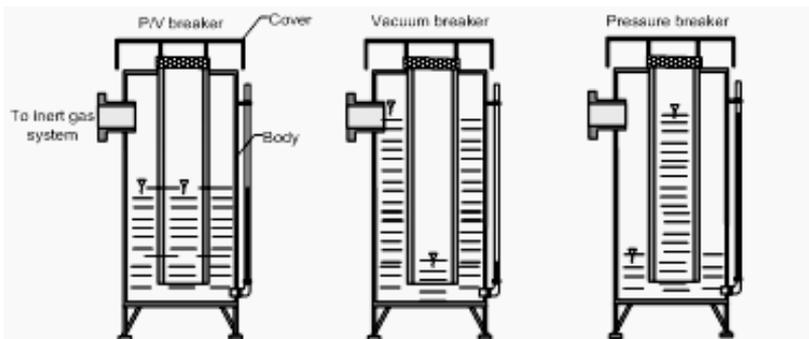


Figure 3. Average Pressure Regulator

3. DESIGN INERT GAS SYSTEM

Through experiments, the inert gas load Q_{IG} (m^3 / hour) with a total capacity of $\frac{1}{2}$ water tanks. To ensure a inert gas enter the ballast tank to reduce O_2 content about 2.5 to 3.5%, then it takes about 6 hours. Inert gas is loaded per second:

$$Q_{IGs} = \frac{Q_{IG}}{6 \times 3600} \quad \text{or} \quad Q_{IGs} = \frac{V_T}{12 \times 3600} \quad (m^3/s) \quad (1)$$

In which V_T = total ballasst water tank capacity (m^3)

Diameter of main pipe D [4]:

$$D = \sqrt{\frac{4 \cdot Q_{IGs}}{\pi \cdot v}} \quad (m) \quad (2)$$

Inlet pipe diameter d_i [4]:

$$d_i = \sqrt{\frac{4Q_{IGs}}{i \cdot \pi \cdot v}} \quad (m) \quad (3)$$

Where: i = number of ballast tanks, v = velocity of inert gas in the tank m/s. Q inert gas calculated by l / sec.

Tower diameter D_{scrub} : [4]

$$D_{scrub} = \sqrt{\frac{4 \cdot Q_{IGs}}{\pi \cdot v_{scrub}}} \quad (m) \quad (4)$$

v_{scrub} - Speed filter working in the tower m/s.

Tower high H_{scrub} :

$$H_{scrub} = 3D_{scrub} \quad (m) \quad (5)$$

Resistance calculated on the pipeline [4]:

$$\sum H_{tt} = \sum H_{\lambda} + \sum H_{\xi} \quad (mH_2O) \quad (6)$$

In which $\sum H_{\lambda}$ = Loss due to friction of flow on the pipeline, $\sum H_{\xi}$ = Partial loss [4].

$$\sum H_{\lambda} = \sum_{i=1}^n \lambda_1 \frac{L_i}{D_i} \cdot \frac{v_i^2}{2g} \quad (mH_2O) \quad (7)$$

$$\sum H_{\xi} = \sum_{i=1}^n \xi_1 \cdot \frac{v_i^2}{2g} \quad (mH_2O) \quad (8)$$

Where λ = coefficient losses along the way, ξ = local loss coefficient

Properties chosen head of the fan[4]:

$$H_{pan} = \sum H_{tt} = \sum H_{\lambda} + \sum H_{\xi} \quad (\text{mH}_2\text{O}) \quad (9)$$

Select the fan capacity[4]:

$$Q_{pan} = \gamma_{H_2O} \cdot H_{pan} \cdot Q_{IG} \cdot \eta_{pan} \quad \text{KW} \quad (10)$$

Where: η_{pan} = mechanical efficiency of fans, γ_{H_2O} = Specific gravity of water.

From these calculations, on the basis of Visual Basic 6.0 software, we will build software for the design of computing systems ballast water treatment with inert gas.

4. EXPERIMENTS

A production of inert gas chamber shown in Figure 4, this chamber with the use of DO to low-carbon fuel. Filtered water tower is a pyramid scheme using filtered water to neutralize many types of trap doors. Spraying water into the tower is taken from water tanks. Most of the larger soot particles are disposed in the trap. Soot particles are retained because they are positively charged in charging devices with potential for soot-loaded from a 10 kV. Most of the soot particles are separated in the filter tower. To remove SO₂ in the exhaust gas in a tank with air from 5-10kg Ca(OH)₂. Exhaust soot after being purified and the impurities are left mainly CO₂ and N₂ will be pushed out a fan. Partly through the election and lead the extract to reduce the temperature cooling down to temperatures greater than ambient temperature from 10⁰C-20⁰C, then passed through a flowmeter into the bunker and jacuzzi. Safe testing volume is 1 m³ inside the container nearly full of water. Drop in the bunker with some organisms such as fish, shrimp, crabs and oysters to check the results of treatment.

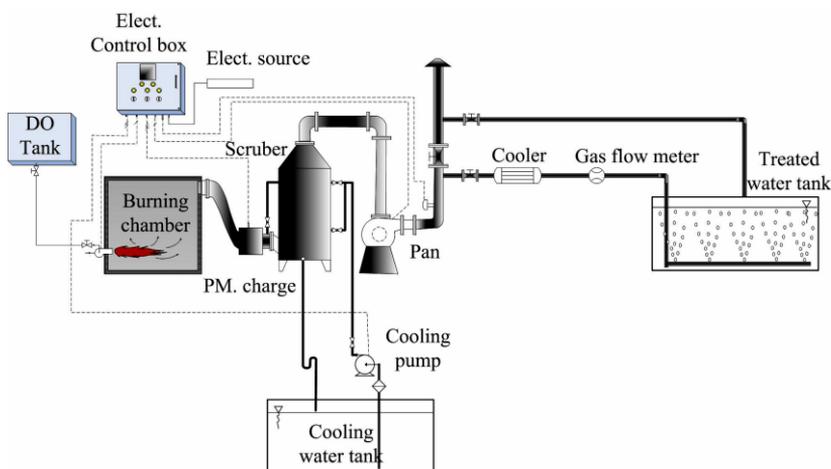


Figure 4. Experimental ballast water treatment system using inert gas

5. RESULTS AND DISCUSSIONS

Results of sampling and analysis components of the exhaust gases before and after electrostatic filter tower is shown in Table 2 below.

Table 2. The composition analysis of emission characteristics before and after filtering

	<i>Before</i>	<i>After</i>
CO ₂	30%	30%
CO	1,3%	0,0%
PM	1,0%	0,0%
O ₂	1,5%	1,5%
SO ₂	0,2%	0,0%
N ₂	66%	66%

In Figure 5, reflecting the results of treatment by living organisms in water by inert gas. In case we have an inert aeration is 50⁰C temperature in tanks filled with water until the measured concentration of O₂ in the country reached 3.5%, the amount of microorganisms that are destroyed very quickly. Within 5 hours to about 60% of organisms had been killed, and within 20 hours, virtually all of the creatures are destroyed. If the temperature inert gas into the tank scouring around 30⁰C with water contained in tanks, the tanks about ¾ effectively destroying inferior creatures. If the tank full of water and temperature inert gas in the tank is loaded into 30⁰C is more effective than biocides as well as the amount of water contained in the tank is not full, but less effective when inert aeration with high temperature, because when the water temperature is greater than 40⁰C, the organism is very difficult to survive. However, cases of water tanks filled with the same low-temperature scouring more realistic controller.

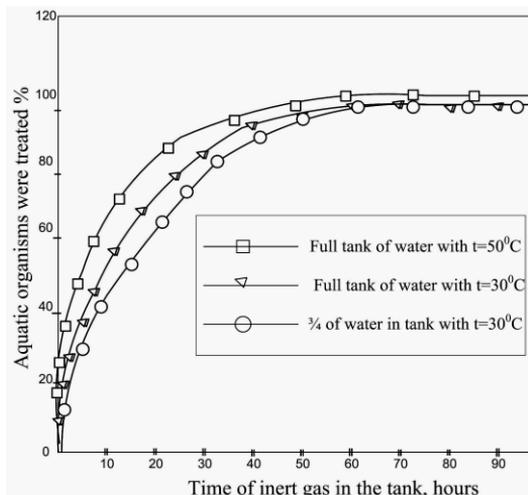


Figure 5. Results in the treatment of organisms with aeration tanks inert

On the other hand if the concentration of O₂ reduction in the bunker will reduce the oxidation tank shell steel tanks leak cause category. Steel oxidation process takes place as follows:



Therefore, reducing the surface leakage tank section. However, to do this is in the tank must always be loaded inert gas, even when the water is not safe ballast.

6. CONCLUSIONS

Use of ballast water treatment with inert gas can be an effective treatment in the future, because it meets the IMO requirements for water treatment systems are eliminated ballast to 90% and domestic animals have ballast. This method costs relatively low cost, non-toxic and environmental pollution. If equipped with water treatment systems on board inert gas ballast will reduce the likelihood of leaks Safe section. This is the main reason for the ballast water of red rust.

Besides inert gas system can also be used as a fire system for the cargo hold, the bunker oil on board very effective.

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