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Apply Optimarin Ballast System for Vietnam's Fleet to Prevent Sea Pollution from Non-Indigenous Aquatic Species

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Abstract

Marine species are usually transported from one area to another by the ballast water used to provide safe operation for vessels. After entering a new environment, they may cause damage to the local ecosystem, leading to the disruptions of the entire marine ecosystem, and seriously affecting not only biodiversity but also several industries such as fishing and aquaculture. Therefore, the United Nations (UN) considers the presence of non-indigenous oceanic species to be one of the top four serious threats to the global environment; and, how to effectively control the non-indigenous aquatic species has captivated the special attentions of several scientists worldwide. With the significant development in the maritime industry, strict requirements the control and management of ships' ballast water and sediments set by The UN's International Maritime Organization (IMO) have well shaped the trend in installing ballast water treatment systems. Among them, Optimarin Ballast System is preferably used in practice. However, currently, Vietnam's fleets use a different chemical method which is not utilized elsewhere in the world. Because it is not environmentally friendly and its effectiveness hasn't been validated yet, this paper suggests the application of OBS in the Vietnam's fleet in order to prevent sea pollution from non-indigenous aquatic species and minimize its associated negative impacts as well as make the Vietnam's fleet comply with IMO requirements in protecting the global environment for sustainable development.

Keywords*: Optimarin, Vietnam's fleet, sea pollution, ballast water system*

1. Introduction

In maritime industry, ballast water is used to maintain the stability and structural integrity of ships and ensure the immersion of the propeller and rudder in the unloaded passage as well as to restore balance during loading/discharge operations and fuel consumption; thus, it is critical to the safety of ship's operation. It is estimated that 3.000 – 4.000 million tons (Mton) of untreated ballast water are discharged from ships every year [1]. The UN's International Maritime Organization (IMO) estimates that 10 billion tons of ballast water is transported around the world [2]. That is actually a huge amount to be well managed for the safety of marine ecosystems because thousands of species of animals, plants and also microorganisms, such as bacteria, microbes, eggs, small invertebrate animals, cysts and larvae of many different species of flora and fauna, called non-indigenous species [3], are usually transferred from an aquatic ecosystem to another one through the charge and discharge of the ballast water. The International Convention for the Control and Management of Ship's Ballast Water and Sediments sets requirements to prevent the transfers of organisms. Several studies undertaken worldwide have shown that ballast water is a major facilitator of the transfer of aquatic organisms, including human pathogens, across natural boundaries [4, 5].

Therefore, the United Nations (UN) considers the presence of non-indigenous oceanic species to be one of the top four serious threats to the global environment [2]. At any given time, about 35.000 ships are en route on the water of the Earth and more than 3.000 species are being transported in their ballast tanks [2]. The past decade has seen a significant increase in

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the wide spread of species to new areas where they do not naturally belong to, creating an imbalance in ecosystems. It is a serious environmental threat because the invaders have no natural predators and the original species become extinct, leading to the disruptions of the entire marine ecosystem, i.e. the invasion of harmful species destroys the stabilization of an aquatic ecosystem, seriously affecting not only biodiversity but also several industries such as fishing and aquaculture [2]. Hence, the number and frequency of invasions of alien species in marine ecosystems has always been a permanent concern. As a consequence, how to effectively control the non-indigenous aquatic species has captivated the special attentions of several scientists worldwide.

Over the years, the global shipbuilding market has been in continuous growth, and undergoing profoundly changed process. Due to a significant increase in transport volumes and worldwide tourism, vessel fleets with larger dimensions dominate today's worldwide maritime traffic [6]. Along with this trend, serious concerns about environment pollution are raised. Therefore, better environmental requirements and stricter standards for not only physical components but also management solutions have been genuinely taken into consideration and implementation. Luckily, the origin of ballast water discharged in ports by large vessels is normally well defined according to vessel types and/or cargo. Thus, it is possible to undertake risk assessments for transport of ballast water from one area to another. The risk assessment approach allows differentiation on the use of treatment (exchange or any other type of treatment) based upon the risk posed by the ballast water transported [7]. In the past, there are 3 basic methods of ballast water exchange: Sequential, Flow-through and Dilution. But these methods were not effective for preventing non-indigenous species in the world.

Currently, chemical treating ballast water with chemical methods is widely used in Vietnam. Practically, one ton of ballast water is mixed with either 15g calcium chlorides with 70% concentration of Cl_2 or 50g of Chloramine B 100%. Based on the volume of each tank, the chemical should first be diluted and dissolved in a bucket before it is poured into the tank through its pipeline. In order to make a quick diffusion, it is suggested to use a pump system with fire-hose to continuously pump the ballast water in 20-30 minutes circulation until the chloride in the water reaches to 0.1 ppm level. The ballast water can finally be discharged after 1-2 hours later. Because the aforementioned treatment method used in Vietnam is not applied elsewhere in the world and its effectiveness has not been officially studied either, a new approach for a better efficient treatment becomes mandatory. From analysis above, it is most urgent that we operate to find the best of ballast water system to apply for Vietnam's fleet in particular and all ships in the world in general.

In order to match the trend for sustainable growth of the industry and completely resolved non-indigenous species problems, Optimarin Ballast System (OBS) with high-quality plastic piping solutions for ballast systems, ballast water treatment and other shipbuilding applications has been developed to unravel these technical, operational and environment challenges [2]. After several years of testing, developing and patenting new technology, OBS was finally approved for its purification system in 2009, in accordance with Guideline 8 and "The International Convention for the Control and Management of Ship's Ballast Water and Sediments, 2004". Since then, the OBS always uses approved technology that significantly exceeds the stringent requirements set out in the IMO Convention [2]. As a consequence, OBS is preferably used in practice. Hence, this paper suggests using the OBS on the ships of Vietnam's fleet to prevent sea pollution from non-indigenous aquatic species.

2. Sea Pollution from Non-Indigenous Aquatic Species in Vietnam

Vietnam, located on the eastern seaboard of the Indochinese Peninsula, is situated on a strategically important trade route between the Indian and Pacific Oceans [8]. Vietnam's mainland is edged by a substantial area of shallow, submerged continental shelf (part of the Sunda Shelf) and thousands of islands are distributed along the coastline from north to south [8]. The coastal zone of Vietnam forms a large interface between land and sea. It contains a number of unique coastal ecosystems with valuable tropical natural resources such as; deltas, lagoon, coral reef, estuaries, tidal marshes, mangrove and upwelling areas etc.

Until 2013, Vietnam has 1.772 vessels with 7.284.000 DWT (Deadweight Tonnage), accounting for 0.45% of the world total volume [9]. The latest data from Vietnam Register [10] show that in the last two years, several shipping companies have been in huge difficulty and

some have gone bankrupted, leading to the significant increase in stopped construction projects and decommissioned ships. Particularly, among more than 150 new ships under construction, 103 pieces have been brought to a standstill [10]. As a result, Vietnam's fleet has been seriously weakened. Specifically, in 2012, there were 260 marine transportation companies, but until August 2014, only 140 companies exist, i.e. a significant decrease rate of 46% [10]. Besides, ocean-going vessels with a total tonnage of at least 500 GT were decreased 73%, from 765 to 372 units. In addition, the decline of 22% in the number of inspected vessels of the same period, from 1.022 units in 2013 to 797 units this year further indicates the ominous shrinkage of the Vietnam's fleet.

3. Optimarin Ballast System [11]

OBS is using ultra violet (UV) radiation as primary treatment. It uses high pressure UV lamps, which produce UV light at wavelengths ranging from 100 - 700 nano meters, which is within the visible spectrum. High pressure UV lamps also produce less UV light with germicidal properties, and operate at temperatures 500 - 600 degrees Celsius [12]. UV exposure is usually used during the intake and discharge of ballast water. However, as UV light penetration is remarkably lowered in turbid water, the effectiveness of using UV to inhibit micro-organisms reproduction is consequently degraded [1].

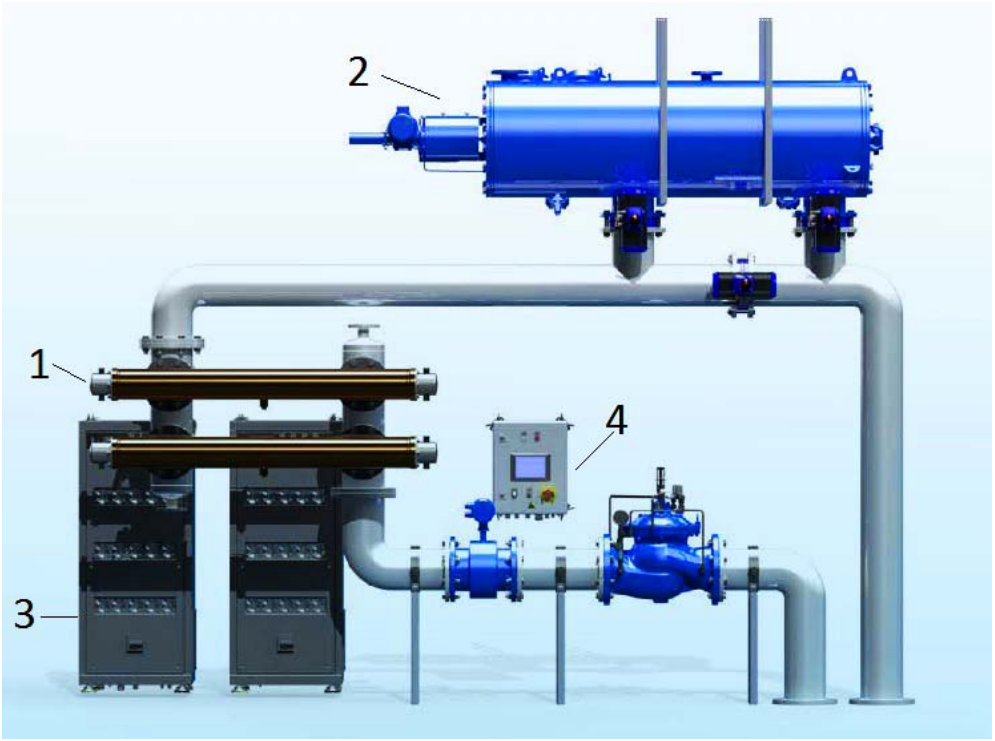

Figure 1. OptiMarin Ballast System

3.1. Installation Location

As every ship has reserved space for a ballast water treatment system, the location for OBS should not be an issue. However, it is important to check if the system fits in the reserved space; otherwise, some other arrangements become a must before the installation. Optimally, the system should be located close to the ballast water pumps, where other components, like starter panels and cabinets may be located as close as possible if space permits because it will reduce the installation cost, and also make the piping arrangement easier. Practically, the location for its installation is not a big problem because the space for a treatment system on a particular ship is bigger than expected; thus, there is enough space for maintenance or other

activities. Moreover, the control panels are relatively flexible when it comes to location. It is reasonable to assume that the local control panel should be mounted at a bulkhead, or directly on one of the treatment units.

The figure 1 shows a typical layout of a 334 m^3/hour OBS Position 1 is used for the MicroKill UV reactors; Position 2 is for the MicroKill filter whereas Position 3 and 4 are for control systems. Position 4 is most likely the local control panel while Position 3 is the remote control panel.

Table 1 displays the dimensions for a typical OBS system of 334m^3/hour. Basically, with these figures, the location for its installation is not a big problem because the space for a treatment system on a particular ship is bigger than expected as shown in Figure 1. Moreover, the control panels are relatively flexible when it comes to location. It is reasonable to assume that the local control panel should be mounted at a bulkhead, or directly on one of the treatment units.

Table 1. OptiMarin estimated dimensions

The Installation Cost	Footprint	LXB
MicroKill UV reactor	1.8 m^2	4x0.45 meters
MicroKill Filter	0.76 m^2	Radius: 0.5 meters
UV Power supply unit	1.8 m^2	4x0.45 meters

3.2. Installation and Operational Costs

The installation cost combined with investment cost will be the most important factors when deciding on a ballast water treatment system. For OBS, the estimated installation cost is $180.000, where the majority would be used on the electrical system. The installation costs are based on standardized prices from Asian shipyards, and it is assumed that the system can be installed during a scheduled docking [11]. Practically, the maintenance of OBS is usually the replacement of UV lamps whose lifetime is expected to be 1.000 hours in operation. Normally, a ship will fill about 90% of the volume of the ballast tanks in each operation. Therefore, for a tank with a total ballast volume of 5.000 m^3, a UV lamp can be used for approximately 155 operations. Consequently, along with the replacement of filter and associated activities, the maintenance cost is considered bearable compared to the initial installation and primary investment.

3.3. The Advantages of OptiMarin Ballast System

OBS is an environmentally friendly ballast water treatment system because it has been developed based on the use of filtration and UV light for the efficient removal and inactivation of marine organisms. The OBS is one of very few treatment options that do not use or generate chemicals or biocides in its treatment or cleaning processes. It was designed in the motto of being environmentally sound, simple, flexible and easy to install, and capable of operating on both new builds and existing vessels [2]. The installation of OBS is easy and simple because OBS is a modular system which is very flexible, with a relatively small footprint and weight; thus, it well fits vessels of all kinds and sizes. It can accommodate a wide range of ballast water capacities and can handle flows up to 3.000m^3/hour (or higher upon request) [2]. The OBS is normally installed in the pump or engine room and in close proximity to the ballast pump. The OBS can be delivered in a container, on a skid or in separate pieces to allow easy installation in almost any available space. The equipment can also be installed horizontally, vertically, on or suspended below deck, along the ship's side or in several separate locations. It is relatively low weight and adds no extra noise. The OBS utilizes every square meter and does not require much space, making it a cost-efficient solution [2].

OBS consists of standardized components because it is a modular system for all flow configurations. All UV spare parts can be used for any system capacity which provides simple procurement and logistic operation for both owners and operators of large and diverse fleets. The filters are also standardized so that in any system, only a few filter sizes are used regardless of the system capacity. The maintenance is easy because OBS is designed based on a simple and reliable structure with few movable parts; thus, it requires little or no system

maintenance and ensures operational reliability. Compared with other systems of similar functions, the OBS has fewer parts and UV lamps, i.e. OBS is much simpler. The patented UV chamber in CuNi, the high water flow and high UV intensity make the UV lamps and the internals of the UV chamber self-cleansed and ensure a relative long service life. A self-cleaning UV system combined with the automatic back-flushing filters results in a minimum requirement for system cleaning and maintenance for the ship's crew [2]. The power consumption of OBS is optimized because the OBS can automatically adjust the power consumption according to UV intensity which is based on the water quality (turbidity, etc.) during ballasting. As such, OBS can easily meet the stringent California standards.

3.4. The Disadvantages of OptiMarin Ballast System

Despite the above marvelous advantages, the investment and installation of an OBS should be carefully considered because of the following hindrances [11].

(1) OBS is operated with several sensors which can be a key disadvantage because they sometimes provide incorrect information about the current operation condition of the system.
(2) The UV lamps in OBS have the shortest expected lifetime.
(3) The initial investment and installation cost of an OBS is sometimes unbearable because OBS is the most expensive system.

4. Practical Applications

Ballast operation will be simple and reliable with an OBS. During the intake, the ballast water flows through OBS's proprietary 40 filters which remove larger organisms and particles and then back flush them overboard at the ballasting location. After passing the filter, the ballast water continues through the UV chambers on its way to the ballast tanks. The UV light kills or inactivates organisms, viruses and bacteria in the ballast water. During the discharge, the ballast water also passes the OBS for the second UV-treatment to make sure it is well treated prior to its dismissal [2]. OBS has been selected as a preferred ballast water treatment system in several projects and successfully installed on many vessels. For example, OBS was chosen for Farstad's new build program. With the presence of OBS installed on board, Farstad vessels won the “Far Solitaire” award [2]. Similarly, Grieg Star, the owner of one of the world's largest open hatch fleets, has also chosen the OBS for several of their new build vessels [2].

5. OBS Application Trend in Maritime Industry

In 2004, the IMO adopted an international convention for the control and management of ships’ ballast water and sediments. The agreed requirements came into effect for not only all new vessels built from 2012 onwards but also older vessels so that the transfer of harmful organisms in ballast water will be completely removed from 2016 [2]. Particularly, it is estimated that at least 35.000 vessels in the existing fleets worldwide have to install systems for the purification of ballast water by 2016. In addition, 1.200 new ships built each year will need such a system [2]. Therefore, in the next few years, all of the operating ships that have ballast tanks must have installed systems to purify the ballast water. To make a valid schedule for the installation of a ballast water treatment system, IMO promulgated that since 2009, all newbuilds with the ballast water tank up to 5.000 m^3 must strictly follow the specified requirements which are then applied to all newbuilds from 2012; and the existing vessels with the ballast water tank capacities between 1.500 m^3 – 5.000 m^3 must be pursuant to the rules by 2014 while others must comply since 2016 [2]. With the above requirements from the Convention, the Vietnam’s fleet must also renovate themselves to adapt to the global trend. Based on the key advantages provided by OBS as mentioned above, it is therefore suggested to be installed on Vietnamese ships in order to prevent sea pollution from invasive species in compliance with the required standards by IMO.

6. Conclusion

The development of more effective and environmentally friendly treatment technologies has become an urgent issue. In this paper, we introduced Optimarin ballast system, one of the

best ballast water systems in the world. As the benefits in terms of quality and reliability from the application of this suggested system outweighs the huge initial investment cost, the Optimarin ballast system is strongly suggested as a suitable choice for its installation in Vietnam's fleet to prevent sea pollution from non-indigenous aquatic species. The OBS will not only minimize the associated negative impacts on human health, environment and economy but also make the Vietnam's fleet comply with IMO requirements in protecting the global environment as well as marine ecosystems.

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