

Below please find a brief, technical description of the DESMI Ocean Guard Ballast Water Treatment System. Part of the system has a Patent Pending Status due to new technology within the Ballast Water Treatment Technology.

Introduction to technology

DESMI Ocean Guard A/S is applying for the Basic Approval of the DESMI Ocean Guard Ballast Water Treatment System (BWTS) with the International Maritime Organization.

The DESMI Ocean Guard BWTS is composed of pre- and after-treatment modules to disinfect aquatic species in the ballast water. The treatment system comprises mechanical filtration in combination with a photo-catalysis based advanced oxidation process (AOP) based on ozone and ultraviolet radiation (UV).

Generated ozone is injected in the water flow; reaction takes place in an Enhanced Ozone reaction reactor. Residual gaseous ozone is decomposed in an excess exhaust system from the Enhanced Ozone reaction reactor. Soluted ozone remaining after the reactor is decomposed completely in the UV step, in an advanced oxidation process, leaving no residual ozone or other oxidants from the ballast water treatment process.

Due to the highly efficient combination of low concentration ozone and UV radiation in an advanced oxidation process (AOP) ensuring oxidant free treated water, the DESMI Ocean Guard technology can be viewed as a stand alone unit without effect on ballast tank or the environment. Because the UV-C technology is very intense compared to the low ozone concentration in our system, even in water without oxidation potential, residual oxidant levels are very low.

UV

DESMI Ocean Guard is using LPUV lamps due to low surface temperature and more UV radiation compared to energy consumption. Further the low surface temperature will require no chemicals for cleaning the UV lamps.

Ultraviolet technology is proving more and more successful and is used as an acknowledged, cost-effective and reliable process. UV-C radiation as disinfection means is well known for almost a hundred years and is used widely in the disinfection of portable water, aquaculture waters, cooling water, hot water systems, ultra pure water, foodstuff industry, medicine, bottling of drinks, etc. It is used primarily wherever the microbiological requirements are particularly high, or where chemical disinfectants are unacceptable for quality or environmental reasons.

The use of UV-radiation as disinfection energy results in no change of the chemical compositions pH-value, temperature, salinity, taste, odor and color of the solution being treated, and safety issues related to the handling and storage of Active Substances or other chemicals are eliminated.

Ultraviolet disinfection requires a minimum dosage to be effective. The applied dosage is a function of the lamp intensity and the exposure time. These parameters are directly affected by equipment configuration, flow path of the water along the bank of lamps and the turbidity of the water to be disinfected. Compared to mid- or high-pressure lamps, low-pressure lamps can only operate with lower power intensity, but they have a much better efficiency of about 40%. Using high- or mid-pressure UV lamps, the operating costs will be higher but the number of needed lamps less.

It is a scientifically well-known fact that resistance of organisms like bacteria, viruses, moulds or fungal spores to ultraviolet radiation is not developed. Most pathogenic germs are especially

sensitive to UV-radiation. An important advantage of physical disinfection is that the sensitivity to UV still functions even when germs have already built up resistance to conventional disinfection measures such as alcohol, antibiotics, chlorinated chemicals, etc.

To address all the mentioned needs, UV-radiation technology provides a powerful barrier to chemical contaminants while simultaneously disinfecting to avoid the dispersal of invasive aquatic species by ballast water from ships.

OZONE

Ozone is one of the strongest known oxidants. It can be used to technically burn dissolved compounds (oxidation). The extra oxygen radical in an ozone molecule quickly binds to each component that comes in contact with ozone molecules. This is because of the instability of ozone and its inclination to return to its original form (O₂). Both organic and inorganic substances may be oxidized by ozone, but also microorganisms such as algae, viruses, bacteria and fungi. This causes the extra oxygen radical to be released from the ozone molecule and to bind to other materials, so that only pure and stable oxygen molecules (O₂) are left.

As a result of the above-mentioned reaction mechanisms, ozone can be used for a large variety of purposes. Ozone is mainly applied in waste water and drinking water purification.

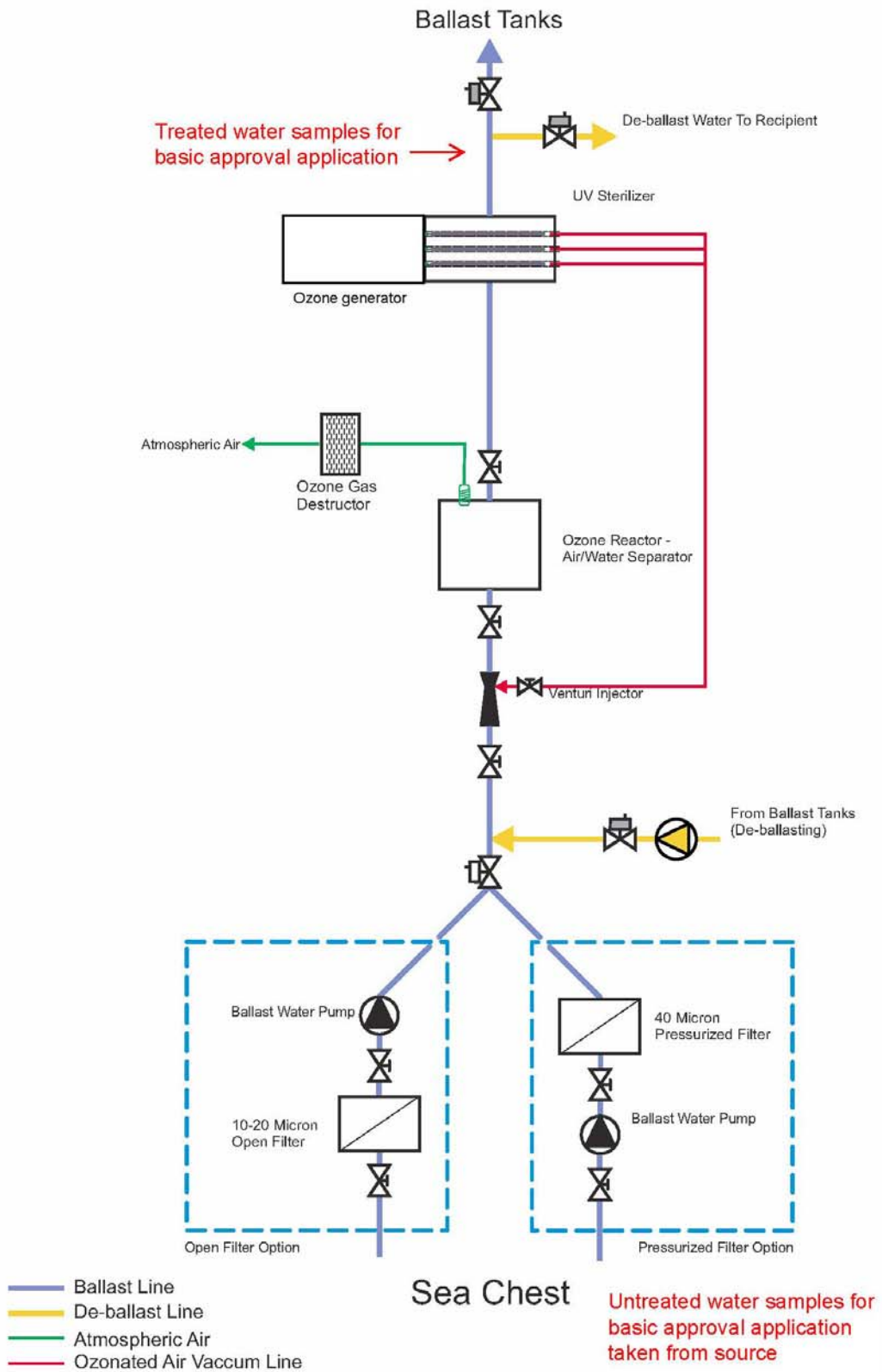
FILTERS

Two different particle filter systems can be applied at the DESMI Ocean Guard BWTS. The base configuration is an open pressure-less filter. This filter will use screens with pore sizes of 20 micron. In an alternative configuration a standard pressurized filter with screens of 40 micron will be used instead. The ballast pump will then be installed upstream.

The pressure less micro screen filter will provide significant filtration, which results in a much lower power consumption of the subsequent disinfection and also reduced accumulation of silt in the ballast tanks. In addition free flow filters have the advantage that the water is not forced through the filter as is the case with pressurized filters. This means that no soft organisms are pushed through the filter. This is known to occur in pressurized filters.

Both filters remove particles so that the efficiency of the succeeding disinfection step is secured. It is only the incoming ballast water, which will pass the particle filters. When de-ballasting, the water bypass the particle filter and is pumped directly to the following disinfection units.

System overview



TECHNICAL DATA

The treatment system is designed as a modular system. In order to reduce space requirements, all units can be installed independently.

Space requirement is for:

2 * 300 m ³ /h ballast water flow:	7/15 m ²	(40micron filter/20micron filter)
1500 m ³ /h ballast water flow:	12/35 m ²	(40micron filter/20micron filter)

Power requirement is for:

2 * 300 m ³ /h ballast water flow:	40/25 kWh	(40micron filter/20micron filter)
1500 m ³ /h ballast water flow:	135/85 kWh	(40micron filter/20micron filter)

Waste water flow from filter flushing is typically less than 2% of the ballast water flow. The waste contains no added substances and will be returned to the sea.

PERFORMANCE TEST

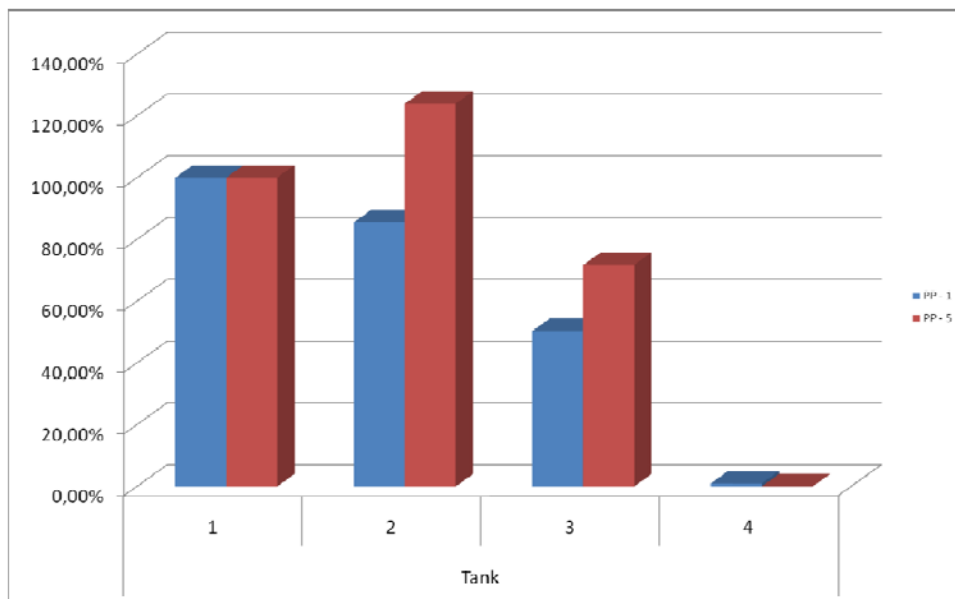
DESMI Ocean Guard BWTS has undergone a pilot scale performance test at DHI, Denmark, in April 2009.

The overall conclusion of the performance test was:

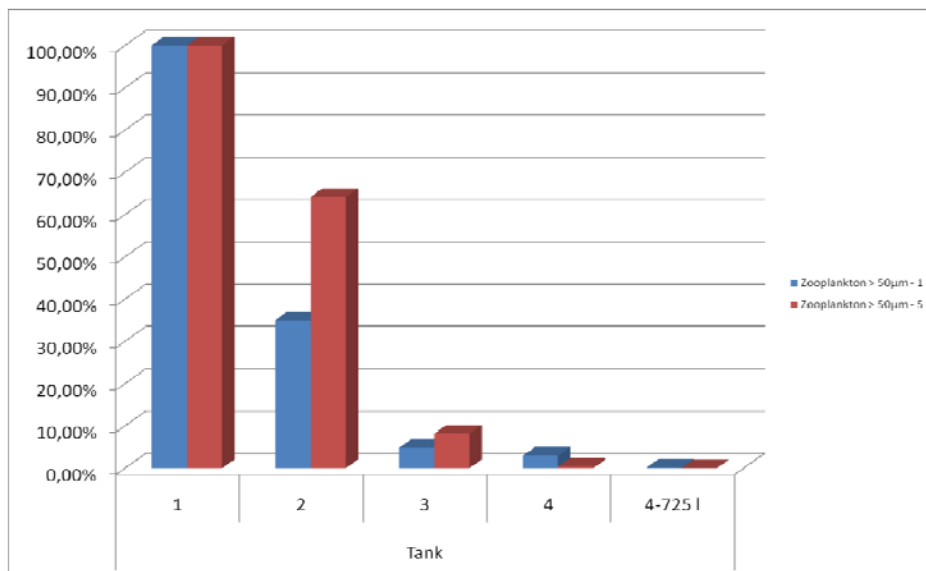
The results of the investigations shows that the BWTS removes the living algae to 1 % at day 0 and less than 0.01% at day five which is in compliance with the requirements of the IMO convention on ballast water. The filter allows some of the algae to pass the treatment but they are not in a viable state.

The reduction of the heterotrophic plate count shows a reduction to between 0.03 and 2 % which is believed to be sufficient to remove any bacterial contamination to a level that comply with the IMO requirements.

Organisms < 50 µm



Organisms > 50µm



DESMI Ocean Guard ADVANTAGES

- Filtration down to 20 micron drastically lower sludge problems in ballast tanks.
- Filtration down to 20 micron lower needed power consumption in disinfection step.
- Filtration down to 20 micron means that a major part of micro life, including the main algae biomass, is filtered out before the disinfection steps.
- The double disinfection strategy with both ozone and UV ensures best possible quality of ballast water no matter how colored or how high turbidity is in the feed water.
- The application of low-pressure radiation and ozone in an advanced oxidation process generates short lived radicals boosting disinfection power. The exact dimensioned low-pressure UV step ensures that no ozone or radicals of ozone is left after the treatment process ensuring safe deballasting and protection of ballast tank coating.
- The application of low-pressure UV and Ozone generated, based on analysis of treated water, none harmful chemicals during the treatment process.