A pressure/vacuum (P/V) valve helps isolate the tank atmosphere from the external atmosphere, yet allows for small changes as per pressure variations inside the tank.

Examples of the commercial use of deoxygenation/supersaturation technology within a ballast water treatment are OceanSaver and Venturi Oxygen Stripping (VOS). Both systems are particularly cost effective for vessels with larger ballast capacities and many orders have been taken for installation onboard large tankers. The Coldharbour BWTS was specifically designed for use with large tankers and LNG/LPG vessels. It should be noted that the upgraded OceanSaver Mark II system offers supersaturation only as an option to reduce corrosion.

14.2.4 OceanSaver Ballast Water Management System

The OceanSaver BWMS is manufactured by OceanSaver AS. While the original system (Mark I) combines several treatments to disinfect ballast water: filtration, cavitation, deoxygenation and production of active substance onboard (in the C2E™ unit), the updated and streamlined Mark II system uses an improved filtration unit as well as the C2E™ disinfection unit, and is only operated during ballast water intake. The N₂ supersaturation process present in the Mark I system is now an optional feature in the Mark II, installed to reduce corrosion. Due to the improvements in the filtration unit, the energy demanding cavitation units have become unnecessary and are not part of the Mark II offering.

The Mark I OS BWTS was Type Approved in April 2009 and during 2010 achieved a particularly high order number for OceanSaver BW systems onboard large tankers. The Mark II upgraded system requires new Type Approval (although the IMO Final Approval for the Mark I system covers the Mark II), the system has completed and passed all tests and TA is expected in October 2011. As well as servicing larger vessels, the more compact Mark II system is also suitable for medium sized vessels and retrofit situations.

14.2.5 Venturi Oxygen Stripping™ (VOS) BWMS

The VOS system has been designed and is manufactured, sold and supported by the US company N.E.I. Treatment Systems. The system was granted Type Approval in September 2008. It is licensed for manufacture, sales and service in Japan by Mitsubishi Kakoki Kaisha and called the Mitsubishi-VOS system. In Korea the VOS system is called the Samgong-VOS and licensed by Samgong Co.

The VOS system is a single unit treatment that has a combination of effects on the ballast water: deoxygenation ($O_2$ concentration reduced to 0.2 mg/l to 1 mg/l), reduced pH (between 5.5 and 6) and cavitation in the Venturi injector. The Stripping Gas Generator (SGG) produces the inert gas when necessary which, when combined with the mechanical effects of the Venturi Injectors, leads to the removal of 95% of the dissolved $O_2$ in less than ten seconds.
The VOS treatment is applied on ballast intake, but air is added back into the ballast water prior to discharge, by passing the ballast water through the Venturi Injector system again but reversing the process. This ensures that the water is re-oxygenated and it is safe for marine life at the deballasting site. The system’s operational efficiency is unaffected by ballast water turbidity or temperature, and all salinities of ballast water can be treated effectively.

14.3 Magnetic/Electric Fields Technology

The technology of coagulation and flocculation is popularly used for the process of tap water purification. However, the normal tap water purification process takes a long time and requires a large amount of space for treatment.

By using superconductor bulk magnets, more than 90% of the particles in the contaminated water can be removed in about 5 minutes. The system has the capability to purify water continuously at a high speed within a limited space. This technology has the advantage of not using any disinfectants and so has no biological toxicity. The levels of mud/sediment and dead microorganisms in ballast tanks are greatly reduced and this leads to the treated ballast water being less abrasive to the internal coating of the ballast tank.

An example of the commercial use of magnetic technology within a ballast water treatment is ClearBallast.

14.3.1 ClearBallast Ballast Water Purification System

The ClearBallast BWPS consists of a combination of stages that are applied to ballast water on ballast intake only. The system is produced by Hitachi Plant Technologies and gained Type Approval in March 2010.

Magnetic flocculants are added to the ballast water, causing suspended particles, like aquatic organisms and sediment, to aggregate into larger flocs. The magnetic separation technology then removes these flocs from the ballast water and the sludge is removed to the sludge tank. Any remaining flocs are removed by the next stage, the filter separator. This technology uses coarse filters to further clean the ballast water before entry into the ballast tanks.

Since ClearBallast uses no chemical disinfectants, there is no risk from any residual oxidants in the ballast water causing harm to the environment after discharge. Similarly, there is no need for a neutralisation step in the process. The system is not dependent on the salinity of the incoming water and works equally efficiently for seawater, fresh and brackish ballast water.

14.4 Ultrasonic Technology

This technology has been successfully applied to control microorganisms in the food processing industry and in land-based water treatment applications.
19.43 Venturi Oxygen Stripping™ (VOS) Ballast Water Management System

**Name of System:** VOS BWMS  
**Manufacturer & Country:** N.E.I. Treatment Systems, USA  
**Status:** Type Approved 2nd September 2008  
**Office of the Maritime Administration, Marshall Islands**

### Overview of System:
The VOS (Venturi Oxygen Stripping™) System uses an inert gas generator to strip dissolved oxygen and also the mechanical disruption of aquatic organisms through cavitation using Venturi injectors. This leaves the ballast water effectively sterilised. Ballast tanks are filled with inert gas to maintain a low oxygen environment.

### Company:
The VOS system is designed, manufactured, sold and supported by N.E.I. Treatment Systems of Los Angeles, USA. In Japan, the VOS system is called the Mitsubishi-VOS and it has been licensed in Japan for manufacture, sales and service by Mitsubishi Kakoki Kaisha (MKK). In Korea, the VOS system is called the Samgong-VOS and has been licensed by Samgong Co Ltd.

### System:
The Venturi Oxygen Stripping™ (VOS) System uses inert gas deoxygenation to create the inert gas that will be mixed with ballast water after it passes through the Venturi injectors. A cavitation process with the inert gas leads to the removal of oxygen dissolved in the ballast water. In less than ten seconds, 95% of dissolved oxygen is removed from the ballast water, leaving the water hypoxic and slightly more acidic. Prior to discharge, the ballast water passes through the VOS Venturi injectors again, the process is reversed and the water rapidly re-aerates.

### Features:
Features include:
- No use of dangerous chemicals
- Comes in six standard models to reflect the wide range of ballast water flow rates of different sized vessels, and can be custom designed to accommodate unlimited flow-rate capacity
- Intrinsically safe
- Significant decrease (up to 84%) in ballast tank corrosion due to the low oxygen environment
- Efficient operation occurs irrespective of water salinity, turbidity or temperature

### Further Technical Details:
The system is a single unit treatment that has a combination of effects on unwanted organisms in ballast water:
- Reduced oxygen levels (0.2 to 1 mg/l)
- Lowering of the pH to between 5.5 and 6
- Mechanical disruption (cavitation) as the organisms pass through the Venturi injector.

All these factors combine to eliminate the organisms effectively.

The VOS system begins treatment as soon as water is drawn into the vessel, and when the water enters the ballast tanks it has been almost entirely stripped of oxygen. The deoxygenated ballast water does not cause the usual corrosion of ballast tanks, with the coating life extended and steel corrosion reduced by up to 84%. On discharge of ballast water, air is added back into the ballast water so that marine life in the area surrounding the vessel is not adversely affected by large quantities of deoxygenated water. All salinities of water can be treated by this system.

The N.E.I. VOS has six standard models ranging from VOS-500, which has the ballast water capacity range of 300 m³/hr to 850 m³/hr, up to the VOS-6000, which has the ballast water capacity range of 5,200 m³/hr to 6,800 m³/hr.

### News:
- **May 2010** – APL Ltd of Singapore teamed up with N.E.I. Treatment Systems and was accepted into the US Coast Guard’s Shipboard Technology Evaluation Program (STEP) for evaluation of an N.E.I. Ballast Water Treatment System (BWTS) installed on the APL ‘England’, a 5,500 TEU container vessel.
- **July 2010** – N.E.I. delivered the first of six VOS Ballast Water Treatment Systems (BWTS) to Dayang Shipyard in China for installation on the first of six 116,000 DWT bulk carriers being built for Hartmann Reederie of Germany. The six 4,400 m³/hr VOS Systems were the world’s largest BWTS installed to that date, four of which were scheduled for delivery in 2010 and the remainder in early 2011.
- **September 2010** – N.E.I. licensee Samgong VOS Co Ltd of Korea received an order from Hyundai Samho Heavy Industries (HSHI) for four Venturi Oxygen Stripping™ (VOS) to be installed on four 318,000 DWT VLCCs being built for SAMCO Shipbuilding Pte Ltd of Singapore. The order represents the largest VOS order to date for the Hyundai Group, the world’s largest shipbuilder.
- **August 2011** – The VOS-6000 BWTS onboard the first of four VLCC vessels built by HSHI in South Korea (see above) has been successfully commissioned during sea trials. Also, N.E.I. received an order for two 6,300 m³/hr VOS BWTS systems to be installed onboard two 320,000DWT VLCCs being built by Bohai Shipbuilding Heavy Industry for Sovcomflot in Russia.

As of August 2011 N.E.I. has eighteen major projects currently underway and projects queuing in the pipeline.