

## **Ballast treatment - the options**

### **A progress report on some of the ballast water treatment technologies currently being developed**

#### **Degussa Peraclean® Ocean**

Degussa is a world market leader in the production of speciality chemicals and one field of expertise is peroxygen chemistry. Degussa has been developing a chemical ballast water treatment method based on this chemistry since 1996, and the end result is Peraclean® Ocean, a special formulation created and tested in laboratory experiments, field trials and in ship ballast tanks.

Degussa is currently helping several interested companies which are exploring ballast treatment options based on the separation of solids plus a dosage of Peraclean® Ocean. The chemical producer is also supporting the planned application of Peraclean® Ocean on merchant ships as part of a series of fullscale trials. Peraclean® Ocean can be applied either as a stand-alone treatment or after the separation of solids, e.g. species and particles down to 50 microns ( $\mu$ ).

To support the field trials and the first fullscale merchant ship trials, Peraclean® Ocean can be shipped around the world in quantities from 20 litres to 20 m<sup>3</sup>. A global distribution network for the chemical is now being implemented in association with shipping industry logistics specialists.

According to Rainer Fuchs, senior manager environment chemistry for Peroxygen Chemicals at Degussa, "Peraclean® Ocean is a viable tool for ballast water treatment because of the following:

1. it is highly effective at killing bacteria, yeasts, viruses, moulds, spores, algae, protozoa, zooplankton, phytoplankton and larval stages directly after dosage to incoming ballast water;
2. it degrades in the ballast water with a short half life, i.e. hours or days, depending on water salinity, pH and temperature;
3. its degradation products are readily biodegradable;
4. it can be used both as a stand-alone treatment and after the separation of solids; and
5. it is suitable for use in treating the high volumes of ballast water encountered in tanker ballasting operations because dosage is quick and proportional to the ballast water uptake and very little electrical energy is required for the dosing pump."

#### **OptiMar UV radiation**

OptiMarin AS is currently involved in several BWM projects using its OptiMar technology. For a start, the result of tests conducted onboard the cruise ship Sea Princess in autumn 2002 on the US west Coast, while the company is preparing for another test project together with the California State Land Commission onboard the container ship Pfeiffer in June 2003.

Another upcoming test project is that involving the chemical parcel tanker Stolt Aspiration. The trial will be funded by the Great Lakes Environmental Fund and is planned to take place this summer. The MicroKill UV system on the parcel tanker represents the first EEx-certified UV system installed onboard a ship. Lastly, OptiMar systems are being delivered for installation on two newbuildings for Wagenborg in the Netherlands. The systems are the largest yet delivered by OptiMar. Each of the two ships will have a ballasting capacity of 1000 m<sup>3</sup>/hour.

The OptiMar ballast treatment strategy uses separation as a pre-treatment and ultraviolet (UV) irradiation as the main treatment. OptiMarin AS is participating in the EU-funded TREBAWA project which is investigating ways of optimising the two components to achieve the best possible total treatment.

OptiMarin AS has also enhanced its own technologies and developed a new patent-pending filter separator which combines separation and filtration technologies into one device. Initial trials have been carried out at the University of Hertfordshire in the UK and these will be continued over the next year. OptiMarin has also developed a new medium pressure UV system that enables the construction of equipment which provides higher flows yet takes up less space onboard the ship.

"OptiMarin AS is the first and, as yet, the only vendor with a shipboard ballast treatment installation," states Birgir Nilsen, OptiMarin vice president business development. "We have five installations running and two more being built. This provides valuable knowledge and experience that enables us to be prepared and able to meet the challenging demands from the shipping industry and environmental regulators.

"Having said that, there is still a lot of work that needs to be done. We continue to work with marine scientist and institutions on ways of increasing the efficiency of removing organisms and supplying trouble-free equipment that is easy to install and operate onboard ship."

One area OptiMarin is continuing to investigate is larger tankers. The existing technology has relevance to all but the largest tankers, and the company has developed explosion-proof equipment that complies with the strict regulations governing pump room installations onboard tankers.

"The largest tankers have ballast pumps with capacities up to 3,000-4,000 m<sup>3</sup>/hour which our system is presently unable to cope with," explains Birgir Nilsen. "Our present separators can handle up to 2,900 m<sup>3</sup>/h and we can install several separators in parallel to increase the flow. Our MicroKill UV, which has an explosion-proof certification issued by NEMKO in Norway for use in tanker pump rooms, has a capacity of 200 m<sup>3</sup>/h.

"We are currently working on larger capacity systems in association with the NEMKO certification company and expect to have a certified system available within 12 months. Another option we are investigating in the drive to produce higher-capacity, more space-efficient equipment is the combination of our approach with other technologies to provide compact systems able to handle the very high ballast water flow rates on large tankers."

### **Hamann three-stage treatment**

Hamann Wassertechnik GmbH has developed a relatively small modular ballast water treatment system in which the treatment is undertaken in three stages, i.e.

1. physical separation using Hamann hydrocyclones;
2. fine filtration (50 microns); and
3. disinfection using a chlorine-free oxidant.

"The Hamann ballast water treatment system, which is suitable for newbuildings and for retrofitting to existing ships, has successfully completed full-scale tests according to Artemia Testing System (ATS)," reports Volker Jautelat, project manager commercial division at Hamann Wassertechnik. "We believe that ATS is going to be the qualified testing procedure accepted by IMO.

"The system will perform to the required criteria for all sizes of ship, including large tankers, as it is simple and easy to adjust the size and capacity of the modules. We are able to work closely with our clients to determine the optimally configured Hamann system to meet their needs."

The Hamann system has performed successfully over a period of weeks in areas of brackish water, namely in the harbours of Brunsbuettel and Kiel in Germany. Similar testing is now about to be carried out in the port of Hamburg.

### **MariSan mix for disinfection**

Having entered the field in 1999, Marine Environmental Partners, Inc (MEP) has taken a process systems approach to the ballast water treatment problem. Rather

than choosing a specified treatment and adapting it to a new application, MEP has selected a mixture of technologies and integrated them in order to provide an efficient, effective, user-friendly solution that minimises impact on ship operations and layout.

The MariSan™ process is an advanced electrochemical process that requires no chemical additives, but rather relies on the inherent properties of air and water for disinfection. Due to the complexity of the matrix that comprises vessel design, engineering, ballast/deballast operations, fleet characteristics, areas of trade, and chemical and biological variables, no one system or treatment method is likely to provide a solution in all cases. The MariSan™ process, which continues to be refined, has been designed to be able to accommodate a significant range of these variable conditions.

Shipboard plumbing and electrical arrangements need to be addressed to accommodate the treatment process. These will be evaluated for each retrofit project involving an existing vessel. For a newbuilding there is more flexibility to configure the most suitable plumbing and electrical arrangements during the design stage.

MEP is operating a scale version of its shipboard system at the Oceanographic Center of Nova Southeastern University as part of the programme of continuously optimising the process under varying conditions. Outside the lab a MariSan™ 250 ballast water treatment system is being installed on a cruise ship in California as part of the State of California Interim Approval process.

MEP is also involved in engineering evaluations with a US flag carrier and is making a proposal for an 800 tonnes/hour (tph) system for a product tanker. In addition, a proposal for a North Sea project utilising a terminal-based system of approximately 1,500 tph was submitted earlier this year.

MEP's first shipboard demonstration initiative was launched in January 2002 in a collaborative project with Carnival Cruise Lines. "Operated over a period of four months, the system demonstrated not only its ability to achieve biological effectiveness but also to meet operational parameters associated with shipboard conditions," confirms Jon Stewart, vice president sales at MEP. "As a result of the pilot tests, we were awarded a contract to install a full-scale, fully automated system for the same cruise liner.

"Numerous other projects are being proposed, including work with the State of Washington Interim Approval Program. As part of the State of California Advance Approval Program, a formal study plan has been developed for onboard evaluations as well as a supplemental regime of testing utilising the scale version of the system on variables of biology and water chemistry not normally encountered by the vessel due to its area of trade and ballasting procedures," continues Jon Stewart. "When installation is completed this month, both Lloyd's Register and RINA will inspect the system with respect to to class criteria now under development. Other classification societies and the US Coast Guard are being invited to inspect the system as well."

### **AHS dissolved oxygen removal**

The AquaHabiStat (AHS) system is a purely mechanical ballast water treatment system based on removing dissolved oxygen (DO) from the ballast water as it is taken onboard. Inbound ballast pumps are used to transfer water into a patented, specially constructed tank where a vacuum is drawn on the water by a vacuum pump. A second pump then transfers the water from the special tank to the ship's ballast tank. Thereafter, the marine life in the water suffocates in the ballast tank during the voyage. After two to three days, marine life is eradicated and the vessel may discharge the ballast water, which regains the oxygen on discharge and, therefore, leaves no ancillary environmental side effects.

The system of vacuum pump and two centrifugal pumps connects with a controller unit run by a laptop PC. The flow, tank level and vacuum level can all be adjusted from the computer. With a shipboard system compliance organisations, such as the

US Coast Guard, will be able to remotely query the system and monitor the vacuum levels, flow rates and the time the system has run from the computer utilising satellite communications links.

AHS has not yet been tested onboard a vessel although plans are being formulated for such testing. "Nevertheless, we have developed what we like to call a full-scale prototype of the system which was built as a one-tenth scale model of a 130,000 dwt bulk carrier with a 720 tph capacity," explains Parker Davis, AHS ceo.

"Amongst other things, the prototype testing revealed that after three days in the treated water, larval stages and all other organisms 75 microns and above that could become nuisance species were eliminated. Our system also showed that in limited ATP testing it eliminates all biomass above 20 microns by 100% in less than three days based on direct microscopic counts.

"We believe the AHS technology represents one of the lowest cost and most effective forms of ballast water treatment currently available," adds Parker Davis.

"The pumps, tanks, piping, valves and instruments that comprise the system can be easily integrated with the vessel's normal ballast intake piping system.

"Relative to the operational cost of the ballast exchange procedure in particular, the the AHS system reduces overall ballast costs for the shipowner by cutting total time spent ballasting in half, reducing fuel expenses, and extending the life of the ballast pumps and the vessel itself. Also, the deoxygenation process has demonstrated a reduction in the corrosion of the ballast tanks and should enable a reduction in ballast tank coating repair and replacement costs.

"We estimate that each AHS system will cost the vessel owner between US\$500,000 and US\$1 million initially and between US\$1 million and US\$2 million over the life cycle of the system, with standard maintenance and service contracts" concludes Parker Davis.

### **HTM AquaTherm disinfection**

A sea trial carried out on a small Australian bulk carrier in May 1997 proved the ability of the Hi Tech Marine AquaTherm system to disinfect ships' water ballast. The technique ensures a 100 per cent mortality of the current list of pathogens supplied by Australian Quarantine and Inspection Service (AQIS). A similar system designed for shore-based applications is currently being used to disinfect sewerage and non-potable household water. The use of the system to treat potable water in commercial quantities is imminent.

AquaTherm uses waste heat, where available, as the power source. Onboard ship both the engine and charge air cooler traditionally draw their cooling water from the sea and discharge it overboard once it has done its work. With AquaTherm the cooling water is drawn from the bottom of the ballast tank and used for cooling. This water is heated in the process, and the combination of heat and passage through the AquaTherm unit disinfects the water which can then be returned to the ballast tank.

### **BMT and tanker ballast**

BMT Fleet Technology Ltd does not promote any single ballast treatment method but rather evaluates a range of technologies as part of the provision of scientific services to the maritime community. Much of the work has been focused on the operation of ships on international voyages to the Great Lakes. The company works in partnership with ESG International whereby BMT has the expertise on the integration of ship design and operation with ballast water management and ESG is responsible for the marine biology aspect.

BMT and ESG have completed a ship system design impact assessment and biological efficacy assessment for the fitment of a two-stage ballast water treatment system on bulk carrier trading to the Great Lakes. Various primary separation systems were investigated, including drum and disc filters and hydrocyclones

coupled to secondary UV systems of different powers and various configurations of "on load", "off load" treatment and during voyage recirculation.

In addition, a full-scale field trial, supported by laboratory work, has been carried out to examine the efficacy and practicality of fitting two biocide systems, copper ion and sodium hypochlorite, onboard a bulk carrier. A series of accelerated corrosion tests were also conducted to assess the impact on ballast tank corrosion and paint damage rates.

As part of the overall work programme, cost models for various treatment systems have been constructed to enable life cycle costs and the impact on shipping rates to be evaluated. Furthermore, the BMT investigative work is continuing. The company is seeking support to conduct efficacy measurements (quantification) of tank rinsing ballast water management techniques; carrying out more work on ship structural integrity, especially with respect to other oxygenating biocides and heat treatment; and researching the quality of ballast water taken onboard to determine the bounds of power required by UV systems and biocide demand.

BMT is well placed to comment on whether larger tankers need to be given special consideration, bearing in mind the volumes of ballast water involved. "Tankers do not pose any special requirements on ballast treatment," explains David T Stocks, BMT program manager. "It is the ship's voyage that poses the specific requirements.

"While ballast volumes are an issue on large tankers, scaling up of the appropriate technology should overcome any difficulties. The time available to carry out ballasting on large ships is another key factor, as is the impact on ship structural integrity.

"If IMO adopts a standard based on biological effectiveness rather than particle size, then in all probability the only cost-effective method of treatment with a predictable efficacy for larger tankers will be some form of biocide," concludes David Stocks.