MARTOB – European research project for on-board treatment of ballast water and application of low sulphur fuels

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The introduction of non-indigenous species has caused problems in many of the world's oceans and major water bodies. Ballast water carried by ships is considered to be a major vector for transferring alien aquatic species, as billions of tonnes of ballast water are transported and released each year. Shipping activities also contribute to the environmental problems resulting from sulphur emissions from fossil fuel use.

The MARTOB project was initiated under the European Union Framework Programme to tackle, on a European level, the issues of ballast water management and high sulphur content of marine fuels.

MARTOB is a three-year project funded through the Transport and Energy Directorate of the European Commission (GROWTH Programme). The MARTOB project began in 2001 and it has the dual aims of developing methods for treating ballast water on-board ships and for developing recommendations of best practice for verification and monitoring of compliance of a sulphur cap for marine fuels.

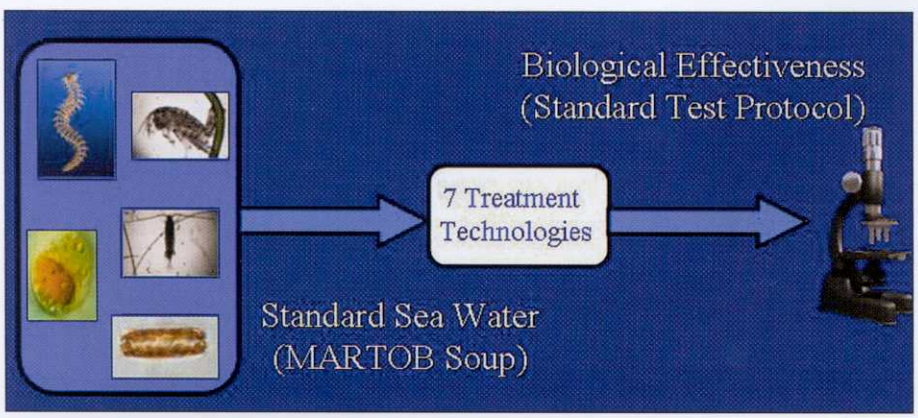
Both of these aims are directed towards making shipping operations more environmentally friendly.

Shipping trade and activities have long been a major industry in Europe. Currently, European Economic Area (EEA) ship owners represent about 40 per cent of the world merchant fleet. 90 per cent of the EU's external trade and 40 per cent of trade by volume between the member states are carried by sea.

Thus any improvements that can lead to reduced environmental impacts from shipping are important for maintaining or improving the quality of the marine environment.

Hundreds of non-indigenous species from different parts of the world have been introduced into European waters, particularly Northern Europe, through vectors such as ballast water. Although many of them have not had any serious effects on the ecosystem, some have created serious problems and incurred considerable costs in remedial actions. The introduction of alien species has also caused problems in other parts of the world, sometimes resulting in significant economic and environmental damage.

Many of the measures introduced to date to help limit the introduction of alien species through ballast water include voluntary guidelines, most related to ballast water exchange. In some jurisdictions there are mandatory requirements for ballast water management.



Work carried out *for the MARTOB project included laboratory-scale testing of ballast water treatment technologies to measure their effectiveness against five target species.*

Ballast water exchange not always effective

Currently, the method of ballast water management most used in practice is deep ocean ballast water exchange. The principle behind ballast water exchange is that ballast water and organisms taken on at a port are flushed out and exchanged with water and organisms from a mid-ocean location (greater than 200 nautical miles from shore). It is assumed that the mid-ocean organisms are less suited to surviving in port environments. In addition the salinity of the water taken on from mid-ocean locations may stress any remaining organisms that were taken on from fresh water or less saline water. There are currently three recognised types of ballast water exchange methods – the empty-refilling option, flow-through and the dilution method.

Regardless of method, ballast water management is not considered to be completely effective at removing organisms from the ballast water, because there may be organisms remaining in sediments in ballast water tanks, and it is often not possible to completely flush out the water that was taken on at port. A goal of the MARTOB project is to develop recommendations for alternative ballast water management methods that involve treating the water on-board the ship.

MARTOB project components

The main work components to be carried out as part of the MARTOB project are as follows:

- Collection and assessment of data and information on ballast water management methods and existing relevant legislation, and a review and update of alien species introductions in European waters.
- Development of selected methods for on-board treatment of ballast water through lab-scale testing and in-depth analysis.
- Large and full-scale testing of selected ballast water treatment methods.
- Assessment of the financial, technical and operational effects of a sulphur cap on marine bunker fuel in European waters.

The first phase of the project related to ballast water management was completed in early 2002. This included collection of information on ballast water management methods that are currently used, that have been tested on board ships, or that are in an advanced stage of development.

In addition to collecting information on biological effectiveness, information was collected on the safety of methods, environmental effects, and costs. Information was also collected on existing and proposed regulations, to give an indication of future directions for ballast water management requirements.

Current legislation review

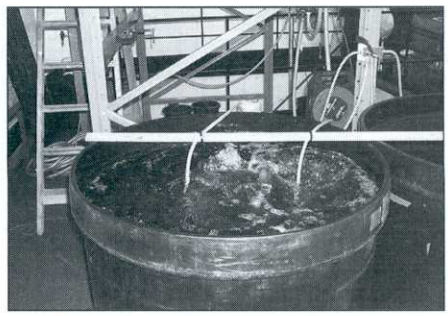
As part of the MARTOB project a review of worldwide regulations for ballast water management and control was carried out.

There are currently no mandatory global regulations addressing the prevention of biological transfer of organisms from ballast water.

However, local and regional initiatives have already been introduced by a number of nations. These countries have spearheaded initiatives in developing ballast water regulations where ships are required to demonstrate that they have taken steps to prevent ballast discharges that contain "non native, harmful species of aquatic lifeforms".

Countries that have implemented regulations include Argentina, Australia, Canada, Chile, Israel, New Zealand, United Kingdom and United States.

The BALTIC 21 network, which includes 11 countries of the Council of the Baltic Sea States (CBSS) and European Union, adopted common goals for sustainable development in the Baltic Sea Region. Prevention of alien species introduction is part of the Baltic 21 action for sustainable sea transport (Transport Sector Action, TR 3), which so far has been focused on identification of the problem and investigation of possible ways to deal with it.



***Artificial seawater** being mixed in preparation for laboratory-scale testing of ballast water treatment systems carried out for the MARTOB project.*

The recent meeting of the International Maritime Organisation's (IMO) Marine Environment Protection Committee (MEPC), held in London in March 2002, included discussions on the issue of ballast water management.

The MEPC approved a circular that contained design suggestions for ballast water and sediment options to be taken into account when developing and building new ships.

A draft international convention is being developed for consideration and adoption for a diplomatic conference to be held in 2003.

A key part of this will be an agreement on standards on effectiveness to help guide the development and selection of ballast water management methods.

After review and assessment of available information on ballast water management methods and legislation, methods were selected for laboratory-scale testing within the MARTOB project.

Laboratory-scale testing of ballast water treatment methods

The purpose of the laboratory-scale testing phase of the MARTOB project was to test a range of ballast water treatment methods using a standard mixture of seawater and target organisms.

Specifications for the seawater/organism mixture were developed within the MARTOB project. The test organisms included three species of zooplankton and two species of phytoplankton. By using a standard mixture and analysis method it should be possible to measure the biological effectiveness of all methods and to make basic comparisons.

In June 2002, laboratory scale testing of selected ballast water treatment methods was carried out at the Marine Technology Department of the University of Newcastle upon Tyne (the MARTOB project coordinator).

The ballast water methods tested included:

- Thermal treatment
- Biological de-oxygenation
- Ultraviolet light and ultra-sound
- Ozone
- Oxicide method
- Oxidation/UV + Ozone + Catalysts
- Hurdle technologies (combinations of the above methods).

Results of the tests are still being analysed and will be reported by the MARTOB consortium when they have been finalised.

In addition to assessing biological effectiveness of the treatment methods, information on safety, corrosion, costs, and potential environmental "side-effects" is being collected for each method.

It is important that the methods be practical, safe for the ship and its crew, environmentally friendly, and economically viable.

These characteristics are in addition to the primary requirement that the methods be effective at controlling the spread of alien species.

Ballast water treatment large and full-scale trials

Methods that showed good potential during the laboratory-scale tests and that are ready for full-scale testing will be tested on-board ships during the next phase of the project.

Other methods may be scaled up to be tested at larger shore-based facilities. Plans for on-board installation and sea trials will be finalised based on the results of the earlier theoretical and laboratory studies.

Technical and classification regulatory advice will be provided for on-board system installations.

This will ensure that the test protocols and procedures, including any additional on-site modifications to the

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system designs, comply with classification rules.

Ballast water will be sampled and treatment efficiency will be assessed from a biological perspective. In addition both direct and indirect environmental aspects of the treatment methods will be evaluated.

Application of low sulphur fuels

Increased use of low-sulphur marine fuel has been identified as a measure for reducing sulphur emissions from shipping.

To successfully restrict the amount of sulphur used in marine fuels, there must be a sufficient supply of low sulphur fuels available in a range of qualities. Marine engines and systems must also be able to operate efficiently on reduced sulphur fuels. The development of marine engine technology and marine fuel and lubrication oil qualities have many interactions, such as:

- Implications of fuel mix changes for the refineries
- Engine and fuel effects on all emission components, fuel economy and hence operating margins
- End user requirements for availability and operability.

Due to these interactions, a co-operative testing and development programme between representatives from the oil industry, engine manufacturers and end users is appropriate when introducing abatement measures affecting fuel quality.

When introducing a new abatement measure in the market, the properties of the market and potential for compliance must be considered. The effect of the abatement measure will depend on compliance from ship owners operating solely within the defined areas where the measures apply, as well as ship owners in transit through or in/out of the defined areas.

Low-sulphur marine fuel is only available at a limited number of locations worldwide.

The price of operating on low-sulphur fuel is significantly higher than operating on conventional marine fuels today.

The European Commission has taken action towards a sulphur cap for marine fuels applicable for the North Sea, with limits far below the average sulphur content of marine fuels sold worldwide. Regulation affecting the refineries fuel mix will affect the market and several technical and capacity related challenges must be overcome by the refinery industry.

Dead or alive? *Zooplankton that have passed through a laboratory-scale ballast water treatment system are examined under a microscope.*

There is no system available today to record or scientifically verify the sulphur content and emissions from consumption of marine bunker fuels in European waters. Present information on sulphur emissions is based on compiled fuel sale statistics and world average values of sulphur content of marine fuels.

Work to be carried out as part of the MARTOB project includes:

Assessment of the world marine bunker market: The present world bunker market is based on the balance of supply and demand within the framework of requested fuel qualities. A change in the framework will affect this balance, and the applicability of forthcoming regulations of sulphur content of the fuel will depend on the supply side being able to meet the new demand with regards to crude quality and refinery infrastructure.

The research will analyse the future situation of the supply side of the bunker market.

Technical aspects related to machinery and systems in the context of application of low sulphur fuels: Potential technical constraints, possible advantages to using reduced sulphur content fuels and effects of new fuel qualities on the performance for marine engines will be assessed. Operational aspects related to operation on low sulphur fuels: The work will address cost-benefit and future challenges for the end user of low sulphur fuels.

Verification of compliance with sulphur cap on marine fuels: New regulations with impacts on costs and operations must be implemented with uniform effect to avoid unintentional distortion of competition between operators in the market.

This research will establish a recommended practice for verification of compliance with new regulations.

MARTOB partners

Twenty-five partners from eight countries are involved in the MARTOB project. The partners are from Norway, Sweden, Finland, Denmark, the Netherlands, United Kingdom, France and Greece.

The consortium consists of:

- Two universities with three departments (two of them from one university) to perform scientific development: University of Newcastle (UK) and Abo Akademi University (Finland).
- Eight marine and environmental research institutes and technology developers: VTT Industrial Systems (Finland), TNO Environment, Energy and Process Innovation (Netherlands), TME Institute for Applied Environmental Economics (Netherlands), SIN-

TEF Applied Chemistry (Norway), FRS Fisheries Research Services (UK), IFREMER French Research Institute for the Exploitation of the Sea (France), MARINTEK Norwegian Marine Technology Research Institute (Norway), EPE Environmental Protection Engineering S.A.(Greece).

➤ One classification society setting important classification rules and international standards, verification of test plans and safety aspects: BV Bureau Veritas (France).

➤ Three marine consultant/services involved in safety assessment, approvals of system design: SSPA AB (Sweden), Three Quays Marine Services (UK), Fueltech AS (Norway).

➤ Three ship owner associations, acting as a liaison for further contact with ship owners for sea trials: INTERTANKO The International Association of Independent Tanker Owners (UK), ICS International Chamber of Shipping (UK), Norwegian Shipowner Association (Norway).

➤ Three ship owners who are the end users of the research results and provide facilities for trials: Souter Shipping Ltd (UK), Wallenius Wilhelmsen Lines (Norway), ABC Association of Bulk Carriers Ltd (UK).

➤ One engine manufacturer providing technical data on engines using low sulphur fuel: MAN B&W Diesel A/S (Denmark).

➤ Three equipment manufacturers contributing to technologies and further development: Berson Milieutechniek B.V. (Netherlands), V/den Heuvel Watertechnologie BV (Netherlands), Alfa Laval Marine & Power AB (Sweden).

➤ One oil company offering technical advice, data and experience of low sulphur fuel studies from supply to market: Shell Marine Products (Norway).

Summary and expectations for use of project results

The MARTOB programme is expected to result in recommendations on probable future ballast water treatment solutions developed through research and shipboard trials.

It is envisaged that information generated through evaluation of the methods with respect to biological effectiveness, environmental effects, safety, and cost will be useful during future considerations of global ballast water legislative measures.

In addition recommendations resulting from this programme of research on ballast water management would provide another source of information to various international organisations like IMO, ICES, IOC and other maritime organisations, marine environment agencies and regulatory bodies.

For the low sulphur fuel portion of the project, recommendations will be developed to help facilitate the introduction of sulphur emission abatement measures.

These recommendations will be based on research into the future supply of low sulphur fuels, technical and operational implications, and the potential effects of a sulphur cap on competition within the shipping market.

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