Environmental Impacts, Risk and Safety, and Economic Aspects of Ballast Water Treatment Methods

Executive Summary

Economic aspects, environmental impacts, and risk and safety effects of ballast water treatment methods tested on board or at large scale in work package 4 of the MARTOB project were evaluated. Information provided by system design partners from the on-board and large scale test reports and from scaled-up designs from a case study ship formed the basis of the evaluation. Evaluation criteria used in Task 3.7, and developed in task 2.6 were used to assess each of these effects.

Risk and safety effects

The preliminary hazard identification and "what if" questions developed in Task 3.7 formed the starting point for the analysis of the safety aspects of the ballast water treatment methods. Each method was re-evaluated in light of the experience gained from the large-scale test trials carried out in WP4. In addition, further recommendations for potential risk control measures were provided. Hazards were considered from the perspective of safety/survivability of the vessel and safety of the crew during ship operations. Categories of hazards related to operation of the ballast water treatment methods include physical hazards such as heat, electrical hazards, ultraviolet or ultrasound radiation hazards, and chemical hazards from gases or hazardous liquids used or generated during treatment.

Conclusions were the same as for WP3, that is, the major hazards associated with the thermal treatment, UV, and US were confined to the equipment location. For biological de-oxygenation, Oxicide, and ozone, the hazard would encompass a larger area of the ship because ballast water is treated in the ballast tanks or is returned to the tanks with a residual amount of disinfectant.

For all of the ballast water treatment methods investigated, there is the potential to reduce risks through appropriate training and safety procedures. For some of the methods, safety features have already been considered and are in place. If the treatment systems are installed on new ships additional safety features could be considered during ship design.

Environmental Effects

Environmental impact categories used to assess the effects of each of the ballast water treatment technologies tested in WP4 where the same as in the previous WP and included:

- Direct Impact through Discharge to Receiving Water:
    - Discharge of water with altered quality:
        - Physical parameter changes
        - Metals
        - Nutrients/Oxygen Demand, Low D.O.
        - Biocide residuals
    - Discharge of surviving organisms
    - Discharge of solids (organisms and sediments)
- Other Environmental Impacts
    - Energy consumption during operation
    - Potential for spill of treatment chemicals
    - Materials use (both for raw materials for construction of treatment equipment and consumables used during operation of the system)

Updated estimates for materials and energy use over the life cycle of the treatment systems was provided based on optimised system operational parameters. The assessment focussed on potential impacts resulting from:

- Major materials used during system production
- Use of energy and consumables over the operational life of the treatment system (resulting in emissions to air)
- Direct discharges to receiving waters

From a life cycle perspective, impacts during system operation were dominant for all treatment methods. Emissions to air resulting from fuel use for energy production represented more than 95% of the total. This is similar to the life cycle of a ship as a whole, with the majority of impacts occurring during the operations phase, and primarily related to energy use, with some impacts from maintenance.

For the large scale tests in WP4, effluents from the ballast water treatment technologies were sampled to determine the changes in water quality. Only those parameters that were expected to be altered by the treatment were measured. None of the discharges included substances that are identified as 'priority hazardous substances', or that have the potential to bio-accumulate.

Economic Aspects

Cost data for treating ballast water on the case ship defined in WP3 was calculated using data from the prototypes of on board ballast water treatment systems. The main objective of the on shore tests and sea trials was on treatment effectiveness, but technical moderation of the treatment systems also resulted in changes in economic data. In WP4, costs were viewed much more from the standpoint of the ship owners and not only of the producers or developers of the treatment systems. This means that the treatment systems are compared not only by costs per treated m^3 ballast water, but also by looking at cost behaviour under different external data.The following cost components were specified: capital costs, operational costs, training and management costs and economic benefits or disadvantages.

The total annual costs per treatment system for 50 trips (100,000 m^3 treated ballast water) ranges from € 10,000 to € 60,000. For some intercontinental ships this equals the total costs to "run" that ship for 1 to 6 days.

An investigation of the sensitivity of cost per m^3 to the amount of ballast water treated per year was carried out. Treating smaller volumes of ballast water per year will lead to relatively higher costs per m^3 treated ballast water and vice versa. In addition, the higher the annualised capital costs; the more expensive the treatment method will be compared to the other systems (or relatively cheaper in the case where larger volumes of ballast water are treated). This was found to be the case for the ultrasound and Oxicide methods.