

Dose-response relationships for H₂O₂ using organisms from different taxonomic and trophic levels

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Introduction of non-indigenous species is a risk associated with discharge of ballast water from ships transporting cargo between regions. Consequently, technologies to treat ballast water to destroy or remove organisms are being developed. Degussa AG has developed a product, PERACLEAN® Ocean, which appears to have suitable characteristics as a ballast water biocide. Ecotoxicological tests were performed to determine residue toxicity.

Introduction

In order to minimize the risks of ballast water transport, IMO has set out a mandatory framework for ballast water management on board of ships. Ecotoxicological tests on the treated ballast water need to be performed in order to determine the residue toxicity and thus the potential ecological risks of discharging the treated ballast water. Therefore, toxicity of ballast water treated with PERACLEAN® Ocean was determined at several time points after treatment, during several treatment runs.

PERACLEAN® Ocean has two active ingredients. The most bioreactive component is Peroxyacetic acid (PA). The second active ingredient is Hydrogen peroxide (H₂O₂). PA is rapidly degraded to levels below the detection limit within 24 hours. H₂O₂, however, is more persistent (half-life >24 hours). It is, therefore, assumed that the remaining toxicity after 5 days will be based upon the levels of H₂O₂.

The sensitivity for H₂O₂ was not known for any of the selected test species and preliminary range-finding tests were conducted in order to assess whether the sensitivity of the test species would fall within the range of expected H₂O₂-concentrations in treated ballast water when discharged.

Methods

Toxicity was determined by groups of several ecological toxicity tests (bioassays), using species from different taxonomic and trophic levels (Table 1). In the tests aged sea water with low biological activity and suspended organic solids was used, or artificial sea water.

Table 1. Bioassays used for determining toxicity of hydrogen peroxide

Species	Type of bioassay
Algae	<i>Chaetoceros gracilis</i> <i>Skeletonema costatum</i>
Rotifer	<i>Brachionus plicatilis</i> (ROTOXKIT M)
Oyster (embryo-larvae)	<i>Crassostrea gigas</i>
Fish (yolk-sac larvae and juvenile)	<i>Solea solea</i>
Bacteria	<i>Vibrio fischeri</i>

Results

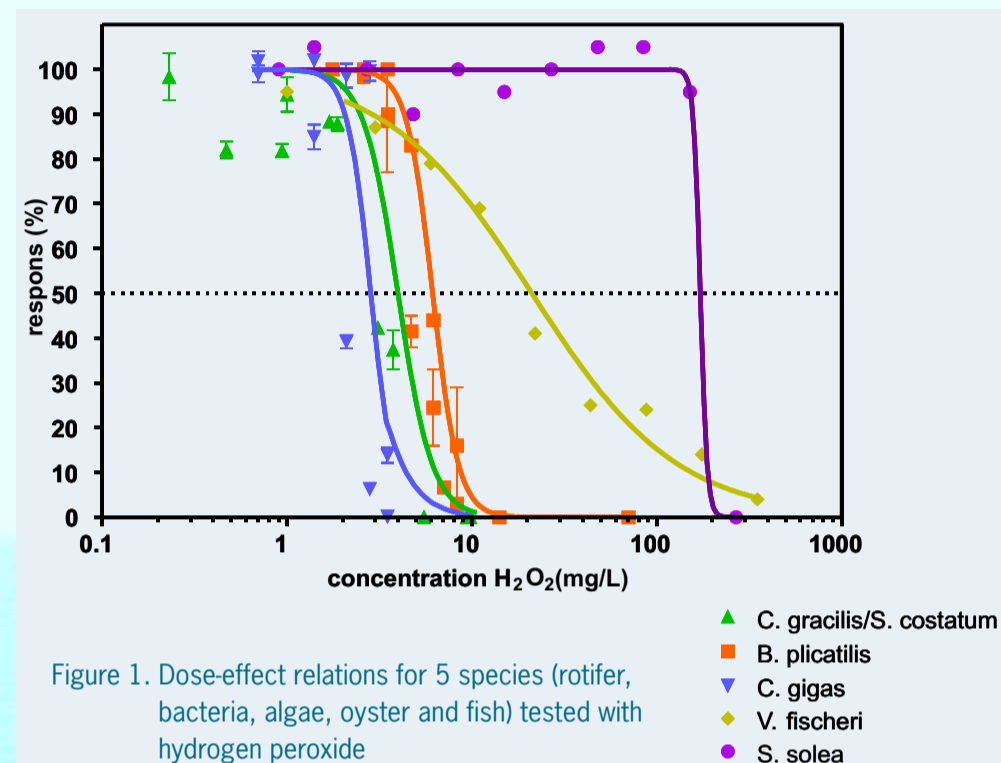


Figure 1. Dose-effect relations for 5 species (rotifer, bacteria, algae, oyster and fish) tested with hydrogen peroxide

Table 2. Results of the bioassays with Hydrogen peroxide (in mg/L). Test results are an average of several tests and species (algae)

Bioassay	EC50	SE
Algae (<i>C. gracilis/ S. costatum</i>)	2.97	0.28
Oyster (<i>C. gigas</i>)	3.16	0.09
Rotifer (<i>B. plicatilis</i>)	5.1	0.62
Bacteria (<i>V. fischeri</i>)	14	4.7
Fish (<i>S. solea</i>)	>150	-

Discussion

In treated ballast water H₂O₂-concentrations are expected from 10 mg/L (24h) to 1 mg/L (5d), depending on initial dosage of PERACLEAN® Ocean and oxidizing capacity of the water.

Algae, oyster and rotifer tests are sufficiently sensitive to detect ecotoxicological effects within 24 to 36h after biocide treatment. The Microtox® Basic test will not be able to detect residual effects 24 h after treatment, but since it is a rapid test, it may be used to follow development of toxicity decline during the first 24 h after the treatment.

Severe effects of H₂O₂ on the receiving (harbour) ecosystem are not expected, since the discharged ballast water will be diluted in the receiving water and remaining H₂O₂ will rapidly degrade under influence of UV-light and suspended organic material, without producing toxic by-products.

Acknowledgement

This study was sponsored by Degussa AG, Germany