

Results of GSI Bench-Scale (Small-Scale) Tests

March 17, 2009

DISCLAIMER: GSI's bench-scale tests do not by themselves provide adequate information to assess a prospective ballast treatment's ability to meet a particular discharge standard or to achieve environmental soundness under shipboard application. Instead these tests provide initial insights into possible strengths and weaknesses of the treatment concentrations tested under the conditions tested.

For more information on GSI's bench scale testing visit www.greatshipsinitiative.org.

GSI BENCH TESTS ON SEAKLEEN 80®

For the full write-up of GSI tests on SeaKleen 80®, including experimental methods and results, please see <http://www.nemw.org/GSI/GSI-BS-P-TR-SeaKleen.pdf>. Please note that the results summary below is intended to provide an overview of treatment characteristics from the bench scale experiments. Results are drawn through interpolation of the quantitative measurements and survivorship observations.

THE TREATMENT PROCESS

What is the proposed treatment process?

Addition of SeaKleen 80®, a chemical mixture consisting of at least 80 % menadione (vitamin K₃).

What is the proposed application?

Routine use as a ballast water treatment.

What is the proposed application dose, if any?

Up to 3 mg menadione (3 to 3.75 mg SeaKleen 80®) per liter of water.

RELEVANT CHALLENGE CONDITIONS

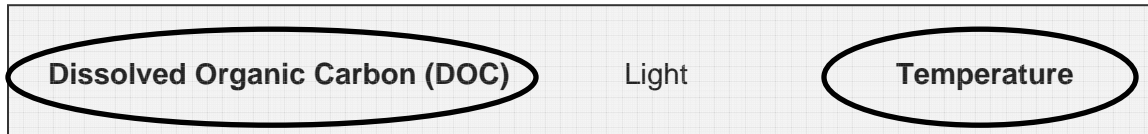
Which environmental variable of those tested (see below) appeared to influence treatment performance and/or degradation the most?

Dissolved Organic Carbon (DOC)

Light

Temperature

What other parameter(s) appeared to have some influence as well?



GSI DOSE EFFECTIVENESS FINDINGS FOR SEAKLEEN 80®

Dose effectiveness testing involves evaluation of treatment effectiveness on robust species across freshwater taxonomic categories. Species tested appear in the list below.

Which of the species tested had less than 1 % survival within 24 hours of treatment at a dose less than or within the proposed dose range? Which species tested had less than 1 % survival within 48 hours?

Major Taxonomic Group	Species	Less Than 1 % Survival?	
		24 Hours	48 Hours
Algae	<i>Selenastrum sp.</i> ¹	NO	NO
Zooplankton (Cladoceran)	<i>Daphnia magna</i>	YES	Not measured
Zooplankton (Copepod)	<i>Eucyclops sp.</i>	NO ²	NO ²
Zooplankton (Rotifer)	<i>Branchionus calyciflorus</i>	YES	Not measured
	<i>B. calyciflorus</i> cysts ³	Not measured	YES
Bacteria	Total Coliforms	NO	NO
	<i>E.coli</i>	NO	NO
	<i>Enterococcus</i>	NO	NO
	Heterotrophic Bacteria	NO	NO

¹ A robust green algae commonly used in toxicity tests because it is highly robust.
² The highest dose tested on *Eucyclops* was less than 1/6 of the maximum recommended dosage. This low dosage produced only 3 (±3) % survival. It is likely that a higher dose (still within the recommended range) would produce less than 1% survival.
³ Resting egg survival is scored as number hatched.

Which freshwater species tested was most vulnerable to the treatment, and which was most resistant to the treatment proposed by the applicant?

Adult daphnia, and adult rotifers were the most vulnerable. The green algae tested, *Selenastrum* spp., Total Coliforms, *E.coli*, *Enterococcus* and Heterotrophic Bacteria were the most resistant.

Other observations related to dose effectiveness tests of this treatment.

While the green algae tested was resistant, all zooplankton tested, including rotifer resting eggs, succumbed at a rate of 97 % or greater in laboratory tests and are likely to succumb at a rate of 99 % or greater when exposed to SeaKleen 80® concentrations no more than the recommended dosage for treatment.

GSI DEGRADATION AND RESIDUAL TOXICITY FINDINGS FOR SEAKLEEN 80®

How long did it take for the dose that achieved 99 % mortality for all test species to degrade to below detection?

No dose achieved 99 % mortality for the green algae tested. The highest dose needed to kill 99 % of all tested zooplankton was approximately 0.5 mg/L. 36 hours was required for 0.5 mg/L to degrade under light conditions in laboratory water to below detection. 0.5 mg/L did not degrade to below detection over the 96 hours of observation in dark conditions and/or filtered harbor water (high DOC) conditions.

Did treated water that was in the condition to be discharged from a ship according to the proposed treatment still have acute toxicity? If so, what types of organisms were sensitive to the toxicity?

Water treated with the recommended dose of menadione and held in the dark, simulating retention in a ballast tank was still toxic even to robust organisms (i.e., daphnids, fathead minnows, and rotifers) after 96 hours when the experiment ended. This result suggests that, except for dilution effects, treated water upon discharge will still be acutely toxic to organisms.

What specific constituent of the treatment process appeared to cause this toxicity?

Menadione, in sample water held in the dark. A degradation by-product was detected analytically (HPLC) in sample water in which menadione had degraded to below detection. The by-product appeared to increase in concentration as menadione decreased over time. The instrumentation used in these studies was not able to describe the by-product in detail. No toxicity testing of this by-product was carried out.

Other observations related to residual toxicity.

It should be noted that some receiving systems have little or no light penetration at the depths at which ballast will be discharged, so little or no menadione degradation by light will take place following discharge. Residual toxicity due to undegraded menadione will be present in these instances unless some other degradation process is installed in the treatment process to supplement degradation by natural light. In addition, further testing should be undertaken on the nature of the degradation by-product detected

MORE INFORMATION

Entire report available at: <http://www.nemw.org/GSI/GSI-BS-P-TR-SeaKleen.pdf>

For more information contact:

Ms. Allegra Cangelosi
Northeast-Midwest Institute.
Washington, D.C.
acangelo@nemw.org