

Hydrogen Peroxide Ballast Water Treatment System

Eltron Research, Inc.

4600 Nautilus Court South
Boulder, CO 80301-3241
Telephone: 303-530-0263
<http://www.eltronresearch.com>

Environmental Problem

During the last century, the problem of biological infestations and chemical contamination spread through waterways has been dramatically accelerated with the advent of modern high-speed freighters and their methods of ballast water exchange. Transport and discharge of contaminated ballast water constitutes a major route by which potentially invasive species are introduced into high-traffic marine and fresh waters worldwide. The discharge of marine vessel bilge and ballast water upon destination arrival can seriously contaminate the surrounding aquatic ecosystems with nonindigenous organisms, and grey/black water effluents with high biological oxygen demand (BOD).

The most problematic organisms to be controlled are bacterial, planktonic, and egg or larval stages of higher organisms. It is almost impossible, very expensive, and environmentally damaging to control/eradicate infestation of an invasive species once it is introduced into a waterbody. The introduction of the zebra mussel into the waterways of the Great Lakes provides a well-publicized and sobering example of both the economic and ecological costs associated with such invasions. Thus, prevention of

initial contamination by invasive species is the most practical approach to this problem.

SBIR Technology Solution

With support from EPA's SBIR Program, Eltron Research, Inc., developed a unique hydrogen peroxide (H_2O_2) generation technology into a turn-key, modular, flow-through water treatment system for bilge, ballast, and wastewater treatment. H_2O_2 is long known to be effective for disinfection and organic material oxidation. The core of this treatment system is Eltron Research's patented electrolytic technology that consumes only water, oxygen from air, and electricity.

A durable electrolytic cell design was developed for this treatment application that achieves the required H_2O_2 production rates and exceeded all expectations in performance during scale-up. Commercial production of the electrolytic cell modules demonstrated this technology's readiness for manufacture. A 3,000 gallon per hour system successfully demonstrated the modular scalability of treatment capacity.

Eltron Research's electrolytic technology produces H_2O_2 onsite and on-demand for about one-half the cost of the standard industrial production process based on power consumption and capital depreciation estimated over a 5-year period. Hydrogen peroxide water treatment with this new system is comparable in power consumption to the newest ultraviolet ballast water treatment systems, but provides the additional key benefits of organic destruction,

reduction of BOD, an estimated 30% reduction in capital costs, and a safe source of H_2O_2 .

Tests conducted by the Marine Biological Laboratory (Woods Hole, Massachusetts) in collaboration with Eltron Research demonstrated broad effectiveness of H_2O_2 to kill algae, fish, invertebrates, and planktonic and bacterial microorganisms. Introduction of 5-7 mg/L H_2O_2 into ballast water by Eltron Research's treatment system during vessel uptake is expected to provide effective treatment against biological organisms within the first 200-500 minutes of contact time. The corrosiveness of seawater with



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this level of H₂O₂ was experimentally determined not to exceed that of natural dissolved oxygen, and thus is safe for ship-board use.

Commercialization Information

SBIR funding was utilized to transition Eltron Research's H₂O₂ production technology from the laboratory to a successful turn-key water treatment system ready for licensing. Ballast and bilge water treatment capacity and performance criteria of Eltron Research's H₂O₂ water treatment system have been examined with a leading U.S. marine equipment manufacturer. Other ship-board water treatment applications have been discussed and opportunities for field testing have been identified.

To date, Eltron Research's technology has been evaluated by a variety of potential end-users and manufacturing partners for applications that will benefit from the convenience, cost savings, and safety of onsite and on-demand H₂O₂ production. Ongoing efforts have produced a second-generation demonstration system for pilot-scale application testing and marketing.

Company History

Eltron Research, Inc., is an energy, chemical processing, environmental, and catalysis research company founded in 1982. The company is located in Boulder, Colorado, and currently employs 60 full-time staff members. Eltron Research is organized into five major technical areas: (1) Catalytic Membrane Reactors, (2) Catalysis, (3) Chemical

Sensors, (4) Electrochemistry, and (5) Material Science. The company's model for technology commercialization involves forming strategic relationships with large corporations to promote this process. SBIR projects at Eltron Research have generated well over \$100 million of non-SBIR support

from the resulting consortia, of which more than \$60 million is private-sector investment. Eltron Research believes this to be among the largest private-sector investments made in technology evolving directly from the SBIR Program.

SBIR Impact

- Transport and discharge of contaminated ballast water constitutes a major route by which potentially invasive species are introduced into high-traffic marine and fresh waters worldwide.
- Eltron Research developed a turn-key hydrogen peroxide (H₂O₂) water treatment system to mitigate marine vessel discharge of exotic, invasive organisms in bilge and ballast water.
- Eltron Research's unique electrolytic H₂O₂ production process consumes only water, oxygen from air, and electricity.
- This onsite and on-demand H₂O₂ production technology is economically competitive, convenient, and environmentally safe.