PROJECT ID:
588

Effluent Copper Quantification by Optical or Voltammetric Detection and Analysis

A ship enters drydock at Puget Sound Naval Shipyard (PSNS) and Intermediate Maintenance Facility (IMF). PSNS & IMF must monitor the levels of copper and other contaminants in its effluent. (Photo Credit: Thiep Van Nguyen II)

OBJECTIVE

The goal of this project is to demonstrate a methodology for rapid quantification of copper in seawater using an optical or voltammetric detection and analysis system.

PROBLEM STATEMENT

To maintain compliance with National Pollutant Discharge Elimination System (NPDES) limits, U.S. Navy shipyards must monitor the levels of copper (and other contaminants) in shipyard effluent (discharge water). The U.S. Environmental Protection Agency (EPA) has set the limit at 3.1 micrograms per liter (µg/L). This measurement is based on total copper concentration, which includes all forms of copper (particulate, total and dissolved). Most copper in shipyard discharges is in the form of the less bioavailable particulate phase, rather than the bioavailable, and toxic, aqueous (dissolved) form.

To satisfy NPDES compliance, there is a need for a fast, easy-to-use tool to differentiate between forms of copper in shipyard effluent and to demonstrate that NPDES permit limitations are being met.

DESCRIPTION

This project team will explore innovative technologies that use optical or voltammetric detection methods for copper quantification at low parts per billion. Commercial systems will be purchased and evaluated for their potential in providing compliance monitoring and investigations at U.S. Navy shipyards.

In the case of the optical system, a spectrophotometer will be used and standard EPA methods implemented for measuring copper in water samples. With the voltammetric method, methods will be adopted from past reports published by personnel from the Navy Warfare

Information Center (NIWC) Pacific (in San Diego, CA) using this technology and search for any potential similar methods in the process of being approved by any regulatory agency. One challenge for both methods will be interferences in the seawater sample matrix with the chloride ions, minerals and other dissolved substances. The NIWC team will perform laboratory testing of the device against copper concentration standards. Next, samples obtained from U.S. Navy shipyards and facilities will be tested in the laboratory. Finally, field testing of the technology will be conducted at representative U.S. Navy shipyards and facilities.

Methodologies similar to the ones proposed here have been successfully applied in several projects over the past several decades at NIWC Pacific, indicating that technical implementation of the system proposed here has high probability to be successful. Past instruments developed did not get commercially transitioned. This new project is revisiting the state of the science, but through commercially available systems that will be more readily implemented and integrated at U.S. Navy shipyards and facilities.

If successful, users of this product will be able to measure low levels of copper in seawater (and brackish or fresh water, seawater being the most challenging) without having to rely on time and money consuming laboratory contracts and procedures.

RETURN ON INVESTMENT

Navy shipyards are subject to increasingly stringent NPDES limits on copper discharges. Historically, Navy shipyards have received Notices of Violations (NOV) from the regulatory agencies for exceeding their NPDES permit limits. In some cases, this has held to even more onerous Federal Facility Compliance Agreements (FFCA). The proposed approach would also reduce the time and effort associated with transporting large equipment to the site, and costs associated with full-scale copper laboratory testing. A near real-time sampling system will greatlyreduce—if not eliminate—these costs. This should lead to a significant return on investment (ROI) at Navy shipyards within a couple of years, perhaps amounting to several hundred thousand dollars.

NAVY BENEFITS

Both the optical and voltammetric methods for portable/field copper quantification offer inexpensive solutions to copper monitoring in effluents. The best performing approach which minimizes the numbers of reagents, preparation time, training and complexity, will be selected for transition and implementation to the operational Navy. Effective management of NPDES discharges, while extremely important, is difficult to accomplish. Avoidance of NOVs is not only valuable from an economic aspect, but also in terms of public perceptions. Having realistic, real-time access to information is critically important to avoid potential violations. Furthermore, real-time information will improve the ability for shipyard activities to continue in a responsible manner without onerous regulatory compliance agreements such as FFCAs.

TRANSITION DESCRIPTION

When proven, this technology should be deployed to Navy shipyards and other facilities where NPDES permit limits exist for copper effluent discharges (e.g., graving docks). Transition and integration will begin immediately at the demonstration site (at a Navy shipyard) to be selected after preliminary laboratory results are evaluated and deemed successful. Results from the demonstration will be presented to the Naval Sea Systems Command's Clean Water Act Working Group at the conclusion of the project. This group is composed of shipyard environmental managers, and provides direction to all the Navy shipyards on new technologies and approaches in the management of effluent discharges. The NIWC Pacific team will provide hands-on training, user manuals and consultation support to help shipyard environmental personnel implement their own monitoring program using this equipment and methodology.

This technology and subsequent improvements to it, based on this testing, will have potential for use in the Navy and other industrial settings, either the military or in the private sector. The project team will use its lessons learned to collaborate with the company or other interested industry partners to develop improved systems that build upon the results of this project.

CONTACT

For more specific information about this project, contact the Principal Investigator at 619-553-8988.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development, demonstration and validation (6.4) program, sponsored by the Chief of Naval Operations, Energy and Environmental Readiness Division (OPNAV N45) and managed by the Naval Facilities Engineering Systems Command (NAVFAC) out of the Engineering and Expeditionary Warfare Center (EXWC) in Port Hueneme, CA.

The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness and lethality. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.navfac.navy.mil/nesdi or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or kenneth.c.kaempffe.civ@us.navy.mil.