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Featured Projects

Remote Imaging System Streamlines Analysis of Tank Coatings on Ships

By Gretchen Jacobson

There are many tasks involved in maintaining the Navy fleet. Whether the asset is an amphibious warship or an aircraft carrier, it takes millions of dollars and thousands of man-hours yearly to protect them from their corrosion element. The cost of repair, replacement, materials, equipment, and personnel time away from other duties all come with a high price tag.

The Naval Research Lab has developed a table-top, computer-based system to improve upon the Navy's physical method of assessing ballast tank coatings. From left, Navy corrosion experts Rich Hays, Ted Lemieux, and Bill Groeninger inspect the tank interior of an LSD 41 amphibious combatant ship in 2002. Photo courtesy of Paul Slebodnick, Naval Research Lab.

The Naval Research Laboratory (NRL) conducts a broadly based, multidisciplinary program of scientific research and developing advanced technology for the Navy and Marine Corps. Part of the program involves finding ways to reduce corrosion-related costs and the time it takes to maintain critical resources on seagoing vessels. One notable effort looks at the challenge of inspecting and maintaining thousands of shipboard ballast tanks each year.

The carbon steel ballast tanks are protected from corrosion primarily with high-solids epoxies. When these coatings are combined with cathodic protection, coating degradation and effects of galvanic corrosion are minimized. There are a variety of maintenance concerns on the tanks. These depend on their contents, size, the location of ship operations, and many other factors.

"Approximately 4,000 tanks are assessed annually fleet-wide at an estimated cost of $32 million per year," said Bill Groeninger of the NRL. "When tank refurbishment and replacement costs are included, ballast tank preservation comes to more than $250 million per year. We are looking at ways to avoid much of this expense by reducing the need for physical coating assessments. This type of analysis is costly, involves safety concerns, and is ultimately subjective in nature."

Physical assessment entails cleaning the tanks first. Then a safe, gas-free environment must be ensured, as well as bringing in trained personnel to evaluate coating integrity. This process has traditionally been done on a uniform, time-based schedule, which can be unreliable when tanks in need of refurbishment are being identified.

"In fact, many time-based assessments on tanks prove to be unnecessary," Groeninger said, "while the coatings of other tanks degrade more quickly than anticipated. As a result, up to 50 percent of current tank maintenance is attributed to unplanned and unnecessary work."

To address these challenges, the NRL evaluated tank assessment technologies that include ultrasonic, infrared, electrochemical, and optical methods in its quest to find a reliable, cost-effective system that does not require manned entry. The outcome is a Tank Monitoring Corrosion Sensor (TMCS) program that uses optical condition assessment technology as one way to determine a tank's state of preservation.

"During our research, we were unable to find an 'off the shelf' system for the kind of optical assessment we wanted, so the laboratory developed its own in conjunction with industry partners," said Groeninger. "The resulting product, called an Insertable Stalk Imaging System (ISIS), can visually and analytically assess coatings inside tanks in a way that is more accurate, quantitative, and repeatable than the traditional physical assessments."

The Naval Research Laboratory is using an Insertable Stalk Imaging System (ISIS) to visually and quantitatively assess the condition of the coating inside a ship's ballast tank. Photo courtesy of Naval Research Lab.

The ISIS consists of a hatch-mountable pan-tilt-zoom video camera, PC-based image viewing and storage, menu-driven software, and joystick camera controls. In addition to providing live video feed of a tank's interior, a typical ISIS assessment collects 12 to 30 still images that are representative of the overall condition of the tank. These are subsequently analyzed pixel by pixel using corrosion detection algorithms (CDAs). The CDAs assess color, wavelet edge, grayscale, fusion, and quantitative damage, and ultimately determine the percentage breakdown of the coating. The coating sites are categorized into four quality levels that range from excellent (less than .03 percent surface degradation) to poor (more than 10 percent degradation). The camera's filming positions are stored in the computer so that future assessments can easily and precisely return to the same areas within the tanks.

"The ability of the CDAs to consistently and accurately determine coatings degradation to these percentage levels is a real breakthrough in assessment technology," said Groeninger. "Assessments by humans, while highly effective in many areas, can provide varying results according to level of expertise and where multiple inspectors are used."

According to Groeninger, the ISIS is suitable for use across a variety of ship types and classes and for all typical coating systems, and can be easily integrated into condition- based maintenance systems. "We are realizing real reductions in maintenance costs while freeing up personnel for other critical shipboard duties," he concluded. "In the future, we are hoping to develop degradation curves of coatings over time. This will shed more light on the specific corrosion processes at work in our tanks."