PROJECT ID:
622

Brush Electroplating Repair of Zinc-Nickel Electroplate

An aviation mechanic inspects a P-8A Poseidon for corrosion.
(Photo credit: Mass Communication Specialist 1st Class Juan Sebastian Sua)

OBJECTIVE

The primary objective of this project is to validate and optimize a brush electroplating repair process for zinc-nickel (ZnNi) and Ion Vapor Deposition (IVD) aluminum applications, with the goal of replacing the current hazardous cadmium-based repair process.

PROBLEM STATEMENT

Recently, Naval Air Systems Command (NAVAIR) approved ZnNi tank electroplating as a corrosion-inhibiting process for aircraft parts. However, when individual parts need to be repaired, and disassembly is not a viable option, brush cadmium electroplating is used, followed by a hexavalent chromium post-treatment. Both cadmium and hexavalent chromium are known carcinogens, and various directives have called for avoidance of these chemicals.

DESCRIPTION

The ZnNi brush electroplating process is intended to replace the current repair method, which uses cadmium brush electroplating followed by hexavalent chromium conversion coating. These materials are toxic, posing environmental and health risks. The ZnNi process eliminates these hazards while maintaining or improving the corrosion resistance and durability needed for NAVAIR applications.

The brush electroplating process for ZnNi is designed for localized metal deposition to repair or enhance surfaces without the need for full disassembly of parts. The process uses portable electroplating equipment, including a power supply, electrode stylus/brush, and specially formulated ZnNi electrolyte solutions, enabling application directly to the damaged area. This project will focus on NAVAIR authorization, developing process specifications, providing operator training, and ensuring successful technology demonstration. Key steps in the process that will be demonstrated include:

1. Surface Preparation: The area to be repaired is first cleaned and mechanically prepared, which may involve degreasing, abrasive cleaning, or chemical treatments

to ensure optimal adhesion of the ZnNi coating.

2. Anode and Electrolyte Preparation: The process utilizes a brush anode, encased in an absorbent material soaked in the ZnNi electrolyte solution. The anode is connected to a direct current (DC) power source, and the soaked brush is applied to the target area.
3. Electrodeposition: As the brush (anode) contacts the workpiece (cathode), the electric current passes through the ZnNi solution, depositing the zinc-nickel alloy onto the surface. This precise application allows for uniform coating thickness and coverage, essential for corrosion resistance and repair integrity.
4. Post-Treatment: After the ZnNi deposition, the plated surface requires rinsing and hexavalent chromium free post-treatment to enhance corrosion resistance and paint adhesion durability.

This process will be demonstrated in a realistic depot level setting, with certified brush electroplaters and engineering experts. The ZnNi coatings will be applied to representative samples, complex geometry mockups, and production demonstration components.

RETURN ON INVESTMENT

The life cycle cost advantage of ZnNi brush electroplating vs. cadmium brush electroplating will be derived from savings in reduction of waste, lower exposure to carcinogenic material to personnel, and improved durability and wear which will extend plating repair cycles.

NAVY BENEFITS

The ZnNi brush electroplating process offers key advantages over cadmium-based methods, including reduced environmental impact, improved operator safety, and better performance. Unlike cadmium and hexavalent chromium, ZnNi is non-carcinogenic, lowering health risks. It also provides superior corrosion resistance and durability for high-strength steel components. The process improves repair efficiency, reduces maintenance costs, and enables localized repairs without disassembly, cutting labor, material, and logistical costs while enhancing operational readiness.

TRANSITION DESCRIPTION

The ZnNi brush electroplating technology transition will follow a structured plan to ensure widespread adoption at Fleet Readiness Centers (FRCs). Key activities include integrating process materials into the supply chain and establishing National Stock Numbers (NSNs) or Local Stock Numbers (LSNs) for consumables. Local Process Specifications (LPS) will be developed to standardize the repair process across Navy facilities. A workload analysis will prioritize FRCs and components for initial implementation, while training programs and certifications will ensure operator proficiency and consistent repair quality.

CONTACT

For more specific information about this project, contact the Principal Investigator, at kaitlyn.t.elkins.civ@us.navy.mil

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by Office of the Chief of Naval Operations (OPNAV) Compliance and Mission Readiness Division (N4I1) and managed by the Naval Facilities Engineering Systems Command (NAVFAC) from 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 and materials; and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring fleet readiness.

For more information, visit the program's web site at www.navfac.navy.mil/nesdi
or contact the NESDI Program Managers at NESDI.fct@navy.mil