PROJECT ID:
613

Black Oxide and Phosphate Coating Hexavalent Chromic Acid Rinse Replacement

Typical appearance of miscellaneous parts following phosphate processing.
(Photo: Crest Chemicals)

OBJECTIVE

The objective of this investigation is to evaluate and approve a hexavalent chromium free process for producing black oxide and phosphate coatings on steel surfaces at NAVAIR Fleet Readiness Centers (FRCs).

PROBLEM STATEMENT

Black oxide and phosphate coatings are essential for enhancing the wear and corrosion resistance of critical aircraft components. However, the current processes involve a post-treatment step utilizing hexavalent chromium, a known carcinogen regulated by OSHA and the EPA. In light of environmental and health concerns associated with hexavalent chromium, there is a need to approve and implement a hexavalent chromium-free alternative for the post-treatment rinse in the production of these coatings.

DESCRIPTION

The black oxide and phosphate processes employed at Fleet Readiness Center Southeast (FRCSE) plays are utilized to enhance the corrosion resistance and functional durability of approximately 800 aircraft parts annually. Primarily utilized for parts such as pinions, shafts, gas cylinders, gears, and screws, these processes adhere to military specifications MIL-DTL-16232 and MIL-DTL-13924.

In the black oxide process, these ferrous components undergo a series of steps. After a thorough cleaning to eliminate contaminants, activation of the steel surface occurs through immersion in an alkaline solution. Subsequent immersion in a hot alkaline solution with proprietary additives promotes the formation of a black ferrous oxide layer, providing both corrosion resistance and an aesthetically pleasing finish. The process is completed with rigorous rinsing to ensure the removal of residual chemicals, offering a durable protective coating. Optionally, sealing may be applied to further enhance corrosion resistance.

Simultaneously, the phosphate coating process involves cleaning and activation steps, followed by immersion in a phosphate solution containing phosphoric acid and manganese phosphate. This results in the formation of a crystalline phosphate coating on the steel surface, enhancing corrosion resistance and promoting adhesion for subsequent paint applications. Rinsing and drying steps complete the process.

Given the nature of the components processed, testing results are of paramount importance. Successful corrosion performance testing outcomes not only lead to NAVAIR approval but also hold the potential to influence future updates of material specifications under the technical cognizance of the U.S. Army. The ability to achieve and maintain compliance with these standards not only ensures the operational readiness of aircraft

components but also underscores the commitment of FRCSE to incorporate environmentally responsible practices.

RETURN ON INVESTMENT

The current process tanks require high operating temperatures resulting in long turnaround time for production and frequent adds to the process tanks. In Fiscal Year 21 FRC Southeast processed approximately 700 work orders for black oxide and phosphate coatings. This resulted in the generation of over 800 gallons of chromic acid waste and the expense that went along with its disposal. For FY24, it will cost $1.51 per gallon of hazardous waste disposal, this will cost $1200 per fiscal year to dispose at FRC Southeast alone. Not only are their costs associated with the disposal of hazardous waste, but there are also costs associated with Hazardous waste related operations.

NAVY BENEFITS

The proposed solution using a non-hexavalent chromium post treatment rinse/seal, will ensure that personnel exposure during operation will meet PEL requirements through an engineering substitution strategy that is not solely reliant upon respiratory PPE. The proposed solution is also designed to operate at room temperature and will thus reduce the need for temperature regulation equipment and utility costs.

In addition, EPA considers chromic acid as a hazardous air pollutant and waste generated requires wastewater treatment prior to discharge. Unregulated release of hexavalent chromium could affect surrounding wildlife, and result in fines from state and federal environmental agencies. An alternate post treatment would eliminate the health and environmental risks associated with hexavalent chromium while streamlining both processes.

TRANSITION DESCRIPTION

Testing will be conducted at the FRC Southeast and Naval Air (NAVAIR) Warfare Center Aircraft Division Patuxent River. Upon successful demonstration and validation, results will be provided to the cognizant engineering authority for consideration of implementation. Technology insertion will be made via NAVAIR authorization letter, modification of local process specifications, and related technical document updates to address specific program needs. For existing FRC processing facilities transition can occur through simple materials substitution and repurposing of existing rinse/seal tanks. Individual parts may need to go through specific qualification testing, depending on their criticality to safety/mission performance issues. A transition package will be provided to other NAVAIR sites performing black oxide, and/or phosphate surface treatments.

CONTACT

For more specific information about this project, contact the Principal Investigator at 904-790-6428.

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 OPNAV N4I Installations Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center 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 Navy readiness and lethality.

For more information, visit the program's 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.