PROJECT ID:
586

Chrome-free, Low-VOC and Fast-Drying Single- and Two-component Primers

This F/A-18E Super Hornet on the flight deck of the USS Ronald Reagan (CVN 76) is among the platforms targeted by the rapid-cure, low-VOC and chromate-free solvent-based primers being evaluated as part of this NESDI project. (Photo Credit: Mass Communication Specialist 2nd Class Samantha Jetzer)

OBJECTIVE

The objective of this project is to test and evaluate rapid-cure, chromate-free, and low-volatile organic compound (VOC) solvent-based primers that meet the requirements for use on tactical Navy aircraft, such as the F/A-18 Hornet jet fighter, the AV-8 Harrier ground-attack aircraft, the UH-1Y Venom utility helicopter and the AH-1Z Viper reconnaissance helicopter.

PROBLEM STATEMENT

The anticorrosive primers most commonly used on Navy aircraft are two-component (2K) products that contain VOCs, including toxic hexavalent chromium as the active corrosion inhibitor. Hexavalent chromium is a carcinogen and therefore poses a human health risk, and as a hazardous waste, there can be significant monetary costs associated with the monitoring and disposal of hexavalent chromium. In addition, these efforts are in line with an April 2009 Office of the Secretary of Defense memo restricting the use of hexavalent chromium when cost-effective alternatives with satisfactory performance become available. Water-based primers have come into use in recent years due to their shorter drying time, which enables application of a polyurethane topcoat within an 8-hour work shift.

However, these water-based primers don't provide the same corrosion protection as solvent-based primers, and ultimately result in repeated cycles of maintenance. A low-VOC alternative primer that provides adequate corrosion protection is needed.

DESCRIPTION

This project team is exploring the use of two alternative solvent-based primers: a single-component (1K) formula and a two-component (2K) formula. The goal is to qualify these to the performance requirements associated with MIL-PRF-23377 (PRIMER COATINGS: EPOXY, HIGH-SOLIDS, Type I/II Class N (non-chrome)), which will allow for their use at Navy aircraft maintenance facilities.

Solvent-based 2K primers are based on epoxy-amine chemistry. They cure chemically by cross-linking, creating a barrier that is abrasion-, chemical- and moisture-resistant. This project is exploring use of a fast-curing two-component solvent-based primer product based on modified versions of currently approved Class N formulas. The solvents and polymers in these primers have been modified slightly to reduce the drying time. These products require metering and mixing in specific ratios prior to application.

Solvent-based 1K primers are easier to use as they require no mixing of components prior to application. The fast-curing, 1K solvent-based primer product being tested under this project is based on novel moisture-curable polymers that were developed at the Naval Research Laboratory. These polymers are soluble in numerous hazardous air pollutant-free organic solvents, they require low levels of VOCs to generate a sprayable system, and they provide improved mechanical properties (e.g. greater flexibility) compared to epoxy-amine chemistries. This primer is also engineered to be tack-free in 1-2 hours. 1K primers such as these, formulated with aluminum alloy inhibitors, have demonstrated greater corrosion resistance in the laboratory than 2K epoxy-amine primers formulated with the same pigments, and the formulation is continually being improved upon by industry partners.

The primer candidates will be applied to pretreated aluminum panels, allowed to cure for 14 days under ambient conditions, tested to the MIL-PRF-23377, Type I/II, Class N performance requirements, and compared to MIL-PRF products on the qualified products database (QPD). During laboratory testing, the primers must provide adequate corrosion resistance and fluid resistance, in addition to demonstrating sufficient flexibility and adhesion. Primers that meet the performance requirements will be demonstrated on active Navy aircraft for a period of 14-18 months.

RETURN ON INVESTMENT

Fast-curing 2K and 1K primers will reduce the amount of time that is necessary for over-coating with a MIL-PRF-85285 polyurethane topcoat, thereby reducing labor costs and enabling workers to paint an aircraft in a single 8-hour shift. It is estimated that the average cost for an additional shift of artisans (painters) is approximately 60 hours (approximately $6,000). The estimated labor savings for the first five years upon completion of this effort is $3.6 million. In addition, there is a reduction of paint booth energy costs associated with air flow, temperature, and humidity control during painting. This will add up to aggregate savings of approximately $1.5 million annually when non-chrome primers are fully implemented (within the next 5-10 years).

The 1K primer would likely generate additional savings as opposed to the 2K primers. As the 1K primers require no mixing, there is no chance of an improperly mixed formula being applied on an aircraft, which might otherwise result in insufficient adhesion or performance.

NAVY BENEFITS

As mentioned above, a substantial labor savings will be realized by adoption of fast-drying primers. In addition, with a shift reduction, the demasking, reassembly, and marking procedures can be performed sooner, thereby enabling a faster turn-around-time, increasing the number of aircraft that can be painted each year, and improving aircraft availability/readiness.

Furthermore, chromate-free versions of 2K and 1K primers

would reduce environmental and health risks due to removal of carcinogenic hexavalent chromium, and maintenance costs would be concurrently reduced due to elimination of hexavalent chromium monitoring and disposal during aircraft depainting.

TRANSITION DESCRIPTION

Fast-curing, low-VOC primers that meet all MIL-PRF-23377, Type I/II, Class N requirements will be listed as qualified products on the QPD. The document will also be revised to include a new "Type" or "Class" for 1K systems. Qualified products will then be submitted for national stock number assignments, which will enable procurement through the Defense Logistics Agency (DLA). Relevant local process specifications and general series manuals will be updated. The 1K primer will be deployed on ships for operational level use so that sailors can easily perform touch-up/repair of aircraft without fear of improperly metering and mixing 2K epoxy primers.

CONTACT

For more specific information about this project, contact the Principal Investigator at 202-404-2889.

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 ken.kaempffe@navy.mil.