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Finishes on U.S. Army equipment must handle extreme environments, provide resistance to chemical agents and blend into their environment.

Protecting the Troops—and Their Equipment

CARCS ADVANCE WITH U.S. MILITARY

By Bob McElroy
The Sherwin-Williams Co.

Chemical warfare survivability has been a concern for the U.S. military for many years. The U.S. Army has regulations requiring all tactical equipment—including ground support equipment, tactical wheeled vehicles and aircraft—to be "hardened" against the effects of both chemical warfare agents and the degradation caused by the cleaning and decontamination procedures necessary in the aftermath of a chemical attack. These regulations are also followed by the Marine Corps and apply to Air Force vehicles and equipment procured through the Army.

As a result, most military vehicles and equipment are painted with Chemical Agent-Resistant Coatings (CARCs). These highly crosslinked topcoats produce a non-porous finish that keeps radioactive, biological and chemical contamination from penetrating the coating and the substrate. Instead of being absorbed into the finish, chemicals bead up on the finish surface where they can be washed away.

CARC finishes also must resist chemical attack from harsh cleaning agents used to decontaminate military vehicles, so the vehicles can be reused post-cleaning without fear of continued contamination and with the assurance that the finish is still fit to resist future chemical agent attacks. CARC coatings simplify the decontamination process.

Coating color is also important, because the military needs specific tones to blend into the landscape. Desert camouflage, for example, differs from jungle camouflage.

CARC coatings are used not only on military bases but also by the government contractors who refurbish vehicles and parts for the U.S. military. For example, Light Armored Vehicles (LAVs), High Mobility Multi-Purpose Wheeled Vehicles (HMMWV), generators, containers and shelter exteriors all are CARC coating candidates.

The Army Research Laboratory is the approving authority for all CARC coatings used throughout the Department of Defense (DoD). The lab is also the lead research facility responsible for the development of CARC coatings.

CARC CHEMISTRIES

For the past several years, three different types of CARC topcoats have been available for exterior use: two-component solvent-borne polyurethanes in conventional, high-solids, and baking formulations; one-component, moisture-cure urethane (MCU) CARCs; and two-component, high-performance, water-reducible polyurethane CARCs.

Solvent-borne CARCs were developed in the early 1980s. The catalyst to initiate their development was the need to protect billions of dollars of military equipment. The build-up for Operation Desert Storm increased concern about the potential for chemical attacks, thereby reinforcing the need for CARC systems. The specification for this coating , MIL-C-46168D, was cancelled in 2005.

MCU CARCs cure in a two-stage process in which water and isocyanate groups co-react to produce a cured paint film. The materials perform well in both abrasion resistance tests and in the field; wind blown dust, sand and chemical agents do not significantly damage the cured paint film. MCU materials have shown significant performance improvement over two-component solvent-borne CARCs, and they offer both lower levels of volatile organic compounds (VOCs) and elimination of hazardous air pollutants (HAPS).

Since 2000, high-performance water-reducible CARCs have gained acceptance. These materials meeting DoD's VOC objective of 1.8 lb/gal and contain no HAPs—in fact, the solvent content of water-reducible CARCs is only about half that of solvent-based CARCs.

Waterborne CARCs are formulated using water-reducible polyurethane resins. This technology enabled development of coatings that eliminate the paint film problems that previously occurred when an undesired reaction took place between water and polyisocyanate crosslinkers.

This breakthrough made it commercially viable for the first time to use water as the carrier in two-component CARC chemistry. This eliminated several solvents, including methyl isobutyl ketone, toluene and xylene.

Waterborne CARC chemistries meet the strictest federal and local air quality regulations, and offer a number of significant performance advantages. These include better low-temperature flexibility after application, resulting in fewer problems with chipping and cracking; better scratch resistance, resulting in reduced spot painting

Blackhawk helicopter testbed for Type II waterborne CARC technology at Fort Hood, TX. All helicopters on the base are now repainted using waterborne CARC.

Radar signature reduction (stealth) is also a consideration for military coatings. This Blackhawk is shown flying over working factories near Baghdad, Iraq.

to fix scratches and scrapes; better color stability for less fading; and better weathering durability than solvent-based CARC coatings.

WATERBORNE EVOLUTION

The newest generation of two-component water-reducible polyurethane CARCs, designated Type II, offers low VOCs (1.8 lb/gal), superior exterior durability compared to previous CARCs and a long wet edge that eliminates dry spray and facilitates camouflage painting. In testing, these materials also have lasted as much as eleven times longer than previous generations of waterborne CARCs.

Further, Type II waterborne CARC provides excellent coverage using up to 30% less coating, resulting in material savings and improved logistics. A direct result of improved application characteristics, material savings is a key logistical advantage: less material must be shipped to remote locations. The coating has low odor and is compatible with electrostatic application. It is non-flammable and provides a durable, flexible finish.

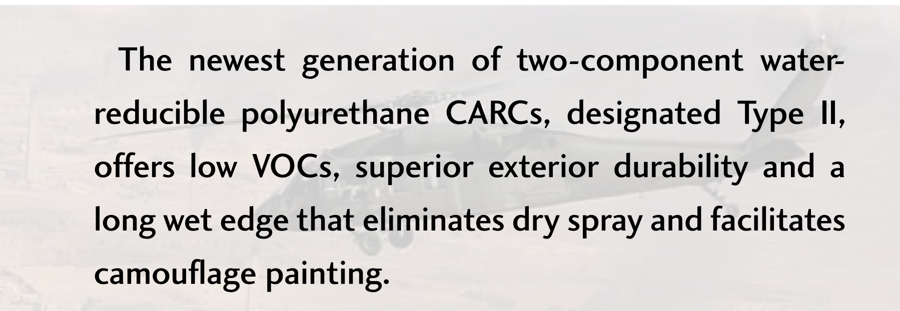
The primary difference between formulation of Type I and Type II water-reducible CARC lies in the type of pigments used. Type I waterborne CARC contains pigments that are extremely similar to those used in solvent-borne CARC. In Type II materials, novel pigmentation is used to improve the coating's mar resistance and weatherability.

Type II waterborne CARC materials are covered by specification MIL-DTL-64159. Because of its lack of abrasive pigments, Type II waterborne CARC is easier on application equipment than the earlier solvent-borne and Type 1 waterborne CARC. Dry-to-handle times are slower than those of moisture-cure urethane CARC coatings. Extended dry time is considered a drawback to incorporating Type II waterborne CARC into painting operations, but by making minimal process adjustments, dry times can be significantly improved.

FIELD TESTING

To test the application and performance of Type II waterborne CARC, the First Cavalry Division, Second Battalion 227th Aviation Regiment, based at Fort Hood (Killeen, TX), volunteered the use of a UH-60 Black Hawk helicopter for a coating demonstration. Fort Hood the only post in the United States capable of stationing and training two armored divisions at the same time.

The aircraft was masked, sanded and prepared for the coating application. Mixing the coating was the next step, and personnel noted that the mixing process was easily accomplished. Test participants—Fort Hood personnel with experience using both two-component solvent-based CARC and single-component CARC—also commented on the ease of application, the lack of dry overspray and a consistent overall appearance on the substrate. As a result of this test, the base now uses waterborne Type II CARC for its helicopter re-paint program.



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USING WATERBORNE CARC

One of the functions of solvents in a coating formulation is to emulsify minor surface impurities such as oil or grease. Water-reducible coatings, which contain significantly less solvents than solvent-borne coatings, are less forgiving when applied to inadequately prepared surfaces. Still, when surfaces are adequately cleaned and primed, water-reducible CARC coatings provide a strong, lasting bond.

When using Type II waterborne CARC, standard substrate cleaning practices apply. The substrate should be clean and free of grease, oil, rust and other contaminants. Required pre-treatments and primers for steel or aluminum are substrate-specific. Type I and Type II waterborne CARC are fully compatible with all existing CARC primers and topcoats, either water-based or solvent-based. They can be used to touch up a vehicle or piece of equipment that has previously been painted with CARC primers or topcoats.

Water-reducible CARC Type I and Type II are available only in two-component kits that have to be mixed before use. The mixing ratio is two parts component A to one part component B.

For application with HVLP spray equipment, two parts by volume of component A should be shaken for 5-10 minutes on a paint shaker. Next, one part by volume of component B should be slowly added into component A using a high-shear conical mixer to vigorously agitate the combined components for at least three minutes. An air drill capable of 2000 rpm is necessary to create sufficient shear to properly mix the materials.

The resulting high-viscosity material needs to be reduced with deionized water to achieve proper viscosity for spraying with HVLP equipment. Deionized water should be slowly poured into the vortex created by the conical mixer and mixed for at least one minute. Users should make sure viscosity is within the specified range before the mixture is sprayed.

Type II waterborne CARCs may be applied by conventional, air-assisted airless, airless and HVLP spray techniques. They are also compatible with electrostatic application methods.

As previously mentioned, relatively long dry time can be an issue for Type II waterborne CARC. With the cooperation of a manufacturing facility in Peoria, IL, representatives of The Sherwin-Williams Company and Camp Dodge, the military's STAR4D program (see sidebar) recently performed a series of drying tests on Type II waterborne CARC applied to a D-7 bulldozer sent through a production paint line.

Approximately 4-6 mils wet film thickness (WFT) of coating was applied using air-assisted airless spray equipment. The bulldozer was then sent through two, 27-minute drying cycles using two separate infrared cure stations.

Test results indicated that dry time could be reduced if internal temperature of the cure booth was raised from 120–140°F. Dry time could be further shortened by rearranging the convection air discharges to adjust for workpiece size of the piece of equipment. The group demonstrated that with proper temperature control and rearrangement of convection air discharges, dry times can be reduced to accommodate a reasonable rate of production. PF

LEARN MORE

Back to School

This article describes how waterborne paints are making inroads in military applications. To read how the U.S. military is helping its personnel apply these and other coatings more efficiently, read Back to School.

Find the link to this article online at *www.pfonline.com/articles/100601.html*

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