High Solids Primer Enhancement

Background:

The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation requires that all facilities engaged, either in part or in whole, in the manufacture or rework of commercial, civil, or military aerospace vehicles or components must be in full compliance by September 1, 1998. To achieve this compliance, the use of corrosion inhibiting primers with a maximum Volatile Organic Compound (VOC) of 340 grams/liter (2.8 pounds/gallon) is required. Substituting high solids materials in applications where the high solvent versions of these primers were in use represents a potential reduction of up to 8400 pounds of VOCs per year at the USAF Air Logistics Centers (ALCs).

Technical problems with high solid, solvent borne primers, both epoxy (MIL-P-23377G Type 1, Class C, "Primer Coating: Epoxy, High Solids") and polyurethane (TT-P-2760A, "Primer Coating: Polyurethane, Elastomeric"), were being experienced at the Air Logistics Centers (ALC), MAJCOM Field Units, and the Air Education and Training Command (AETC).

Project Sponsor/Customer: Air Force wide
Period of Performance: Sep 96 – Nov 99

Objective:

The objective of this project was to address these technical problems of high solids primers in order to expedite the transition of reduced VOC systems to the refinish sites. The long dry time needed before topcoat application increases the chance for the wet primer to become contaminated. Long primer dry times before topcoat application reduce the productivity of the paint facility. The environmental conditions in the facility affect dry time. For example, the dry time of polyurethane primers is significantly increased by lack of humidity, even at elevated temperatures. The higher viscosity of high solids, low VOC primers contribute to reduced atomization resulting in a pronounced orange peel appearance of the surface. This resultant orange peel is more apparent when overcoated with high gloss topcoats. Refinishing facilities are restricted from adding solvent to reduce the viscosity, because the paints are formulated at the maximum allowable VOC to remain in compliance; any additional solvent would negate this NESHAP compliance.

Status:

A survey of personnel at ALC and field repaint facilities identified difficulties being experienced using NESHAP compliant (high solids) primers. The most prevalent complaint was the longer dry time to a topcoat condition required by these primers when compared to low solids primers under other than standard environmental conditions, especially low temperature. The long dry times slow production and allow time for the wet primers to become contaminated. The surveyed personnel expressed willingness to accept a two-hour pot-life if dry time could be reduced.

Nine NESHAP-compliant primers (6 epoxy and 3 polyurethane) were evaluated for "wet" paint characteristics and final film properties when applied and cured under several environmental conditions. Two epoxy primers were on the Qualified Products List (QPL) for MIL-P-23377G. Four epoxy primers were modified by the manufacturers to achieve faster dry time. Two of the polyurethane primers were on the QPL for TT-P-2760A and one was modified by the manufacturer to accelerate the cure time.

The primers selected for this task were:

Primer	Specification		Vendor	Manufacturer's Id	Used
1	MIL-P-23377G	Modified	Courtaulds	RW-3355-64A/B/C	
2	MIL-P-23377G	QPL	Deft	02Y40	GSA Contract
3	MIL-P-23377G	Modified	Dexter	10-P20-12	
4	MIL-P-23377G	Modified	Sherwin-Williams	RP2108E90/RP2122V93	
5	MIL-P-23377G	QPL	Spraylat	EEAE154A/B	Randolph
6	MIL-P-23377G	Modified	US Paints	R9007	
7	TT-P-2760A	QPL	Courtaulds	833x089	
8	TT-P-2760A	QPL	Deft	09Y0002	GSA Contract Control
9	TT-P-2760A	Modified	Deft	09Y0002FD	

During this project, high solids, solvent-borne, and chromated primers were tested for the following characteristics: dry time, viscosity and pot-life, color, adhesion and water immersion resistance, pencil hardness, and modified PATTI test.

Within each primer category, no single product performed best under all environmental conditions. In all cases, primers with the lower initial viscosity had a lower viscosity after a two-hour pot-life. In general, the primers with the longer pot-life also exhibited longer dry times.

Within each environmental condition, a modified primer was judged to have the best balance between dry time, pot-life, and film properties. However, substantial differences were seen between QPL approved products in differing environmental conditions. Individual painting operations, therefore, have substantial opportunity to improve operations by evaluating the QPL materials available to them and choosing the material performing best under their specific conditions.

Based upon the testing conducted in this project, potential exists for primers to be formulated for optimum performance under specific environmental conditions. Purchase Descriptions (PD) or AMS Specifications for primers could be developed for primers to be applied under specific environmental conditions. These specifications should be tailored for dry time and pot-life under specific temperature and humidity conditions, while maintaining the film performance of the standard QPL primers.

Based on minimizing dry time and viscosity increase (measured after two hours), while maintaining acceptable adhesion, the best performing primers (epoxy and polyurethane) under each environmental application and cure condition were:

Condition	Primer	Type	Dry Time	Viscosity
77°F/50% RH	Sherwin-Williams mod	Epoxy	3 hr	32 sec
77°F/50% RH	Courtaulds-QPL	Polyurethane	6 hr	14 sec
60°F/20% RH	Dexter modified	Epoxy	9 hr	25 sec
60°F/80% RH	Sherwin-Williams mod	Epoxy	6.5 hr	47 sec
60°F/80% RH	Courtaulds-QPL	Polyurethane	5hrs	16 sec
90°F/20% RH	Spraylat-QPL	Epoxy	3 hr	75 sec
90°F/80% RH	Sherwin-Williams mod	Epoxy	2 hr	48 sec
90°F/80% RH	Courtaulds-QPL	Polyurethane	2.5 hr	15 sec
*Polyurethane Primer 7 (Courtaulds-QPL) was very slow drying. Polyurethane Primers 8 and 9 (Deft-QPL and modified) dried fast, but possessed very short pot-life				

No primer was judged the “best” for film characteristic and wet paint property under all environmental conditions. A more comprehensive test matrix is required to examine other film properties and determine the optimum primer to use under each environmental condition of application and cure.

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