DRAFT SF 298

1. Report Date (dd-mm-yy)	2. Report Type	3. Dates covered (from... to)
4. Title & subtitle Nonchromate, Low Density, Waterborne Epoxy Primer Tri-Service Committee on Corrosion Proceedings		5a. Contract or Grant # 5b. Program Element #
6. Author(s) Dr. Robert Chiang Mr. Chris Athanasopoulos		5c. Project # 5d. Task # 5e. Work Unit #
7. Performing Organization Name & Address		8. Performing Organization Report #
9. Sponsoring/Monitoring Agency Name & Address Tri-Service Committee on Corrosion USAF WRIGHT-PATTERSON Air Force Base, Ohio 45433		10. Monitor Acronym 11. Monitor Report #
12. Distribution/Availability Statement Approved for Public Release Distribution Unlimited		
13. Supplementary Notes		
14. Abstract		
15. Subject Terms Tri-Service Conference on Corrosion		

Security Classification of			19. Limitation of Abstract	20. # of Pages	21. Responsible Person (Name and Telephone #)
16. Report	17. Abstract	18. This Page			

TRI-SERVICE CONFERENCE ON CORROSION

21-23 JUNE 1994

**SHERATON PLAZA HOTEL
ORLANDO, FLORIDA**

PROCEEDINGS

NONCHROMATE, LOW DENSITY, WATERBORNE EPOXY PRIMER

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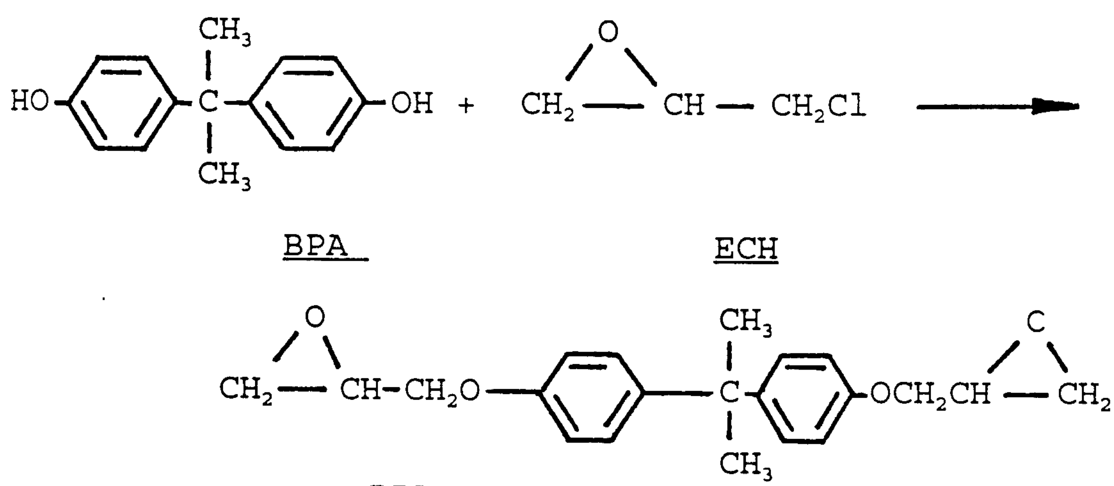
ABSTRACT:

A chrome-free, low density, waterborne epoxy primer was developed to meet MIL-P-85582B Specification. This primer does not contain toxic pigments and provides comparable corrosion protection as strontium chromate counterparts. Its dry film density was calculated at 0.0073 lbs/mil/square ft. It can be top coated with MIL-C-83286 and MIL-C-85285 urethane coatings within an hour at 77° F and 50% RH.

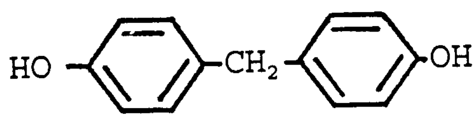
INTRODUCTION:

Epoxies were developed over fifty years ago. They are made by reacting Bisphenol A (BPA) and epichlorohydrin (ECH). Depending on the ratio of BPA and ECH and reaction conditions, epoxies with different molecular weight can be obtained.



BPA EPOXY

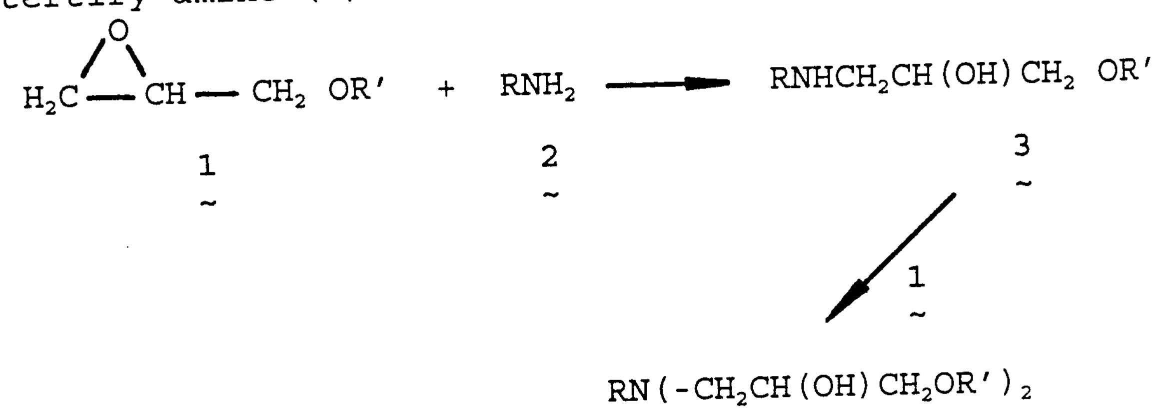
Other epoxy resins have also been synthesized. For example, Bishpenol F (BPF) epoxies are made by reacting BPF with ECH. BPF epoxies give lower viscosities as compared with BPA epoxies.



BPF

Exterior durable epoxies, cycloaliphatic epoxies, are also commercially available. These are derived from alkenes by epoxidation.

The most widely used epoxy curing agents in coatings are modified amines and polyamides. The curing mechanism is as follows. Epoxy (1) reacts with primary amine (2) to form secondary amine (3). The secondary amine (3) further reacts with epoxy (1) to give a tertiry amine (4).



Epoxies are widely used in surface coatings. They provide excellent corrosion protection, adhesion, and chemical resistance.

Because of the stringent environment requirements, waterborne epoxy coatings have been extensively studied and used as viable alternatives to traditional solvent-based coatings.[1-3] Water-borne epoxy systems provide additional advantages such as lower VOC (volatile organic compounds), fast tack-free time and easy cleaning among others. The recent advances in water-borne epoxy dispersion technology have resulted in water borne epoxy primers with equal or better corrosion protection properties than those of the solvent-based epoxy counterparts.[4]

In addition to lowering VOC, the need to eliminate carcinogenic compounds such as hexavalent chromium in coating systems has also been emphasized.[5] Revisions of current military coatings specifications have been proposed[6,7] to address this need.

In response to these challenges and the demand to reduce the VOC and eliminate hazardous chromate pigments, Spraylat Corporation launched a new development program in 1993. The goal was to formulate a nonchromate waterborne epoxy primer maintaining the corrosion protection of its chromate counter parts. It was intended for MIL-P-85582B specification.

RESULTS AND DISCUSSIONS:

In late 1993, an experimental nonchromate waterborne epoxy primer was developed at Spraylat Corporation based on proprietary technology. The physical characteristics of the primer, EWDY048A/B, are listed below:

Table 1. Physical Characteristics of EWDY048A/B

Solids	44 +/- 1% by weight 36 +/- 1% by volume
LBS/GAL	9.5 +/- 0.2
Mixing Ratio	3:1 by volume
#4 Ford Cup Viscosity	30-40 seconds
Sprayable Pot Life	4 hours
Coverage	572 sq.ft/mil/gal
Dry Film Density	0.00732 lbs/sq.ft/mil

The VOC for this coating is 2.64 lbs/gal (317gm/liter).

The viscosity of the admixed primer remains very stable during its 8 hour pot life. No induction time is required. The theoretical dry film density is 25% less than that of the chromate counterpart. The performance of EWDY048A/B primer was measured on the dry film of 1 mil thickness on 2024-T3 and T0 aluminum panels. The coated panels were allowed to dry at ambient temperature for 7 days before testing. Table 2 shows the performance properties of this coating.

Table 2. Performance Properties of EWDY048A/B

Tack-Free Time, Hrs	0.5
60° Gloss	< 5
Cross-Hatch Tape Adhesion	Excellent
G.E. Impact Elongation, %	60
MEK Resistance	Excellent
Pencil Hardness	H
Compatibility w/ Urethane Topcoats	Compatible

The corrosion resistance properties (Salt Fog Test, ASTM B117) of EWDY048A/B were compared with its chromate counterpart, EWDE072A/B, and several commercially available chomate containing water-borne epoxy primers. EWDE072A/B is a newly approved coating on QPL (Qualified Products List) from Spraylat Corporation for MIL-P-85582A, Type I, Class 2 Specification. Both EWDY048A/B and EWDE072A/B did not show defects after 2000 hours of salt fog test. Competitor B system passed 1500 hours exposure. Both competitors A and C coatings had some field blistering after 1000 hours. They also had some undercut rusting after 1500 hours of testing. Table 3 and Figure 1 summarize the results. All EWDY072A/B and competitor's materials are intended for MIL-P-85582A specification which require 1000 hours salt fog test. An upgrade of increase to 2000 hours corrosion test is proposed in the revised MIL-P-85582 Specification.[6] The new Specifications also call for chroamte-free systems. Based on its performance, EWDY048A/B system would meet these revised requirements.

Table 3. Salt Fog Test of EWDY048A/B And Other Systems

Salt Fog HRS	EWDY048A/B[3]	EWDE072A/B[1,2]	BRAND A[2]	BRAND B[2,3]	BRAND C[2,3]
1000	No Defects	No Defects	9 #8 FB[4]	No Defects	10 #8 FB
1500	No Defects	No Defects	11 #8 FB undercut rust	No Defects	12 #8 FB undercut rust
2000	No Defects	No Defects	----	undercut rust	----

1. MIL-P-85582A, Type I, Class 2, QPL, Spraylat Corp.
2. chromate containing
3. low density
4. FB: field blisters

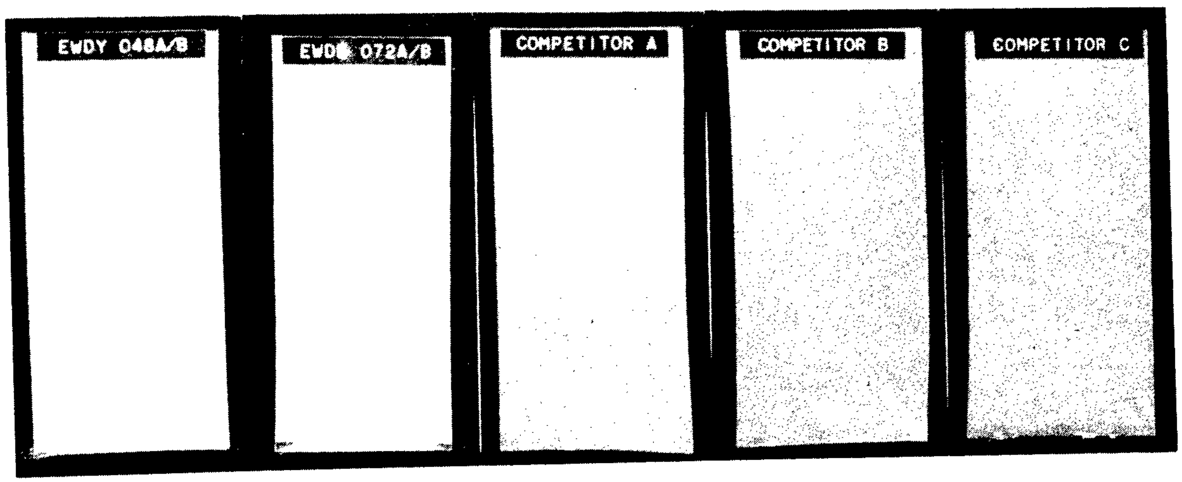


FIGURE 1 SALT FOG CORROSION TEST RESULTS OF EWDY 048A/B AND OTHER SYSTEMS

Waterborne epoxy primers generally give somewhat longer pot life than their high solids solvent-based counterparts. The effect of pot life of EWDY048A/B on its properties was studied. The flexibility and corrosion resistance of this coating at various pot life intervals were compared. It was found that the coating's impact elongation determined by a G.E. impact tester decreased over its pot life. A 60% enlongation was obtained when the coatings was applied 6 hours after the coating and hardener were mixed. The elongation reduced to 10% when the coating was applied 30 hours after mixing. The salt fog corrosion resistance also decreased with pot life. Table 4 and Figure 2 illustrates that the coating showed minor field blistering after 1080 hours of salt fog test when it was applied 6 hours after mixing or longer.

Table 4. Pot Life vs. Performance of EWDY048A/B

A. Corrosion Resistance

	HOURS BEFORE ADMIXED COATING WAS APPLIED		
SALT FOG HOURS	0.5	6	30
1080	No Defects	1 #4	1 #4
2600	Undercut Rust	1 #4& Undercut	1 #2, 2,#4 Undercut Rust

B. Impact Elongation %

	0.5	6	30
	60	60	<10

CONCLUSION:

A low VOC (317 grams/liter), low density, chromate free waterborne epoxy primer intended for revised MIL-P-85582 Specification has been developed by Spraylat Corporation. This coating, EWDY048A/B, has excellent salt fog corrosion resistance (2000 hours). Its corrosion resistance is superior to that of the

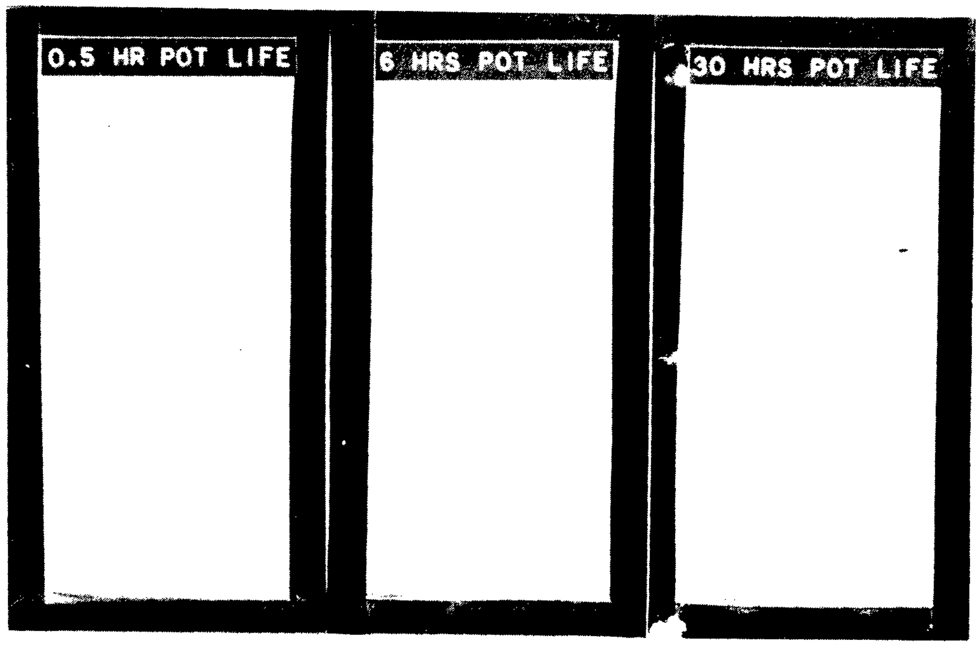


FIGURE 2 CORROSION VS. POT LIFE OF EWDY 048A/B

In addition to its high performance, lower VOC, ease of handling, and toxic-free pigments, it also provides the advantage of lower density.

ACKNOWELEDGEMENT:

The authors wish to appreciate the management of Spraylat Corporation for their encouragement and support. Special thanks are due to Kelly Myers for preparing the manuscript.

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