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DEVELOPMENT OF CORROSION INHIBITING WHITE PRIMER

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FACILITY FORM 602

Paul Schnake
Derwood P. Jensen
Robert H. Albrecht

Chicago Lacquer Laboratory

THE SHERWIN WILLIAMS COMPANY

Prepared for:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NASA
HUNTSVILLE, ALABAMA

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ABSTRACT

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Studies were conducted to develop a corrosion resisting white primer. In the development of this primer the effects of pigments and vehicles were evaluated. A vehicle based on a safflower RJ100 urethane varnish was found to contribute superior corrosion resistance, largely without deleterious effects on other film properties. A combination of Titanium Dioxide and Zinc Molybdate pigments was found to contribute to a maximum in hiding and corrosion resistance.

Various cleaning and metal treatment methods as well as various film thicknesses of the primer were evaluated to achieve maximum metal protection at a minimum primer weight.

Author

INTRODUCTION

THE GOAL

I. To determine the extent to which 2219 Aluminum Alloy is effected by salt spray corrosion.

II. To determine an efficient method of metal pretreatment.

III. To develop a primer or priming system which has the following properties:

A. The primer is to be white, low in density, and have appreciable coverage. The primer plus MIL-E-5556A White Flat Enamel are to form a system of minimum weight which would be achieved only by the use of a white primer (a colored primer would require increased film thickness of topcoat to achieve desired coverage and whiteness).

B. The primer must contribute to the corrosion inhibition of the system as determined by two salt spray tests.

1. Two weeks in five per cent salt spray [1]
2. Two weeks in twenty per cent salt spray [1]

C. The primer is to meet the physical requirements, film and resistance properties, and quality provisions of MIL-P-8585A.

THE SCOPE OF WORK [2]

I. An evaluation of various cleaning methods for adhesion promotion and corrosion inhibition leading to an improvement of corrosion resistance.

II. An evaluation of various vehicles, pigments and inert pigments to arrive at good starting formulations.

III. An evaluation of wash primers for possible system advantage - film thickness variation of each primer.

IV. An evaluation of additives and formulation refinement.

SUMMARY

White primer, E42 W 2, developed to meet the performance of MIL-P-8585A was tested and found to be deficient in drying rate, but acceptable for protective qualities.

An evaluation of corrosion resistance of 2219 Aluminum Alloy was conducted. This showed that metal pretreatment seemed to have little effect on the corrosion resistance of this alloy.

An evaluation of vehicles, pigments and inerts was conducted. The results of this evaluation showed that the nitrocellulose-castor maleic rosin varnish, the vinyl-epoxy and the safflower RJ100 urethane varnish were the most probable vehicles to yield satisfactory results. The pigment combination should be about eighty per cent titanium dioxide and twenty per cent zinc molybdate. Inert pigments did not appear to contribute enough to justify their use.

An evaluation of cleaning methods, film thickness, wash primers and primers was conducted. Proper cleaning seemed to give equally satisfactory results to that of wash primers. A suitable film thickness seemed to be 5/10 mil. The nitrocellulose - castor maleic rosin varnish vehicle was eliminated from testing due to failure in several areas.

An evaluation of formulation refinements was conducted. The optimum pigment by volume concentration was found to be about 45% and the solids content should be about 50%.

Salt spray tests extended to six weeks of these last two evaluations did not show appreciably more failure than did the two week tests.

An evaluation of goal fulfillment indicated that we did fulfill our objective.

1. These tests were extended to include six weeks or 1000 hours in salt spray.

2. An evaluation of goal fulfillment including six weeks or 1000 hours in salt spray was added per supplemental agreement modification number 1.

RESULTS AND DISCUSSION

In the development of this primer the effects of pigments and vehicles were evaluated. A vehicle based on a safflower RJ100 urethane varnish was found to contribute superior corrosion resistance, largely without deleterious effects on other film properties. Various vehicles were evaluated including those used in MIL-P-6889A and MIL-P-8585A, but none were equal in either corrosion protection and film properties to the safflower RJ100 urethane varnish. Although the vinyl-epoxy vehicle was nearly equal to it, time limited the necessary stability information for serious consideration of this vehicle.

A combination of Titanium Dioxide and Zinc Molybdate pigments was found to contribute towards a maximum in hiding and corrosion resistance. Because of the high coverage requirement of this primer and in an attempt to achieve maximum corrosion resistance the optimum pigment combination was found to be 90% Titanium Dioxide and 10% Zinc Molybdate. Although a pigment by volume concentration of 45% was found to be optimum, 40% was used to give better film strength and a more continuous film at minimum thicknesses.

The resultant formulation will provide maximum protection to 2219 Aluminum Alloy with a minimum weight. In the evaluation of goal fulfillment, no significant difference between primers was found during six weeks of salt spray testing. (See Data #1 for these results and statistical analysis of the data). A comparison was made to illustrate the difference in corrosion protection between the urethane primer at 1/10 mil and MIL-P-8585A at 4/10 mil. Both were topcoated with 5/10 mil MIL-E-5556A Flat White Enamel. Referring to the salt spray exposure tests (Illustration #1) note that no difference exists in the body of the panels. The only slight corrosion on panels primed with the urethane primer is at the scratch marks.

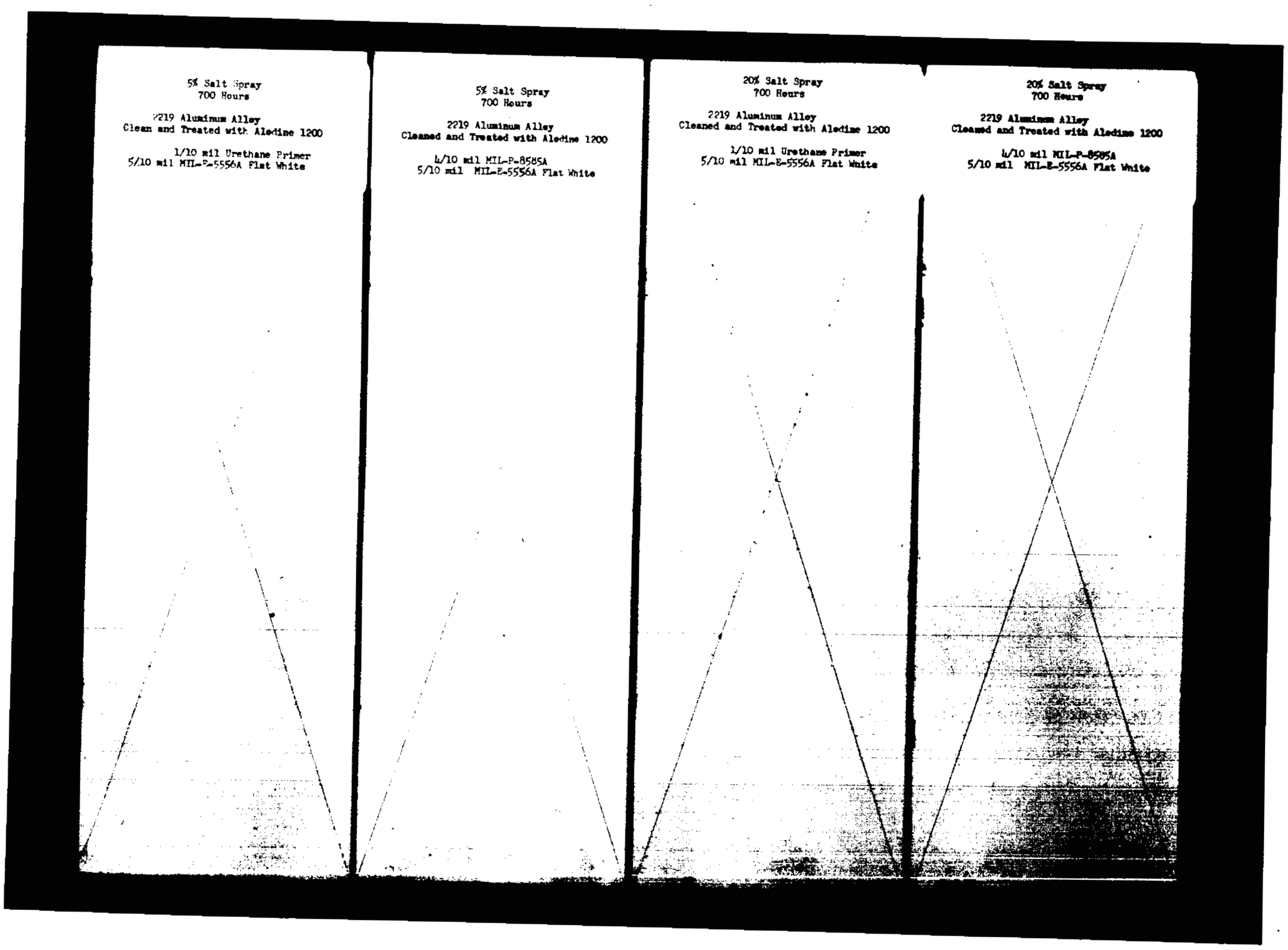
Contemporary to this, the effect of increasing driers was evaluated and the addition of 16 pounds of Zirconium drier per 100 gallons (Zirconyl - 2 - Ethyl Hexoate 28% - Advance Solvents) seemed to increase corrosion resistance significantly. With 1/10 mil of the urethane primer containing this drier there was no corrosion at the scratch marks after two weeks in 5% or 20% salt spray.

However, we do not believe that we have sufficient stability information at this time for inclusion of the zirconium drier in the primer formulation.

This formulation will fulfill most of the requirements set forth in MIL-P-8585A. Perhaps, the place where it is deficient is in the gloss requirement. At 1/10 mil the gloss of the urethane primer is 4 to 6 units and at 5/10 mil it is 8 to 10 units. MIL-P-8585A requires 3 gloss units maximum at 3/10 mil. Although at 5/10 mil this urethane primer yields satisfactory salt spray resistance without topcoating, 1/10 mil of this primer plus 5/10 mil of MIL-E-5556A forms a system yielding good corrosion resistance at a minimum weight.

The urethane primer (Sherwin-Williams formula number E90 W C9) should be reduced 200% with toluene for normal spray application. A medium spray coat will then deposit slightly more than 1/10 mil. As suggested in MIL-E-5556A the primer should be dried six hours prior to topcoating with MIL-E-5556A for best results.

ILLUSTRATION #1



DATA #1

1000 HOURS IN SALT SPRAY [3]

	IA1	IB2	IC3	IIA2	IIB3	IIC1	IIIA3	IIIB1	IIIC2
5%	4	6	9	7	7	9	6	9	10
20%	3	8	8	7	6	8	8	10	10

STATISTICAL ANALYSIS

5% Salt Spray

Source	ss	DF	MS	Fobs	Certainty
Primers	6.2	2	3.1	1.72	60%
Primer Film Thickness	20.2	2	10.1	5.6	78%
Topcoat Film Thickness	.2	2	.1	.56	35%
Remainder	3.6	2	1.8		

20% Salt Spray

Source	ss	DF	MS	Fobs	Certainty
Primers	14.9	2	7.5	1.98	61%
Primer Film Thickness	10.9	2	5.5	1.45	56%
Topcoat Film Thickness	2.9	2	1.5	.4	24%
Remainder	7.5	2	3.8		

It is significant that the topcoat film thickness is not significant.

3. See Technical Progress Report #4, October, 1964, for a listing of the specific variables.