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EVALUATION OF DRY-TO-THE-TOUCH, ULTRA THIN FILM, WATER DISPLACING, CORROSION PREVENTIVE COMPOUNDS

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13. ABSTRACT

This report covers the evaluation of a material which is ultra thin, has good water displacing properties, and possess corrosion preventive properties, and which is dry-to-the-touch when used on land-based aircraft in dusty areas.

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DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PA. 18974

AERO MATERIALS DEPARTMENT

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AIRTASK NO. F00543202 Work Unit No. OR

Materials currently qualified under specification MIL-C-81309A are very good water displacing and corrosion preventive compounds. However, they are soft films, and some land based units in dusty areas have stated that sufficient dust will adhere to the material to produce an undesirable appearance. For this reason, an investigation was undertaken to develop a material which, in addition to being ultra thin, having good water displacing and possessing corrosion preventive properties, would also be dry to the touch. Three materials were found to meet these requirements.

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S U M M A R Y

INTRODUCTION

Materials that meet the Grade A requirements of specification MIL-C-81309A, Corrosion Preventive Compound, Water Displacing, Ultra-Thin Film, are now being used effectively on exterior surfaces of aircraft and other equipment for the temporary prevention of corrosion.

These materials produce soft films which are oily to the touch, and, therefore, there is some dust pickup. This dust which will adhere to the surface of the material does not appear to reduce the corrosion protection afforded by the compound, but does detract from the aesthetic appearance of aircraft and other equipment. For this reason, many users have expressed a strong desire for a material which will be as efficient in displacing water and preventing corrosion as specification MIL-C-81309A materials yet be dry to the touch.

All materials which currently qualify under MIL-C-81309A when sprayed onto surfaces which are painted white impart an amber or light brown color to the surfaces. This effect is undesirable since it spoils the appearance of the equipment. Therefore action was taken to develop a material which would eliminate these objections.

SUMMARY OF RESULTS

A number of materials were received and evaluated in this investigation. Many of the samples claimed to be transparent, were not noticeably more transparent than current products. None of the samples which were transparent had satisfactory water displacing abilities. Three samples were obtained which, in addition to meeting all the requirements of specification MIL-C-81309A, were drier to the touch than currently qualified products. These three materials also showed better corrosion protection when evaluated in the new ACES test cabinet, which was designed to simulate closely the exposure conditions aboard carriers.

CONCLUSIONS

It is concluded that:

(1) A need currently exists for materials which meet all the requirements of Grade A of specification MIL-C-81309A and, in addition, are dry to the touch in order to reduce dust pick up.

(2) Exhibits A, B and C fulfill this need.

(3) A requirement still exists for a material which, in addition to possessing these properties, will be completely colorless and transparent. No material has as yet been found which will adequately do so.

(4) The Aircraft Carrier Environment Simulator test cabinet which was used in this evaluation more nearly simulates actual carrier exposure conditions and can be more precisely controlled than the apparatus currently used in the Synthetic Sea Water-Sulfurous acid spray test outlined in Specification MIL-C-81309

RECOMMENDATIONS

It is recommended that:

(1) Specification MIL-C-81309A be revised to include a requirement that materials meeting this specification leave films dry to the touch.

(2) The test to determine dust pick up described in this report be added to the specification with a requirement that no more than 0.002 grams of talc adhere to the test panel.

(3) Specification MIL-C-81309A be amended to substitute the Aircraft Carrier Environment Simulator (ACES) test cabinet for the apparatus currently used in the Synthetic Sea Water-Sulfurous Acid Spray test.

(4) The requirements that Grade A show no visible corrosion after 2 cycles on low carbon steel and 8 cycles on 410 steel, and that Grade B show no visible corrosion after 8 cycles on 410 steel be retained when the ACES test cabinet, including the ultra violet light, is substituted for current apparatus.

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EVALUATION AND DISCUSSION

BACKGROUND

The Naval Air Development Center developed an ultra-thin film, water displacing, corrosion preventive compound and packaged it in gas pressurized (aerosol) containers. Designated AML-350, it was developed for use on highly critical metal surfaces, both for initial protection during shipment and storage and for in-service treatment of critical areas. The Grade A requirements of specification MIL-C-81309A were written to cover this type material. Grade A materials, which give the equivalent protection of AML-350, are intended for use on all metals, including magnesium and mild steel and also for use on areas containing two dissimilar metals in order to prevent galvanic corrosion. Grade B materials contain the same basic ingredients as Grade A materials, but in lesser amounts thus offering considerably less protection. They are intended for use only on stainless steel and aluminum and in interior locations. The films produced by both grades are soft. As reported in references (a) to (d), both laboratory tests and field use indicated that Grade A materials provided adequate corrosion protection. However as reported in reference (d), a number of land based units which reported dusty climatic conditions did not like the appearance of the film because dust adhered to the surface of it. Some units also reported that they did not like the light brown color of the material, which is visible on white paint but not noticeable on bare metal.

Because of these reports it was concluded in reference (d) that a need exists for a material similar to Grade A of MIL-C-81309A except that it would be dry to the touch, particularly for use in dusty areas. Therefore, the Naval Air Development Center undertook to develop or obtain a material which would be so, and, if possible, also colorless. By reference (e) and subsequent contacts, 64 manufacturers were invited to submit materials which might meet these requirements. Seven manufacturers submitted a total of nine materials.

METHODS & RESULTS

All samples received were tested to determine their ability to pass the Synthetic Sea Water-Sulfurous Acid Spray test and the Synthetic Sea Water Displacement test as described in specification MIL-C-81309A. The results are found in Table I. Samples which failed either of these tests were eliminated from further consideration. Three materials, Exhibits A, B and C, passed both of these tests as shown in Table I.

These three materials were then subjected to the following additional tests of MIL-C-81309A:

Flash Point
Removability
Abrasives
Film Thickness
Sprayability
Corrosivity
Staining

They each passed all of these tests as shown in Table II.

A new test had to be developed in order to determine how dry-to-the-touch films formed by these material were. Since the purpose of having a dry-to-the-touch material was to decrease or eliminate dust pick up, the logical test would be to measure the amount of dust a panel coated with the material would pick up. This was accomplished by dipping freshly abraded and cleaned 1010 steel panels in each of the materials, hanging them for one hour (to allow the solvent to evaporate), weighing them, and then dipping them into a large container of talcum powder. All surfaces of the panels were allowed to come into contact with the talcum powder and then the panels were reweighed. The gain in weight was a measure of the amount of talcum powder which adhered to the preservative compound. Since a small amount of talcum powder will normally adhere to nearly any surface, uncoated 2" x 4" x 1/16" 1010 steel panels were weighed and then dipped in powdered talc and reweighed. These were considered blanks and their gain in weight was subtracted from the gain in weights of the coated panels. The gain in weight for panels coated with Exhibits A, B and C was negligible (0.002 grams or less). This compared to 0.173 to 0.228 grams for panels dipped in products currently qualified under specification MIL-C-81309A.

Because of the possibility that these materials might soften and thereby pick up dust at more elevated temperatures, similar tests were run at both 100°F and 120°F. In this series of tests the panels after dipping in the corrosion preventive compound were conditioned for either one hour or 16 hours at the elevated temperature and then dipped in the talcum powder. The results showed that even at 120°F, the amount of dust adhering to any of the three materials was quite low; a maximum of 0.018 grams.

In order to determine how colorless the corrosion preventive materials were, 3" x 6" aluminum panels which were painted white were dipped into the materials. The color of the panel after drying was compared to uncoated white panels. Each of the three materials, Exhibits A, B and C, produced a color on white panels.

In addition to running the Synthetic Sea Water-Sulfurous Acid Spray test, as described in specification MIL-C-81309A, these materials were tested in a new test cabinet, recently designed and developed at the Naval Air Development Center which combines exposure to ultraviolet light with the synthetic sea water-sulfurous acid spray. In addition the new cabinet is able to control other variables such as the temperature and relative humidity of the air. The details of this test cabinet, called the Aircraft Carrier Environment Simulator (ACES) test cabinet, will be described in a separate report.

Exhibits A, B and C successfully passed 2 cycles in the ACES test cabinet. Materials meeting the Grade A requirements of MIL-C-81309A will not pass 2 cycles of this test, which includes ultraviolet light exposure. They will, however, pass 2 cycles when the UV light exposure is eliminated.

EXHIBIT SHEET

NADC Designation	Manufacturer's Designation	MANUFACTURER
A	U.S.O. 380	U. S. Organics, Inc. 13156 Saticoy Street No. Hollywood, California 91605
B	Clarco KB171	The Clarkson Laboratories 1450 Terry Avenue Camden, New Jersey 08104
C	Alox 2230F	Alox Corporation P. O. Box 517 Niagara Falls, New York
D	Globo M2000	Casten Enterprises, Inc. 2118 West Roscoe Street Chicago, Illinois 60618
E	Cee Bee SR Kote #2	Chemetron Corporation 9520 E. Cee Bee Drive Downey, California 90241
F	RD-4150	Armour Industrial Chemicals 8401 West 47th Street McCook, Illinois 60520
G	RD-4151	Armour Industrial Chemicals (same address)
H	RD-4152	Armour Industrial Chemicals (same address)
J	THPO	Hooker Research Center Niagara Falls, New York 1430[illegible]

REFERENCES

(a) Report No. NAEC-AML-2090 of 3 December 1964

(b) Report No. NAEC-AML-2129 of 25 February 1965

(c) Report No. NAEC-AML-2606 of 20 April 1967

(d) Report No. NADC-MA-6837 of 13 June 1968

(e) NADC ltr MACE 5409 of 21 September 1970

TABLE I

PROTECTION PROPERTIES DATA

Exhibits	Synthetic Sea Water Displacement Test	Synthetic Sea Water-Sulfurous Acid Spray
A	Passes	Passes
B	Passes	Passes
C	Passes	Passes
D	Fails	Fails
E	Fails	---
F	100%—Fails 50%—Borderline pass	50%—Fails
G	Fails	---
H	Fails	Fails
J	Fails	Fails

TABLE II

PHYSICAL TEST DATA

Property	Requirement	Exhibit A	Exhibit B	Exhibit C
Flash Point	140°F minimum	168°F	155°F	156°F
Removability	Not more than 3 cycles to remove	1	1	1
Abrasives	None present	None	None	None
Film Thickness	0.0005 inch maximum	<.0005	<.0005	<.0005
Sprayability	Sprayable	Sprayable	Sprayable	Sprayable
Corrosivity	No visible pitting, etching, or dark discoloration	No visible pitting, etching, or dark discoloration	No visible pitting, etching or dark discoloration	No visible pitting, etching or dark discoloration
	No weight change, (milligrams/cm^2) greater than			
	0.5 for magnesium	0	0.1 0.1	0.1
	0.5 for cadmium	0	0	0
	0.5 for zinc	0	0.1	0.3
	0.2 for aluminum	0	0	0
	0.2 for copper	0	0	0.1
	0.2 for brass	0	0	0.1
Staining	No visible evidence of staining	None	None	None
Synthetic Sea Water Displacement	No visible corrosion	None	None	None
Synthetic Sea Water Sulfurous Acid Spray	No visible corrosion 2 cycles on low carbon steel	No corrosion	No corrosion	No corrosion