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Evaluation of VpCI-325 according to MIL-PRF-81309F

Background: Cortec wanted VpCI-325 to be tested in accordance with MIL-PRF-81309F.

Purpose: Evaluate VpCI-325 according to *MIL-PRF-81309F, Corrosion Preventative Compounds, Water Displacing, Ultra Thin Film.*

Method:

1) MIL-PRF-81309F, 4.6.15 Neutral Salt Spray Protection, referencing ASTM-B117 Salt Spray (Fog) Apparatus Operating

2) MIL-PRF-81309F, 4.6.5 Corrosivity Test

3) MIL-PRF-81309F, 4.6.3 Compatibility with MIL-PRF-32033 and MIL-L-87177

*4) ASTM D-877, Dielectric Breakdown

**5) Pour point

Materials:

1) MIL-PRF-81309F, 4.6.15 Neutral Salt Spray Protection
VpCI-325
Acetone
7075-T6 Aluminum panels, 2 x 4 x 1/8 inch
Plastic coated paperclips
Metal hanging rack
CCX-Advanced Cyclic Corrosion Exposure System (Salt chamber)
Wooden tongue depressor
Salt Chamber, ASTM B-117

*This test was performed by Harris Testing Laboratories, Inc.
**Pour point was tested by Lubricating Technology, Inc.

2) MIL-PRF-81309F, 4.6.5 Corrosivity Test
Magnesium, SAE-AMS4375
Cadmium, A-A-51126
Zinc, MIL-A-18001
Aluminum, SAE-AMSQQ-A-250/4
Copper, ASTM-B152
Brass, ASTM-B36

3) Used for Neutral Salt Spray Protection and Corrosivity Test
VpCI-325
Methanol, lab grade
Exx-Print 189 D Fluid, conforms to MIL-PRF 680
8oz glass jar with plastic screw cap
240 grit silicon carbide paper

4) Compatibility with MIL-PRF-32033 and MIL-L-87177
100 ml cone shaped centrifuge tube
VpCI-325
Hyprene 100 Napthenic Oil, conforms to MIL-PRF-32033
VpCI-369 M (conforms to MIL-L-87177)
8oz glass jar with plastic screw cap
800 ml glass beaker

Procedure:
MIL-PRF-81309F, 4.6.15 Neutral Salt Spray Protection

1. 4 specimens of 2 x 4 x 1/8 inch 7075-T6 Aluminum were polished with 240 grit silicon carbide paper on one side of the specimen and in one direction.
2. The specimens were then cleaned by wiping them with kimwipes wet with acetone, and then wiped with a clean kimwipe. The procedure was then completed again using methanol instead of acetone. One specimen was set aside to be used as a control panel for comparison.
3. Air bubbles, if present, were skimmed from the surface of the well mixed 500ml sampleVpCI-325 using a wooden tongue depressor.
4. Three specimens were then dipped into the VpCI-325, and were completely immersed for one minute.
5. The specimens were then removed from the sample of VpCI-325 at a rate of 4 inches per minute until the entire specimen was removed from the representative sample.
6. After being conditioned for 24 hours in a draft, dust, and fume free environment, the coated specimens were then placed into the salt chamber.
7. The panels were regularly viewed for signs of corrosion, and the time that the specimens corroded was noted.

8. After 336 hours the specimens were removed from the salt chamber and cleaned using MIL-PRF 680.

MIL-PRF-81309F, 4.6.5 Corrosivity Test

1. Specimens shall be 3 by ½ by 1/16 inches and shall be of the following metals: Magnesium, SAE-AMS4375; Cadmium, A-A-51126; Zinc, MIL-A-18001; Aluminum, SAE-AMSQQ-A-250/4; Copper, ASTM-B152; Brass, ASTM-B36.
2. All sharp edges and burrs were removed by using 120 grit silicon carbide paper.
3. The specimens were then hand polished using 240 grit silicon carbide on one side and in one direction.
4. Panels were then cleaned by dipping the specimens into methanol, and wiped with a dry kimwipe.
5. After weighing specimens, one specimen of each metal was placed in an 8 oz jar with VpCI-325. Only 1 type of metal was allowed per jar. Specimens were covered with enough of the compound so that the specimens were ¼ inch below the surface of the compound.
6. The jars were then sealed with a screw cap, and placed in an oven at 130˚±2˚F.
7. After 7 days the sealed jars were removed from the oven and cleaned per number 4.
8. Specimens were reweighed and weight loss or weight gain was calculated in milligrams per square centimeter.

Compatibility with MIL-PRF-32033 and MIL-L-87177

1. 5 ml of VpCI-325 was added to 15 ml of MIL-PRF-32033 in a 100 ml cone-shaped centrifuge and the mixture was shaken until the mixture appeared homogeneous.
2. The 100 ml cone-shaped centrifuge, which was then set into an 800 ml beaker.
3. The beaker with the cone-shaped centrifuge was then put into an 170˚±2˚F oven.
4. After 15 minutes the beaker was removed from the oven and was visually examined for sedimentation, chemical precipitation, or reaction.
5. Steps per 1-4 were then repeated using 15 ml of VpCI-325 with 15 ml of VpCI-369 M instead of 5 ml of VpCI-325 was added to 15 ml of MIL-PRF-32033.

Results:

1. Corrosivity Test[1]

VpCI-325 Corrosivity Test[2]

Specimen	Weight Difference (mg)	Cm^2 of specimen	mg/ cm^2
Brass	1.0	12.75	.0784
Copper	.9	12.75	.0706
Zinc	1.8	12.75	.1412
Magnesium	1.7	9.75	.1744
Cadmium	1.5	9.75	.1538
Aluminum	1.7	9.75	.1744

2. Neutral Salt Spray Protection[1]

Neutral Salt Spray Test[2]

Coated with	Panel #	Time to Failure (Hours)	~ % Corrosion after 336 hours	Corrosion spots >1 mm
VpCI-325	1	DNF*	0	0
VpCI-325	2	DNF*	0	0
VpCI-325	3	DNF*	0	0
Control	N/A	<24	>75	>10

*Did Not Fail

3. Compatibility with MIL-PRF-32033 and MIL-L-87177[2]

1. VpCI-325 did not show any sedimentation, evidence of chemical precipitation or reaction when in the presence of MIL-PRF-32033.

2. VpCI-325 did not show any sedimentation, evidence of chemical precipitation or reaction when in the presence of VpCI-369 M (MIL-L-87177).

[1]Photos at end of the report.
[2]Required performance characteristics can be found at the end of the report

4. Dielectric breakdown results are attached.

5. Pour point was found: -51°C.

Conclusion:

1. The results of the Neutral Salt Spray Protection test concluded that VpCI-325 has sufficient anticorrosion properties. After 336 hours in the "neutral salt spray" conditions, no corrosion was present.

2. The Corrosivity test results concluded that VpCI-325 passed all metals, making it an effective corrosion inhibitor for magnesium, cadmium, zinc, brass, and aluminum.

3. The compatibility test results concluded that VpCI-325 compatible with MIL-PRF-32033 and MIL-L-87177.

Based on the results above VpCI-325 can be recommended for QPL approval in Accordance to MIL-PRF-81309F

Required Performance Characteristics

Property	Requirement
Compatibility with MIL-PRF-32033 and MIL-L-87177	No sedimentation or separation
Corrosivity, maximum weight change Magnesium, Cadmium, and Zinc Aluminum, Copper and Brass	 .5 mg/cm^2 .2 mg/cm^2
Neutral salt fog protection, minimum hours to unacceptable corrosion 1/	336

1/ Unacceptable corrosion is not more than three rust spots less than 1 mm in diameter, excluding the area within 1/8 inch of the panel edges or hole.

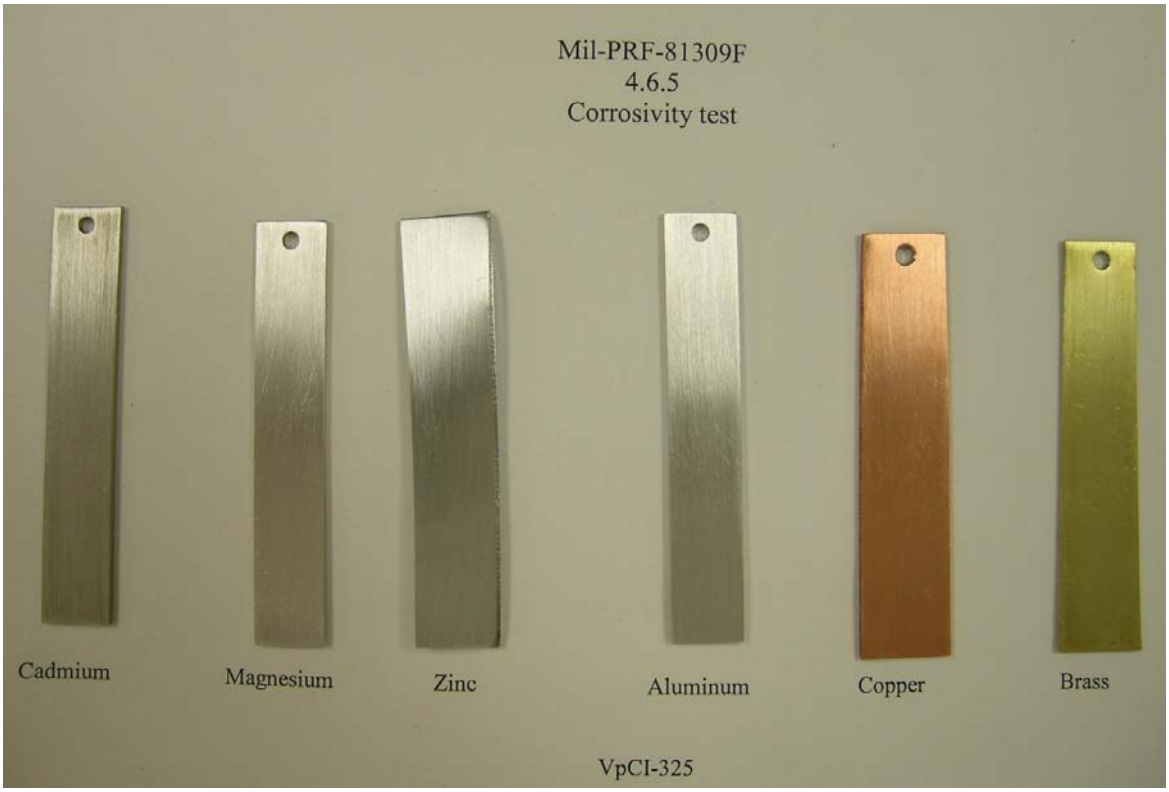

Figure 1. Specimens that were immersed in VpCI-325, after 1 week. Notice that all specimens display no corrosion.

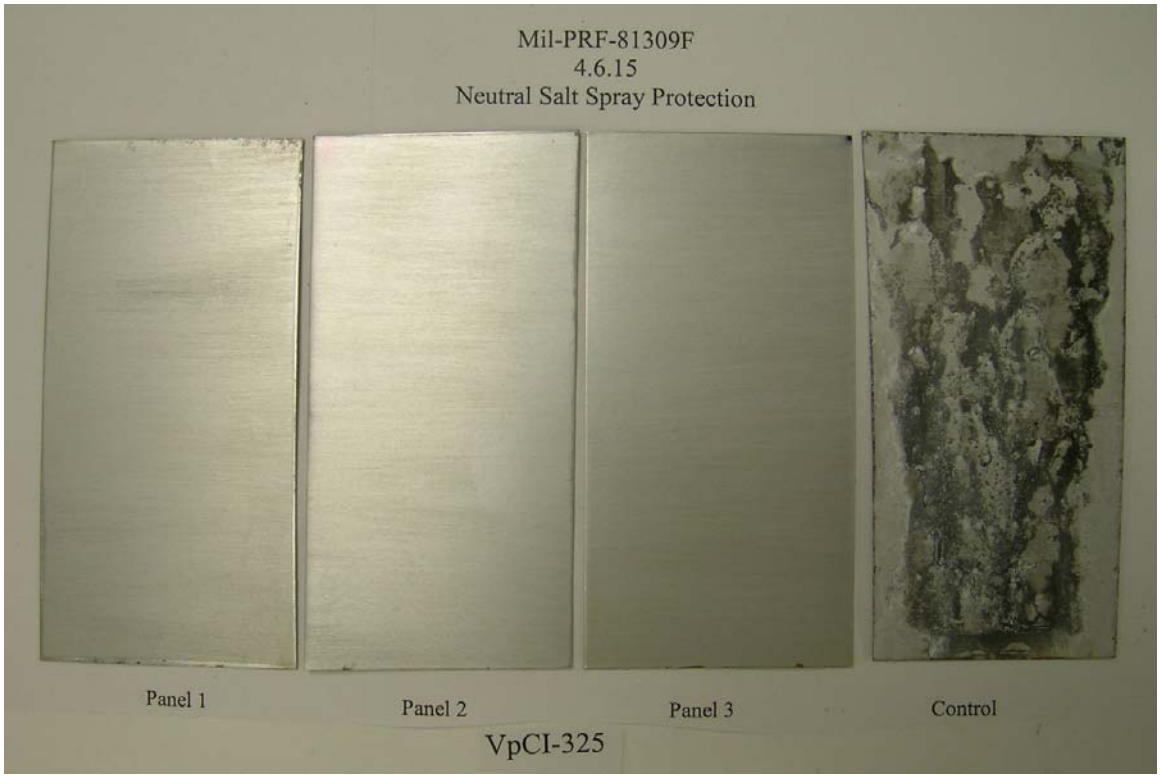

Figure 2. VpCI-325 on 7075-T6 Aluminum panels after 336 hours, no corrosion is seen on the panels coated with VpCI-325.

HARRIS TESTING LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT
Cortec Corporation
4119 White Bear Parkway
St. Paul, MN 55110

PRODUCT: Oil
DATE RECEIVED: 11/1/2004
LAB NO.: HH0411-0102
SUBMITTED BY: Cortec Corporation

METHOD	D-877	SPECIFICATIONS	
TEST	Dielectric Breakdown, kV	MIN.	MAX.
MARKS			
VCI-327	4	XXX	XXX
VpCI-325	32	XXX	XXX

Comments:

Date Issued:
11/8/2004

Chemist

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