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MIL-SPEC Evaluation of EcoLine 3690

Purpose: To test EcoLine 3690 in accordance to military specifications MIL-PRF-16173E, grades 2 and 3.

Materials: Closed Cup Flash Tester (product of GCA / Precision Scientific, Cat #74617)
Graco XT Series Air Spray Gun
Panels for Immersion/Coatings Test:
- -Brass
- -Zinc, 99.9% pure
- -Magnesium Alloy AZ31B H-24 (QQ-M-44)
- -Steel, QQ-A-250, cold rolled
- -Aluminum Alloy QQ-A-250/4 (2024 T-3 Bare)
- -Lead/calcium Alloy

Panels for Humidity and Salt Spray testing (1010 carbon steel panels)
Super Lube- Synthetic Gear Oil
1010 carbon steel panels
Mineral Oil

Method: ASTM D-1748 (Humidity)
ASTM B-117 (Salt Spray)
ASTM D-93 (Flash Point)
ASTM D-2369 (NVC/VOC)
Sprayability Test
Film Thickness Test
Immersion Testing
Coating Test
Stability Testing- Low Temp. Recovery
Stability Testing- Confirmatory Recovery
Stability Testing- Uniformity
Water Displacement and Water Stability
Water Displacement and Water Stability (dilution)
Drying Test
Miscibility Test
Storage Stability

Procedure: The following procedures were followed (note- all ASTM tests were performed according to the ASTM procedures):

1) Sprayability Test- EcoLine 3690 was first cooled to a temperature of 40°F and then sprayed with the air spray gun at a rate of 35psi to determine whether or not the compound is sprayable.
2) Film Thickness Test- a carbon steel panel was weighed and then dipped in Ecoline 3690. For 24 hours the panel was hung to drip/dry and then reweighed to determine the film thickness.
3) Immersion Testing- The appropriate specimens were pre-weighed and then immersed in a upright vertical position hanging from the lid of an 8oz glass jar for one week at a temperature of 55°C. After the testing the specimens were cleaned and re-weighed to determine the mg/cm² weight loss.
4) Coating Test- The appropriate specimens were pre-weighed and coated (immersed) in Ecoline 3690. After a 24 hour drying period the specimens were then placed in an oven for 7 days with a temperature of 49°C. After the testing the specimens were cleaned and re-weighed to determine the mg/cm² weight loss.
5) Stability Testing, Low Temp. Recovery- 50mL of Ecoline 3690 went in a cork stoppered test tube and was placed in an oven set at 55°C for 8 hours. Immediately after the 8 hours the test tube was transferred to a cold chamber set at -20°C and held there for 16 hours. 24 hours consists of one cycle and the test is cycled four times after which an evaluation is made.
6) Stability Testing, Confirmatory Recovery- After testing for low temp. recovery, a sprayability test was performed.
7) Stability Testing, Uniformity- After the immersion testing was done, the solution was examined for precipitates and haziness.
8) Water Displacement/Stability- Fifty mL of Ecoline 3690 went into a 125 mL flask with 5mL of distilled water (this will be the solution used for testing). First a carbon steel panel is dipped in DI water and then dipped in the above solution. Then the panel is hung inside a gallon size jar and tested for 1 hour at room temperature. At the end of 1 hour, the panel is observed for rusting.
9) Water Displacement/Stability (dilution)- At a 1:1 ratio, Ecoline 3690 was diluted with mineral oil, and the test was performed according to the above procedure (6).
10) Drying- dip a carbon steel panel in Ecoline 3690, hang to drip for 4 hours at room temperature, and then examine the panel for softness.
11) Miscibility- In a test tube, 5mL of Ecoline 3690 was added to 95mL of synthetic gear and shaken till uniform. The solution was then heated to 170°F for 15 minutes and then allowed to cool to room temp. for 24 hours before being examined for separation and/or sediment.
12) Storage Stability- for 3 months Ecoline 3690 was stored at 100°F, then for 3 months at 77°F, and then for 3 months at 40°F. The product was then humidity and salt spray tested.

Results: The following results were found:

Test	Requirements	Results	Pass/Fail
Humidity (ASTM-D1748)	no corrosion after 30 days of exposure	no corrosion after 30 days	Pass
Salt Spray (ASTM-B117)	no corrosion after 7days exposure	no corrosion after 7 days	Pass
Flash Point	minimum of 38°C	>90°C	Pass
Non Volatile Content	N.A.	90.1%	N.A.
Volatile Organic Content	N.A.	0.8 lbs/gal	N.A.
Sprayability	must be sprayable at 40°F and above	Sprayable at 40°F	Pass
Film Thickness	1 mil. (max)	~0.63mils	Pass
Stability Testing- Low Temp. Recovery	no gelling or solidification @ -40°C	no gelling or solidification @ -20°C	N.A.
Stability Testing- Confirmatory Recovery	Must be sprayable after low temp. recovery	Sprayable	N.A.
Stability Testing- Uniformity	No precipitates of haziness after immersion testing	no precipitates or haziness observed	Pass
Water Displacement and Water Stability	no rusting or surface stains after testing	no rusting nor surface stains	Pass
Water Displacement and Water Stability (dilution)	no rusting or surface stains after testing	no rusting nor surface stains	Pass
Drying	coating should remain soft after drying & exposure	soft after drying & exposure	Pass
Miscibility	no separation or sediment	no separation or sediment	Pass
Storage Stability	Must pass humidity & salt spray tests after storage	Test in progress	N.A.

Immersion Testing

Specimen	Requirements (weight loss in mg/cm²)	Results (weight loss, mg/cm²)	Pass/Fail
Brass	<1.0	0	Pass
Zinc	<7.5	-0.4	Pass
Magnesium	<0.5	0	Pass
Aluminum	<0.2	-0.05	Pass
Steel	<0.2	0	Pass
Lead-calcium	<5.0	0	Pass

Coating Testing

Specimen	Requirements (weight loss in mg/cm²)	Results (weight loss, mg/cm²)	Pass/Fail
Brass	<1.0	0	Pass
Zinc	<7.5	0	Pass
Magnesium	<0.5	0	Pass
Aluminum	<0.2	0	Pass
Steel	<0.2	0	Pass
Lead-calcium	<5.0	0	Pass

Conclusion: These preliminary tests indicate that, EcoLine 3690 meets the requirements of the military specifications MIL-PRF-16173E, grades 2 and 3.