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ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Comparing Competitor Film and Cardboard Emitters to VpCI-126 film and BioPad

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ISO 9001 QUALITY SYSTEM REGISTERED

ENVIRONMENTAL ISO 14001 CERTIFIED SYSTEM REGISTERED

Background: Our customer develops and manufactures deep drawn metal stampings for clients around the world. They are currently using competitor film and cardboard emitters, but would prefer to use Cortec products if they provide equal or greater corrosion protection.

Samples Received: The following samples were received in good condition:

1. One bag of metal parts packaged in competitor film, received on 2-22-19
2. One bag of metal parts packaged in VpCI-126 film, received on 2-22-19
3. Three competitor cardboard emitters and two competitor bags (2mil), received on 2-28-19
4. Two competitor cardboard emitters and one competitor bag (2mil), received on 3-8-19

Method: Humidity Testing, ASTM D1735
Razor Blade Test, CC-004*
NACE Standard VIA Test, TM0208-2008, item No. 21253*
Nitrite/Nitrate Test*
*The tests marked are not covered under Cortec Laboratories, Inc. ISO 17025 Scope of Accreditation

Materials: Q-fog humidity chamber
VIA test kit (testing jars/apparatus, steel plugs, 400grit sandpaper)
Steel panels, SAE 1008/1010 (Q-Panel, S-35 DG, 3"x5"x0.032")
Copper panels
VpCI-126 film, 2mils (batch #810240)
BioPad, 3"x3" (batch #148718)
Glycerol (lot #Q10A018)
Nitrite/Nitrate Test Strips (lot #HC719626)
Methanol, ACS grade (lot #18F066507)

Procedure: The following procedure was followed for the Humidity Testing:

1. The submitted metal parts packaged in competitor film were equally divided into three piles and then packaged into three separate competitor bags. One competitor cardboard emitter (3" x 3") was added to each of the bags and packaging tape was used to seal the bags shut.
2. The submitted metal parts packaged in VpCI-126 film were equally divided into three piles and then packaged into three separate VpCI-126 bags. One piece of BioPad (3" x 3") was added to each of the bags and packaging tape was used to seal the bags shut.
3. Parts were placed in the Q-fog humidity chamber so that the folded edge of the bag was facing down to avoid any water to enter the package.
4. Time to failure was noted at the first appearance of corrosion.

For VIA testing, the procedure was followed according to NACE VIA Test, TM0208-2008 option 2 (option 2 uses machine-aided grinding and polishing for the steel plugs).
Note- the VIA tests were conducted using two strips of sample per jar (1" X 6" per strip)

The razor blade testing was conducted according to standard procedure.

Results: The following results were found:

Humidity Testing

Submitted metal parts packaged in:	Bag #	Time to Failure	# of Parts with corrosion
2mil Competitor Film Bag with One Competitor Emitter (3" x 3")	1	70 hours	25 out of 36 (69%)
	2	140 hours	21 out of 36 (58%)
	3	165 hours	10 out of 36 (28%)
2mil VpCI-126 Film Bag with One BioPad (3" x 3")	1	70 hours	7 out of 54 (13%)
	2	194 hours	6 out of 54 (11%)
	3	Did not fail	0 out of 54 (0%)

Testing started on 3-12-19 @ 1:30pm and ended on 3-20-19 @ 3:30pm (194 Hours total)

Razor Blade Test- Carbon Steel Panels

Sample	Panel #1	Panel #2	Panel #3	End Result
Competitor Film	Fail	Fail	Fail	Fail
VpCI-126 Film*	Pass	Pass	Pass	Pass
Control	Fail	-	-	Fail

Razor Blade Test- Copper Panels

Sample	Panel #1	Panel #2	Panel #3	End Result
Competitor Film	Fail	Fail	Fail	Fail
VpCI-126 Film*	Pass	Pass	Pass	Pass
Control	Fail	-	-	Fail

NACE VIA Test

Sample	Plug #1	Plug #2	Plug #3	End Result
Competitor Film	Grade 1	Grade 1	Grade 0	Fail
VpCI-126 Film*	Grade 3	Grade 3	Grade 2	Pass
Control	Grade 0	-	-	Fail

***Note- The razor blade and VIA results for VpCI-126 film was previously tested (from 16-083-1125)**

Nitrite/Nitrate Test Strips

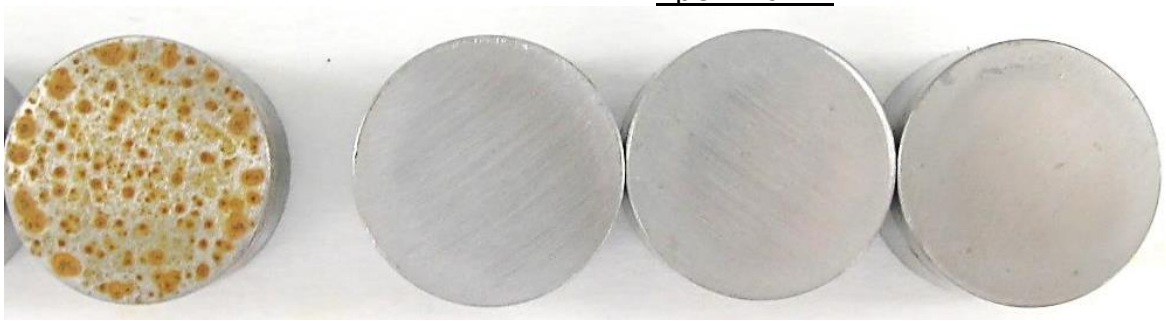
Sample	Results
Competitor Film	Does not contain any nitrite or nitrate

Photos from the NACE VIA test:

Competitor film

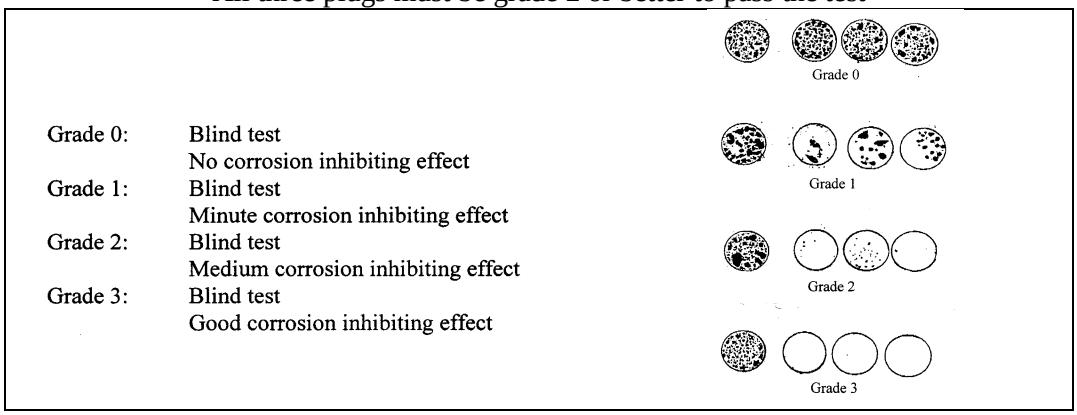
Control Plug#1 Plug #2 Plug #3

VpCI-126 film



Control Plug#1 Plug #2 Plug #3

VIA Test Grades (Grade 2 or 3 are passing)
All three plugs must be grade 2 or better to pass the test



Photos after 194 hours of Humidity testing:

Packaged in Competitor Film with one 3” x 3” Competitor Cardboard Emitter (Bag #1)
(showing only the corroded parts, 25 out of 36)

Packaged in Competitor Film with one 3” x 3” Competitor Cardboard Emitter (Bag #2)
(showing only the corroded parts, 21 out of 36)

Packaged in Competitor Film with one 3” x 3” Competitor Cardboard Emitter (Bag #3)
(showing only the corroded parts, 10 out of 36)

Photos after 194 hours of Humidity testing:

Packaged in VpCI-126 Film with one 3" x 3" Piece of BioPad (Bag #1)
(showing only the corroded parts, 7 out of 54)

Packaged in VpCI-126 Film with one 3" x 3" Piece of BioPad (Bag #2)
(showing only the corroded parts, 6 out of 54)

Interpretations: VpCI-126 film provides better corrosion protection than the submitted competitor film. The competitor film failed the razor blade and VIA testing while VpCI-126 film passes these tests. The results of the humidity testing also shows that VpCI-126 film and BioPad provide better corrosion protection for the submitted metal parts than the competitor film and competitor cardboard emitters.