

Cadmium Alternatives Conversion Coatings Studies



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Outline

- Introduction
- Key parameters investigated
- Tests
- Bright zinc
- IVD-aluminum
- Acidic Zinc/Nickel
- On-going tests
- Future work



Introduction

Objectives

To demonstrate and validate the performance of TCP (trivalent chromium process) and NCP (non-chromium process) as an alternative post-treatment to hexavalent chromium containing compounds on Cd replacement sacrificial coatings such as IVD-aluminum, acidic zinc-nickel, and bright-zinc on steel.



Test Parameters

- Type of sacrificial coating
 - Bright zinc
 - Acidic zinc-nickel
 - IVD-aluminum
- TCP/NCP composition with and without additives
- Key Processes
 - Activated versus non-activated
 - Peened versus unpeened for the IVD-aluminum
 - Immersion temperature, time, and solution concentration



Key Tests

- Unpainted corrosion resistance via ASTM B117 and ASTM G85.A4
- Painted corrosion resistance via ASTM B117 and ASTM G85.A4
- Paint adhesion via tape test (dry and wet 1, 4, and 7-day accelerated measurements)



NAVAIR Schedule

- Evaluate various compositions of TCP and NCP as post-treatments for the aforementioned Cd-replacement sacrificial coatings
- Optimize activation, temperature, and immersion times
- Determine suitable field test components
- **Demonstrate technology at the Depot level**
- Treat actual components and commence field testing



Description of TCP and NCP Compositions

- TCP-P*: Cr(III) sulfate basic, K_2ZrF_6 , manipulation during manufacture, indefinite shelf-life.
- TCP-S*: Similar to TCP-P but contains a complex fluoride additive that increases composition activity and auto-stabilizes pH during manufacture, indefinite shelf-life.
- CC1#: Modified version of TCP-P
- CC2#: Modified version of TCP-S
- NCP#: Non-chromium corrosion inhibiting post-treatment

*Matzdorf, C., *et al*, US Patent 5,374,347; 6,375,726; 6,511,532;
6,521,029; 6,527,841

#Patents pending



Benefits of TCP over Chromated Conversion Coatings

- No hexavalent chromium
- Reduced total chromium

Additional Benefit Provided by NCP

- Elimination of chromium from the process



Chromium (VI) Regulations

- OSHA is pushing lower Cr (VI) PEL (personal exposure limits), thereby requiring industry to eliminate or reduce Cr (VI) tanks
 - This reduction will make the use of Cr(VI) cost prohibitive, thereby requiring alternatives to be in place
- TCP does away with Cr (VI), thereby eliminating personal exposure.



Variables Tested for Bright Zinc

| Activation* | Post-treatment# | TCP Concentration | Immersion Time (min) | Temperature (°F) |
|--------------------|------------------------|--------------------------|-----------------------------|-------------------------|
| YES | P | 5 | 10 | 120-150 |
| YES | CC1 | 5 | 10 | 120-150 |
| NO | P | 1-10 | 5-20 | RT-150 |
| NO | S | 5 | 5-15 | RT-150 |
| NO | CC1 | 5 | 5-15 | RT-150 |
| NO | CC2 | 5 | 5-15 | RT |

* 1 vol.% H₂SO₄, 10-15 sec

Variation of TCP



Results for Bright Zinc

- Activation of the panels prior to TCP treatment severely decreased the corrosion resistance
- Room temperature application of TCP outperformed commercial Cr (III)
- Optimum TCP performance was found when TCP was applied at 120 °F for a 5-10 min immersion time



Preliminary Test of Temperature Variations on Corrosion Protection for Bright Zinc

The commercial Cr(VI) performed only slightly better than 2P applied at 120° F.

The 2P applied at RT, 85° F, and 100° F outperformed the commercial Cr(III).



26 Days Neutral Salt Fog (ASTM B117)



2P, 120 °F,
5 min



Commercial
Cr (III)
25 days



Commercial
Cr (VI)



Variables for IVD-Aluminum

- Compositions
 - 5P, 5S, 5CC1, 5CC2, and NCP
- Temperature
 - Room
- Activated and non-activated
- Peened and unpeened
- Immersion time (5-15 minutes)



Results for IVD-Aluminum

- Activation of the panels (more apparent with the peened samples) increased corrosion protection
- At over 4000 hours, the TCP and NCP is performing as well as the chromate control
- Optimum performance for the non-Cr (VI) post-treatments was found on activated, peened samples with an immersion time of 10-15 minutes applied at room temperature for the NCP and TCP



Neutral Salt Fog (ASTM B117) for IVD-Aluminum



5S, RT, 10 min
Activated
Not peened
158 days



NCP, RT, 10 min
Activated
Not peened
131 days



Factory
Applied
5S, RT, 10 min
Peened
158 days



Commercial Cr
(VI)
Peened
158 days



Neutral Salt Fog (ASTM B117) for
IVD-Aluminum



5S, RT, 15 min
Activated
Peened
183 days

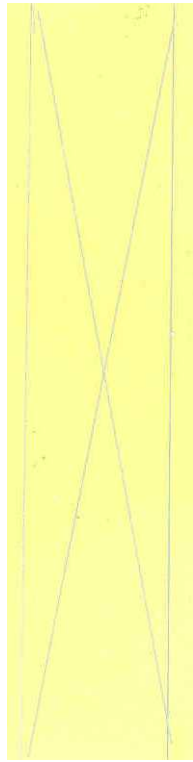
NCP, RT, 10 min
Activated
Peened
209 days

Factory
Applied
5S, RT, 10 min
Peened
209 days

Commercial Cr
(VI)
Peened
209 days



Wet-Tape Adhesion for 23377 Primed Panels



Dry, NCP
Not peened
5A
(ASTM D3359)

Dry, NCP
Peened
5A
(ASTM D3359)

Dry, Factory TCP
Peened
5A
(ASTM D3359)

Dry, Factory Chromate
Peened
5A
(ASTM D3359)



Wet-Tape Adhesion for Panels Treated with Self-Priming Topcoat (TT-P-2756)



Dry, NCP
Not peened
5A
(ASTM D3359)

Dry, NCP
Peened
4A
(ASTM D3359)

Dry, Factory TCP
Peened
4A
(ASTM D3359)

Dry, Factory Chromate
Peened
0A
(ASTM D3359)



IVD with NCP after 6 Months of Carrier Deck Exposure

Rack of Panels



NCP Treated IVD
after 6 months on
carrier deck



IVD post-treated with NCP and TCP and primed (23377) after 6 Months of Carrier Deck Exposure



Ongoing Tests

- Zinc-nickel
 - Optimization of corrosion protection through the use of various additives
- IVD-aluminum
 - Bare panels have been in SO₂ for 1 week with no signs of red rust
 - Painted corrosion
 - Panels from the Stennis are going out on the Nimitz
 - Depot validation



Preliminary Field Test Platforms for IVD Components

- In collaboration with Cherry Point we have identified two platforms for field-testing of TCP and NCP pending the outcome of the laboratory testing
 - AV-8B
 - H-46



Conclusion

With optimization, non-hexavalent chromium post-treatments have been found to provide corrosion protection that surpasses specifications and equals Cr(VI) containing post-treatment performance on various Cd-replacement coatings. Plans are underway to test the TCP and NCP with non-chromate primers.



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