CHEMEON SURFACE TECHNOLOGY

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CHEMEON Pretreatment & Conversion Coating for Magnesium Alloys

Abstract

A new pretreatment and a non-chromated conversion coating were developed as a replacement to conventional hexavalent chromium based conversion coatings for magnesium alloys. Neutral Salt Fog tests revealed that CHEMEON pretreated Magnesium performed similar to hexavalent chromated test coupons. Calculated corrosion rates showed that the new CHEMEON non-chromated pretreatment on Magnesium alloy had relatively better corrosion resistance than chromated conversion coatings. Pull-off adhesion tests on primed samples after the oil immersion showed that the CHEMEON pretreated test coupons had relatively higher adhesion value. Primed and scribed surfaces with and without stripping & rework gave comparable results for both the CHEMEON and hexavalent chromium processed magnesium alloy surfaces.

Introduction

Although magnesium quickly forms a passive oxide film on its surface in air or water, it is porous in nature, poorly bonded, inhomogeneous and non-protective against corrosive medium. The corrosion susceptibility of magnesium and its alloys in humid and aqueous environments restricts their potential applications. There are various physical or chemical surface treatment technologies developed in order to improve the anti-corrosion and/or surface adhesive bonding properties of magnesium alloys. Chemical conversion coating methods have been proven to be very effective and cost-efficient technologies to provide anti-corrosion and paint adhesion properties on magnesium alloys.

Mechanical, chemical and electrochemical pretreatment methods, including alkaline cleaning, acid pickling, fluoride activation, etc., have been commonly used for the removal of the natural oxide layer to provide a relatively better receptive surface for the subsequent chemical conversion coatings on magnesium alloys. Proper pretreatment enables the formation of homogeneous conversion coatings on the magnesium surface with good barrier layer properties and higher corrosion resistance. The same coating also forms a good base for subsequent organic primers and/or paints.

Conventional chemical surface treatment of magnesium alloys involves the use of hexavalent chromate compounds, which are highly toxic and adversely affect the environment and human health. Although there are other commercially available conversion coating technologies, which do not contain hexavalent chromate, their corrosion protection and paint-adhesion properties cannot compete with the hexavalent chromates. Therefore, an environmentally friendly chemical surface treatment method was developed to eliminate the usage of chromates and to meet or exceed the protectiveness to cost ratio of the conventional chromated conversion coatings.

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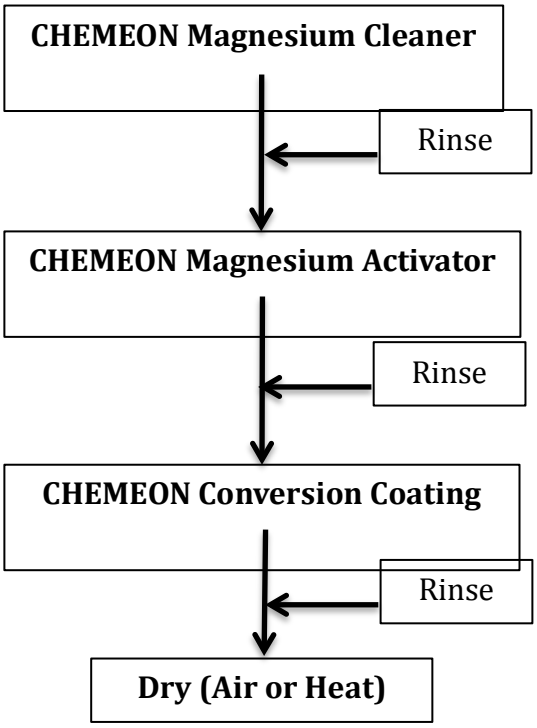
Results and Discussion

CHEMEON pretreatment & conversion coating application details are given in the following flowchart.



Corrosion resistance performance of CHEMEON conversion coated, hexavalent chromated, and uncoated AZ92A-T6 magnesium alloys were measured after 4 hours of salt spray exposure in accordance with ASTM B117. Uncoated magnesium showed significant corrosion formation throughout the exposed surface and hexavalent chromated magnesium alloy showed some white corrosion along with a few pit formations after 4 hours of neutral salt spray exposure. On the other hand, CHEMEON processed AZ92A-T6 magnesium developed relatively less amount of corrosion except a few isolated pits on the exposed surface.

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CHEMEON pretreated & coated (top), hexavalent chromated (bottom) AZ-92A-T6 magnesium alloy before (left column) and after (right column) 4 h salt spray testing performed in accordance with ASTM B117.

Corrosion rates were measured by using potentiodynamic studies in neutral 5% NaCl water solution. Calculated corrosion rate for bare AZ92A-T6 magnesium alloy was 682 mils per year (MPY), hexavalent chromium coated sample had 10.84 MPY and CHEMEON conversion coated magnesium had a corrosion rate of 1.53 MPY.

Coated and uncoated AZ92A-T6 magnesium samples were primed with non-chromated epoxy primer (MIL-PRF-23377J, Type I, Class N) and then top-coated with MIL-PRF-85285 polyurethane paint before neutral salt spray exposure. Primed and painted samples were scribed and exposed to salt spray for 336 hours. CHEMEON pretreated and hexavalent chromated samples had the same rating of 8 in accordance with ASTM D1654. On the other hand, samples with no conversion coating had a corrosion rating of less than 3.

Oil immersion tests were conducted in MIL-PRF-23699F turbine oil at 250 ºF by immersing the test samples half way through into the bath for a period of 24 hours. Samples without any conversion coating had a corrosion rating of 9 and the failure mode for the pull-off adhesion was substrate/adhesive with very low adhesion value of 2271 psi. On the other hand, both CHEMEON pretreated & conversion coated and hexavalent chromated AZ92A-T6 magnesium alloy samples had a corrosion rating of 10 and the failure mode for the pull off adhesion was

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primer/cohesive. CHEMEON pretreated & coated samples had relatively higher pull-off adhesion value of 3140 psi compared to the hexavalent chromated samples (2542 psi).

Conclusions

New environmentally green CHEMEON pretreatment & non-chromated conversion coating chemicals were used to coat AZ92A-T6 magnesium alloy to improve the corrosion resistance and to improve the paint adhesion properties. The coating formed a uniform and compact layer on the magnesium substrate. Comparative performance analysis showed that CHEMEON coated surface provided comparable, in some cases relatively better, corrosion performance compared to the conventional hexavalent chromated magnesium. Primed and scribed surfaces with and without stripping & rework gave comparable results for both the CHEMEON pretreated & conversion coated and hexavalent chromium coated magnesium alloy surface. These results showed that this eco-friendly CHEMEON pretreatment & conversion coating chemical could be a drop-in replacement to the conventional hexavalent chromates for magnesium alloys.