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ZINC RICH PRIMERS

A Comparative Study

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ZINC RICH PRIMERS
A Comparative Study

The concept of using zinc rich primers gained acceptance in the 1940's with the advent of products using inorganic silicates as the binder and a content of pure zinc powder in excess of 80% of the final cured film. Over the intervening decades, these products gained wide acceptance because of their ability to protect steel structures by means of the zinc sacrificing to the parent steel in the same manner as galvanizing or the use of anodes.

The handling characteristics of these products made it difficult, however, to achieve the desired result. They require meticulous surface preparation, will mud crack if applied at more than 4 dry mils and will cure improperly in wet conditions. Some brands cannot be topcoated for at least 24 hours, tying up valuable shop time. Inorganic zincs inherently have low flexibility and will readily crack if the coated part bends or moves significantly. Abrasion resistance varies from high to low, and impact resistance is relatively low.

Over the past thirty or more years, a number of alternative products have been developed with the goal of providing similar protection but with fewer of the application difficulties. Most of these products use moisture-curing polyurethane resins as the binder. Consequently, they are more surface tolerant, less prone to mud cracking, have better flexibility and are preferred for repair and maintenance coating due to faster topcoating time and lower porosity. They will not cure at cold temperatures, however (<5^0C/40^0F).

The development by Madison Chemical of AlumiZinc 'S' was undertaken in order to retain the desirable performance properties of zinc rich primers in a more user friendly format. The resin system chosen was a polyurethane prepolymer, which cures by two mechanisms: a resin/polyol cross linking that occurs when inhibitors in the formula evaporate during the application process, and a hydroxyl-bearing catalyst mixed in with the product immediately prior to use. The product is iso-rich, ensuring that any unreacted molecules are crosslinked by ambient moisture as the two curing mechanisms are near a state of completion.

The additives are a unique blend. Zinc provides sacrificial protection. Micaceous iron oxide provides barrier protection and aluminum provides both. Two corrosion inhibitors are incorporated into the formula. A recently-discovered and very powerful adhesion promoter, Madison AP-50, enhances the bond to the substrate so as to give not only excellent results on well prepared surfaces but surprisingly adequate results at all levels of surface preparation. AlumiZinc 'S' will even provide good protection on surfaces power washed with warm water and Madison PreWash, a proprietary mix of degreasers, corrosion inhibiters and AP-50.

The following tables compare AlumiZinc 'S' to both of the traditional kinds of system. AlumiZinc 'S' is very paint-like to apply. It can be built at thicknesses of 7 to 8 dry mils and will not mud crack, even if allowed to puddle. It will cure at temperatures down to 5^0 F (-15^0 C). It can be used on its own, being quite UV resistant and color stable; it develops a silver metallic patina, much like galvanizing. Cure-to-handle and cure-to-recoat times are shorter than any competing technology, which translates to faster throughput. AlumiZinc 'S' remains resilient over the years and does not "post cure" to a brittle state. Impact resistance is 4 to 8 times greater than other technologies. The topcoat window is indefinite, although we advise topcoating within 90 days. Performance data such as salt fog cabinet testing is on a par with the older technologies.

The tables on Pages 2 and 3 provide details. Table 1 examines handling characteristics, while Table 2 looks at performance properties. A point-by-point comparison shows that AlumiZinc 'S' achieves Madison's goal of providing the advantages of zinc rich primers without the usual disadvantages.

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Table 1 - HANDLING PROPERTIES OF ALUMIZINC ‘S’ VS. TRADITIONAL ZINC RICH PRIMERS

HANDLING PROPERTY	REFERENCE	UNITS OR BASIS	ALUMIZINC 'S'	INORGANIC ZINC PRIMER	ORGANIC ZINC PRIMER	COMMENTS
Description			Single-component-plus-catalyst polyurethane	Solvent based inorganic zinc	Moisture cured polyurethane	Alumizinc 'S' incorporates the anti-corrosive properties of zinc dust, the barrier protection of aluminum flakes and micaceous iron oxide (MiOX) and corrosion inhibitors together in an easy to use, surface tolerant, high performance primer
Dry Film Appearance			Silver, metallic sheen	Dark grey, some particles in film. Film cracks above 4 dry mils	Green-grey color	Alumizinc 'S' may be applied at dry film thickness > 6 mils with no mud-cracking. This together with its bright color make it suitable for use as a 'stand-alone' coating
Minimum Recommended Surface Preparation	SSPC Surface Cleanliness Standards		SP-1(Degreasing wash)	SP-6 (Commercial blast)	SP-6	Surface tolerant Alumizinc 'S' offers a range of surface preparations. For moderate to heavy service a power tool clean (SP-3) is recommended. For severe service, use an 'Near White' abrasive blast (SP-10)
Minimum Ambient Curing Temperature		^{0}F (^{0}C)	5 (-15)	15 (-10)	40 (5)	Lower temperatures allow for work in harsher environments
Cure To Handle	75^{0}F (24^0 C)	Hrs	0.5 - 2	1	4	Choice of three catalysts for Alumizinc 'S' allows for tailoring production to accommodate application temperatures and production parameters
Cure To Topcoat	75^{0}F (24^0 C)	Minimum (Hrs)	0.5 - 2	18	4	Rapid topcoating allows for faster throughput of work
		Maximum (Days)	90	N/A	60	A long topcoat window allows for storage of pieces and topcoating as required by customer preference (without a sweep blast 'refresh')

Table 2 - PERFORMANCE PROPERTIES OF ALUMIZINC ‘S’ VS. TRADITIONAL ZINC RICH PRIMERS

PERFORMANCE TEST	REFERENCE	UNITS OR BASIS	ALUMIZINC 'S'	INORGANIC ZINC PRIMER	ORGANIC ZINC PRIMER	COMMENTS
Adhesion	ASTM D-4541	PSI	1600 psi; cohesive failure	1000 psi; cohesive failure	2200 psi; adhesive failure	Although the competitive organic zinc coating has a higher number, Alumizinc 'S' has 100% cohesive failure (i.e., within the coating layer). This is cited by experts as the 'ideal type of coating failure' (Corrosion Prevention by Protective Coatings, Second Edition - NACE Int’l Publication, 1999 - p.199)
Abrasion	ASTM D4060, CS-17, 1 kg, 1000 rev	mg	154	1270	160	Of greater concern when the primer also functions as the topcoat. This measures its ability to withstand abrasion caused by erosion, scraping and faying surfaces
Impact	ASTM D-2794	in-lbs	200	50	25	A high impact strength reflects the ability of the coating to withstand a direct or indirect blow
Film Hardness	ASTM D-3363	Pencil (9H is hardest, 6B is softest)	4H	2H	HB	A harder film is more resistant to scratching, gouging and dirt pick-up - an important property when the primer performs as a topcoat
Flexibility	ASTM D-522 (180^{0}, 5 mm mandrel)	Pass/Fail	Pass	Fail	Pass	A primer must 'give' along with the substrate. Lack of flexibility can lead to cracking, loss of film integrity and undercutting corrosion
Salt Fog	ASTM B-117 (500 hrs)	Blister Rating	10 (none)	10	10	This test is useful in predicting relative performance between coatings under controlled laboratory exposure. The results suggest the primers will perform comparably in actual exposure with respect to their corrosion resistance.
		Corrosion (X-cut) rating	8 (slight)	8	10	