OVERVIEW OF CORROSION PROTECTION

ALLOY MP-ACQ FASTENER COATING SYSTEM FOR USE IN ACQ-PRESSURE TREATED LUMBER

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Corrosion is the electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties over time. The metal atoms of a component change from the metallic state into an oxidized state resulting in the solid, undesirable corrosion products of white and red rust. Because corrosion is related to the material and its environment, it occurs under a wide variety of conditions.

The new **ACQ-Treated** wood products create a more corrosive environment for coated fasteners, critical flashings, bottom slab plates and anchors, and other connectors used in this application. For many years, the norm for wood preserving was CCA (Chromated Copper Arsenate), approximately composed of 60-70% CrO_3, 15-20% CuO, and 15-20% As_2O_3. The arsenic and chromium are considered toxic and this has led to legislation to end its manufacture and availability for a variety of applications as of January 1, 2004. The new **ACQ-Treated** wood, containing alkaline copper and quaternary ammonium compounds, is the industry's answer to the requirement for more environmentally compatible treatment. It contains approximately 60-70% CuO and 30-40% didecyldimethylammonium chloride (DDAC). There is no chromium or arsenic, but up to about 4 times the copper. Copper, while a good biocide, is at the same time corrosive to steel fasteners and their coatings. The fear is that the new **ACQ** lumber is 4-5 times or more corrosive to the fasteners. The American Wood Preservers Association's (AWPA) own testing has confirmed this when test protocol designated under AWPA Standard E-12 "Standard Method of Determining Corrosion of Metal in contact with Treated Lumber", was used. The industry desperately seeks new coatings to address this new challenge.

In the case of zinc-coated fasteners, it is generally accepted that the life of the zinc coating is directly proportional to its weight and independent of the method of application. The intrinsic corrosion resistance of zinc lies in its ability to form dense and adherent corrosion product films that resist further metallic corrosion. Initially a fresh zinc surface corrodes fairly rapidly until it is covered with protective corrosion film products. Often, the corrosion rate is consistent in relation to time. Under other conditions, this is not so. Consider some of the examples below:

- **Zinc-coated fasteners in ACQ-Treated Lumber**
- Highly polluted industrial atmospheres
- Certain marine atmospheric situations
- Strongly acidic or basic environments (dissolves the protective films)
- Certain ions, such as chlorides (promotes dissolution of the films)
- High fluid velocity (can loosen films or break them off)
- Duration and frequency of moisture contact (thin moisture films with higher oxygen concentration promotes corrosion)
- Rate of drying

Properly protected with the **Alloy MP-ACQ**, the corrosion reaction will continue, but at a greatly reduced rate. As long as the coating remains continuous and intact, the corrosion behavior of **Alloy MP-ACQ** is generally superior to that of other typical finishes used to protect fasteners such as zinc and alloy electroplating, hot dip galvanizing, and certain organic and paint coatings.

Some of the main requirements for good atmospheric protection, are the protective film properties of the coating material. In this case, an "alloy" mechanical coating of multiple synergistic metals and binding agents, combined with specially formulated topcoat sealer options, form the new **Alloy MP-ACQ** fastener coating system . In the true sense of the word, the coating is not an alloy but a codeposited matrix of metals and linking agents applied by physically mixing them in a aqueous slurry (see Fig.1) in the appropriate ratio over a period of time usually between 30 and 60 minutes. Sacrificial properties of the coating, means that the coating material , will start to corrode before the part (i.e., steel screw, nail, washer, flashing, etc). Corrosion protection is basically guaranteed as long as coating material is present. The thicker the coating, in this case, the longer time it takes for the corrosive ACQ wood treatment chemistry to react with the coating and reach the steel substrate of the fastener.

To obtain information on the long-term corrosion behavior of parts, accelerated (short-time) laboratory tests are used as a basis of evaluating and comparing different coatings and methods. The environment used might simulate a humid tropical area, the salt air of a seaside area or salted road in winter climate areas, a highly industrialized area with acid atmosphere (acid rain), or others. Salt spray fog, humidity, and cyclic tests have long been used and accepted to determine the degree of protection of coatings on metal parts. The reproducibility of these tests and their correlation to actual "real life" service performance has been debated. In other words, accelerated corrosion test results (hours, days, cycles, etc.) should not be directly correlated to real life service (years of real life corrosion protection). There are a variety of salt spray and cyclic tests used, but one of the most widely accepted methods is the neutral salt spray test according to ASTM B117. A 5% salt (NaCl) solution of pH 6.5 to 7.2 is used. The temperature of the cabinet is kept at 95° F (35° C) and the parts are checked daily. Results are reported in hours or days. Kesternich tests (DIN 50018) using moist, warm sulfur dioxide to simulate acid rain is also used. **Alloy MP-ACQ** screws and nails were tested in the former method and reported in hours.

Normal test results to <u>red rust</u> for zinc plated coatings on un-driven steel screws range in the area of 48 to 500 hours depending on thickness. Their are more and more "exotic" type coatings or combination coatings that claim 1000+ hours in the salt spray tests. Some of these are organic type coatings or paint, electroplated metals or alloys with or without topcoats, or various forms of molten zinc applications. The results obtained on the **Alloy MP-ACQ** coated parts with supplementary topcoat sealers are quite impressive in that they are in the very upper or "elite" range of <u>hours to red corrosion</u>. It would be safe to say that these results surpass results normally achieved with parts that have been:

- **electroplated**
- **electro-galvanized**
- **hot-dip galvanized**

- **mechanically zinc plated or galvanized**
- **non-specialized paint dipped**
- **matrix coatings of fluoropolymer sprayed or dipped**
- **subjected to many organic type coatings combination coatings**

The un-driven results have achieved a median average salt spray hours of 1500 to 3000 hours when applied at an average thickness of 25-40 microns. The results specifically range from a low of 1156 hours to somewhere over 3000 hours at the point where the tests were stopped with many still un-failed. Driven fastener tests are on-going with test reporting to follow regularly (see Fig. 2). The reporting of corrosion results should be carefully considered so as to relate to the specific application and part. Each case should be studied and confirming corrosion testing is always recommended. Variations in wood treatments, age of treated wood products, installation and assembly methods should be carefully noted. Quality, and corrosion protection of the coating are directly related to process control and repeatability. Any problem or change in the process can directly impact corrosion test results. For example, a lower coating thickness, weaker topcoat sealer concentrations, less clean part surfaces (less adhesion), less uniform or less consolidated coating, etc., will lower corrosion resistance. As noted earlier, accelerated corrosion testing does not necessarily correlate directly to "real life" field applications. Other factors such as wear, unusually harsh conditions, ultraviolet/infrared light rays, wet/dry cycling, etc., are not completely accounted for in the accelerated tests.

The **Alloy MP-ACQ** fastener coating system and equipment (see Fig. 3) provides a number of advantages which are significant in today's push for a better performing fastener. The coating utilizes the characteristics of its multi-metal/binding agent/topcoat component matrix, to provide:

- Excellent corrosion resistance in **ACQ treated** wood products
- Resistance to chipping
- A very high operating temperature range
- Excellent lubricity
- Good wear and abrasion resistance
- Post finishing compatibility
- Environmentally compatible coating and process characteristics
- An alternative to many currently utilized fastener finishes

There are many factors to consider in reporting corrosion results and deciding on the best finish for fastening devices. Consider the requirements carefully, analyze the desired engineering properties, and consider **Alloy MP-ACQ** fastener coating system as a viable option.

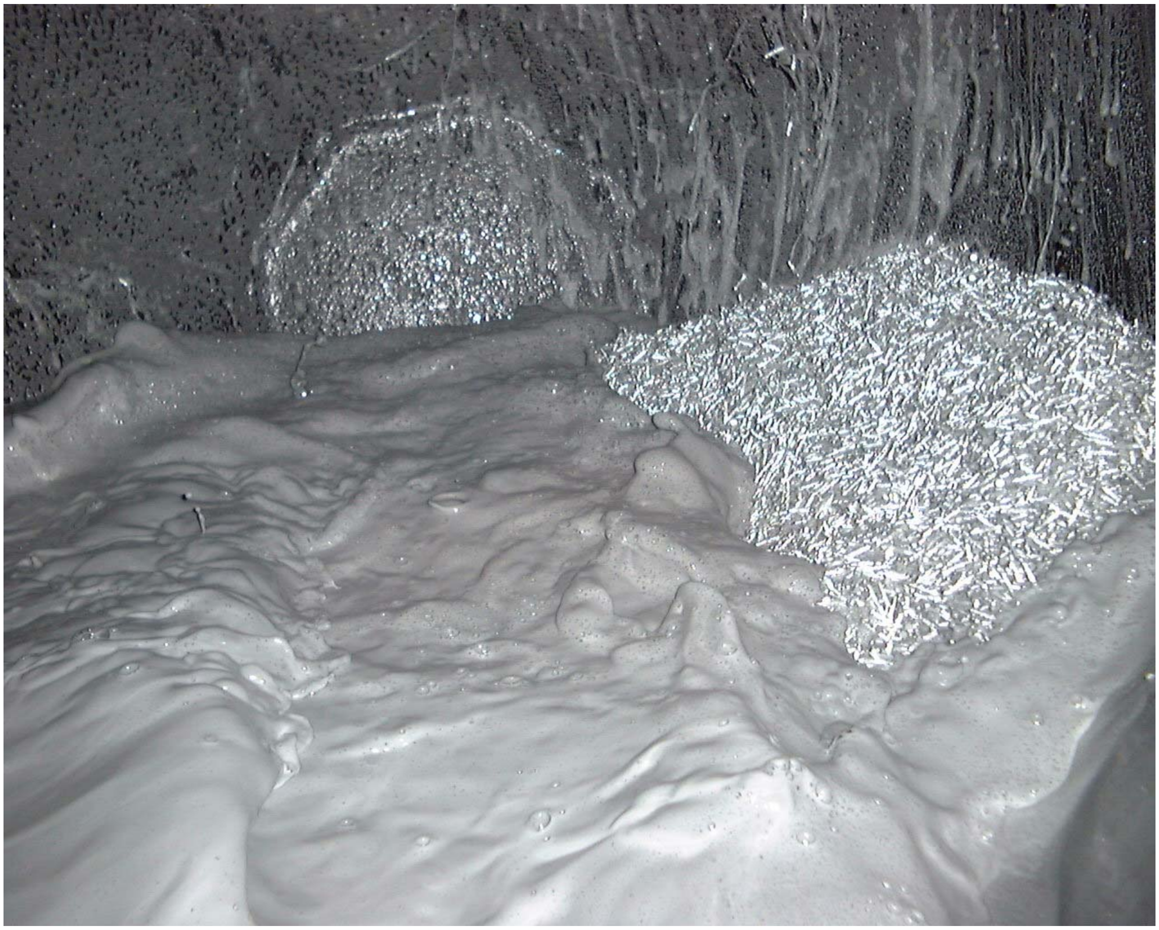

Fig. 1 – Co-deposited matrix of metals and linking agents applied by physically mixing them in a aqueous slurry.

Commercial "A" | Commercial "B" | Alloy-MP ACQ-1 | Alloy-MP ACQ-2 | Alloy-MP ACQ-3 | Commercial "B" "C"

Fig. 2 - Ongoing corrosion testing (driven in ACQ lumber). ASTM B-117
(No red rust on Alloy-MP samples)

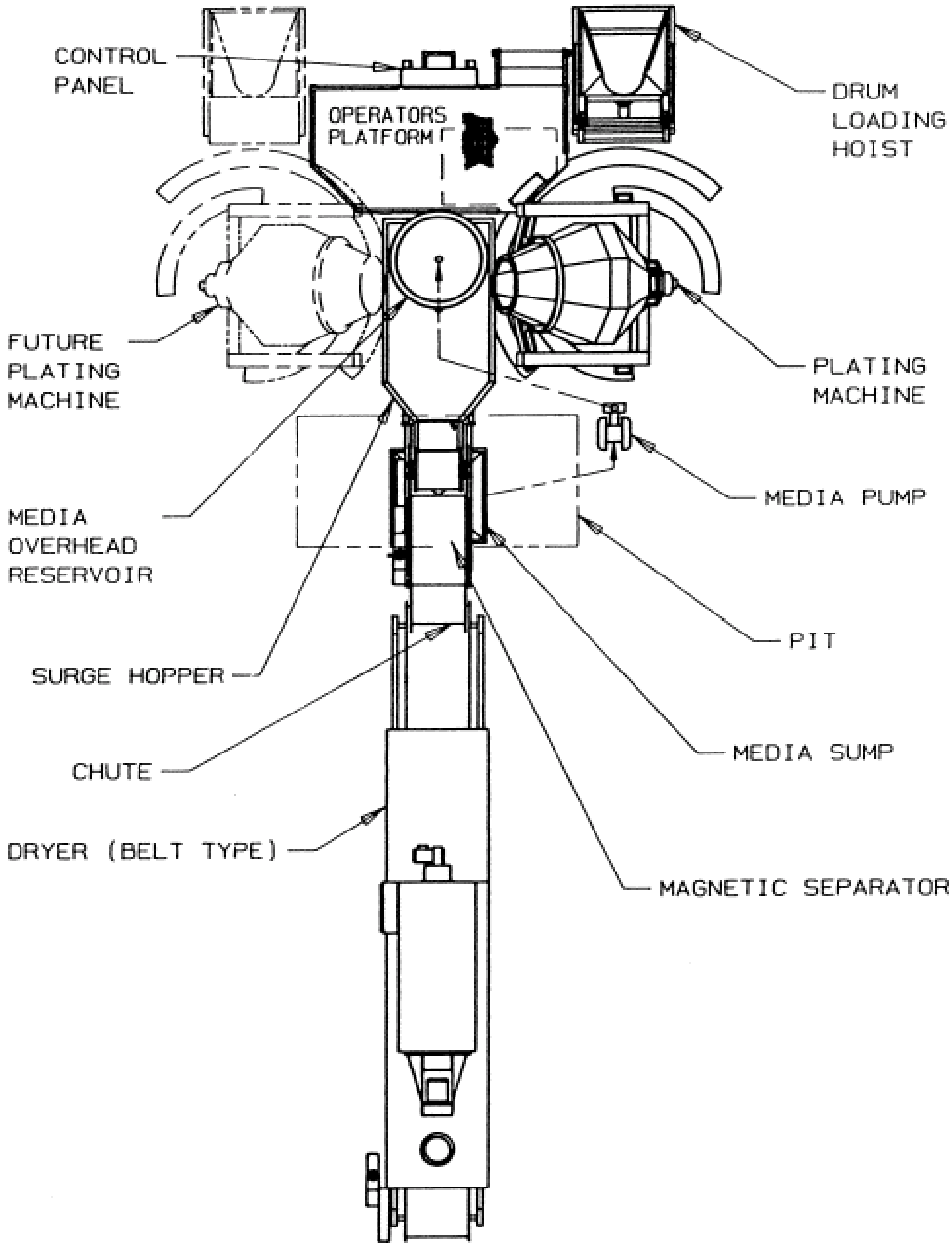

Fig. 3 - The **Alloy MP-ACQ** fastener coating system equipment.