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# Avoiding Salt Spray Failures and Double Handling of Parts

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Balancing production efficiency while ensuring specifications are met is a key focus for many plating shop managers. Unfortunately, double handling of parts to meet the requirements of a salt spray specification can be a challenge faced by platers who perform hydrogen embrittlement relief on acid zinc plated fasteners. The ideal process for production efficiency in an acid zinc barrel line is to zinc plate the fasteners, passivate, then perform the hydrogen embrittlement relief step without the need to double handle the parts. However, many platers face salt spray failures when doing so and end up having to zinc plate, bake, activate (flash or nitric) then passivate in order to get the corrosion protection needed. This double handling of the parts slows down efficiency and drives up cost.

Since passivates are designed to enhance corrosion protection, understanding why corrosion protection would be reduced during the heat treatment phase and how the situation should be addressed can go a long way toward easing this frustration for plating shop managers.

An important factor related to the thickness of the passivate layer is its correlation to corrosion protection. A general rule of thumb is that every nanometer of film thickness will yield approximately one hour of salt spray protection. For instance, a passivate film thickness of 100 nanometers will yield roughly 96-120 hours of salt spray protection as long as all other parameters are optimized.

When running an acid zinc barrel plating line with fasteners that require heat treatment, the first inclination is often to process the zinc plated fasteners in a thick film passivate (200+ nm) designed to provide greater than 200 hours of resistance to white corrosion in neutral salt spray testing (NSST). However, it is important to understand that following heat treatment, some thick film passivates substantially degrade and early onset NSST failures can occur. The most significant reason for early corrosion failure after hydrogen embrittlement relief is a high concentration of water within the passivate film. Reduced chromium density in the deposit can also be a contributing factor.

As traditional thick film passivates build, they have a natural tendency to trap a large amount of water within the resulting film. Under normal operating conditions, the passivate will perform as intended. However, when introduced to the high temperatures (400°F) during the hydrogen embrittlement relief stage, the water will evaporate. As the water evaporates, it causes a decrease in thickness of the film. The dehydration can damage the integrity of the passivate, leading to cracking and providing a means for early corrosion failures in neutral salt spray testing. The resulting decrease in film thickness is also significant, because one of the primary ways passivate films inhibit corrosion is by acting as a simple barrier against the external environment. When that barrier is much thinner, it leads to a greater chance of early NSST failure. For example, a thick film passivate which provides >200 hours of corrosion protection under neutral salt spray testing may be reduced to only 48-72 hours of corrosion protection after heat treatment.

The good news is there are alternatives to traditional thick film passivates. Newer technologies have developed thin film passivates that offer comparable corrosion protection with the ability to withstand hydrogen embrittlement relief. These newer thin film technologies are designed to provide a layer that is comprised of chromium and cobalt in a tighter grain structure compared to that of traditional thick film passivates.

Considering the factors above allows us to better understand why corrosion protection is reduced during the bake stage with a traditional thick film passivate. A newer technology thin film passivate that is designed to withstand hydrogen embrittlement relief often has <100 nm of film thickness and will provide approximately 168 hours of corrosion protection in neutral salt spray testing. Significantly less water is incorporated into the film, which allows for a more stable annealing process. As a result, after the hydrogen embrittlement relief stage, the salt spray protection may only be reduced to 144 hours, which is a considerable improvement over a traditional thick film passivate or the option of double handling parts.

In addition to selecting a newer technology thin film passivate, options for sealers are available to further improve on corrosion protection. Choosing the correct sealer that is designed to cross link at elevated temperatures is key. Take the example of a plating shop that was failing to meet their corrosion resistance specs. They report double handling of parts, only achieving 72 hours of corrosion protection under neutral salt spray testing when they have a specification of 200 hours. After switching to a newer technology thin film passivate and applying a cross linking sealer designed to improve corrosion protection under elevated temperatures, the final parts surpass 350 hours of corrosion protection in neutral salt spray testing. The plating shop can transition back to a standard line process that includes acid zinc plating, passivating, sealer and then heat treatment, completely eliminating their need to double handle the parts.

When faced with a scenario that requires double handling of parts to ensure corrosion protection is achieved after hydrogen embrittlement relief, it is best to discuss your potential options with a knowledgeable chemistry supplier. The use of newer technology thin film passivates operate at lower thicknesses while maintaining high levels of corrosion resistance even after hydrogen embrittlement relief and should eliminate the need to modify your standard processing steps.

## About the author

Mark Adams is a longtime Technical Account Manager with Columbia Chemical. He provides technical service, analytical testing and troubleshooting expertise in Kentucky, Tennessee and the Southeastern territory. He is a Certified Electroplater-Finisher (CEF), a Certified Fastener Specialist (CFS) and has an extensive background in surface finish engineering and technical service. He is a member of NASF and is active in the regional metal finishing associations.