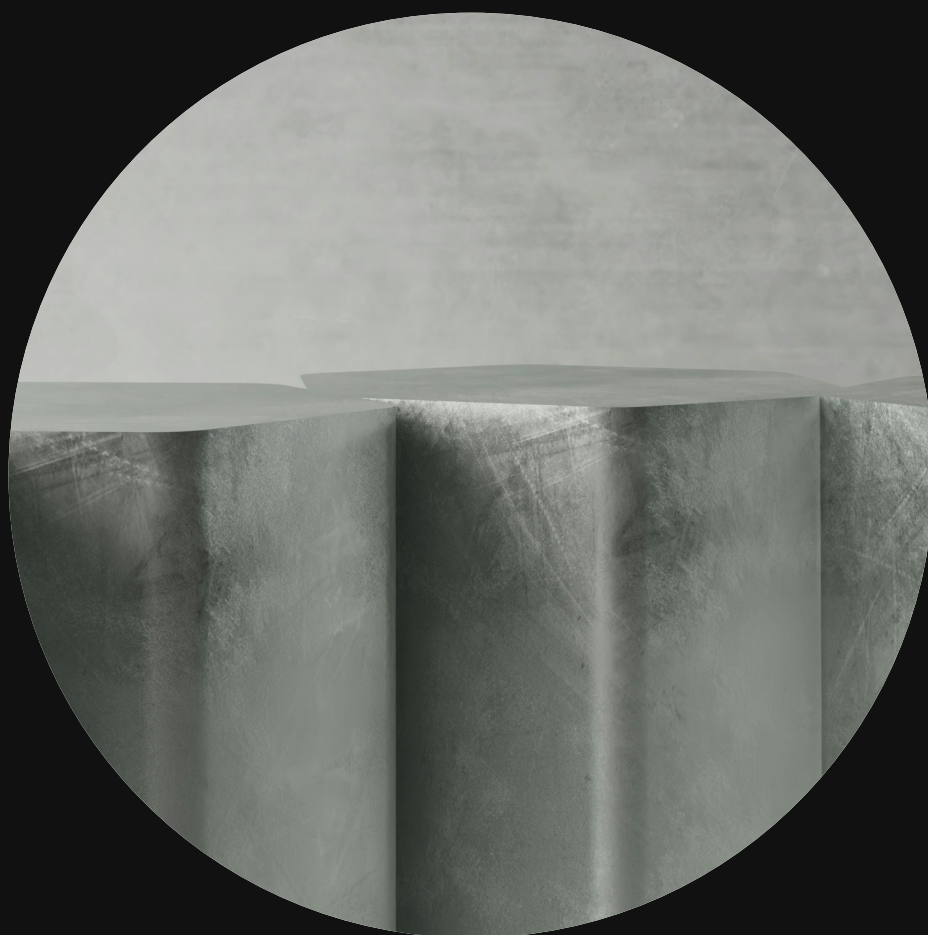
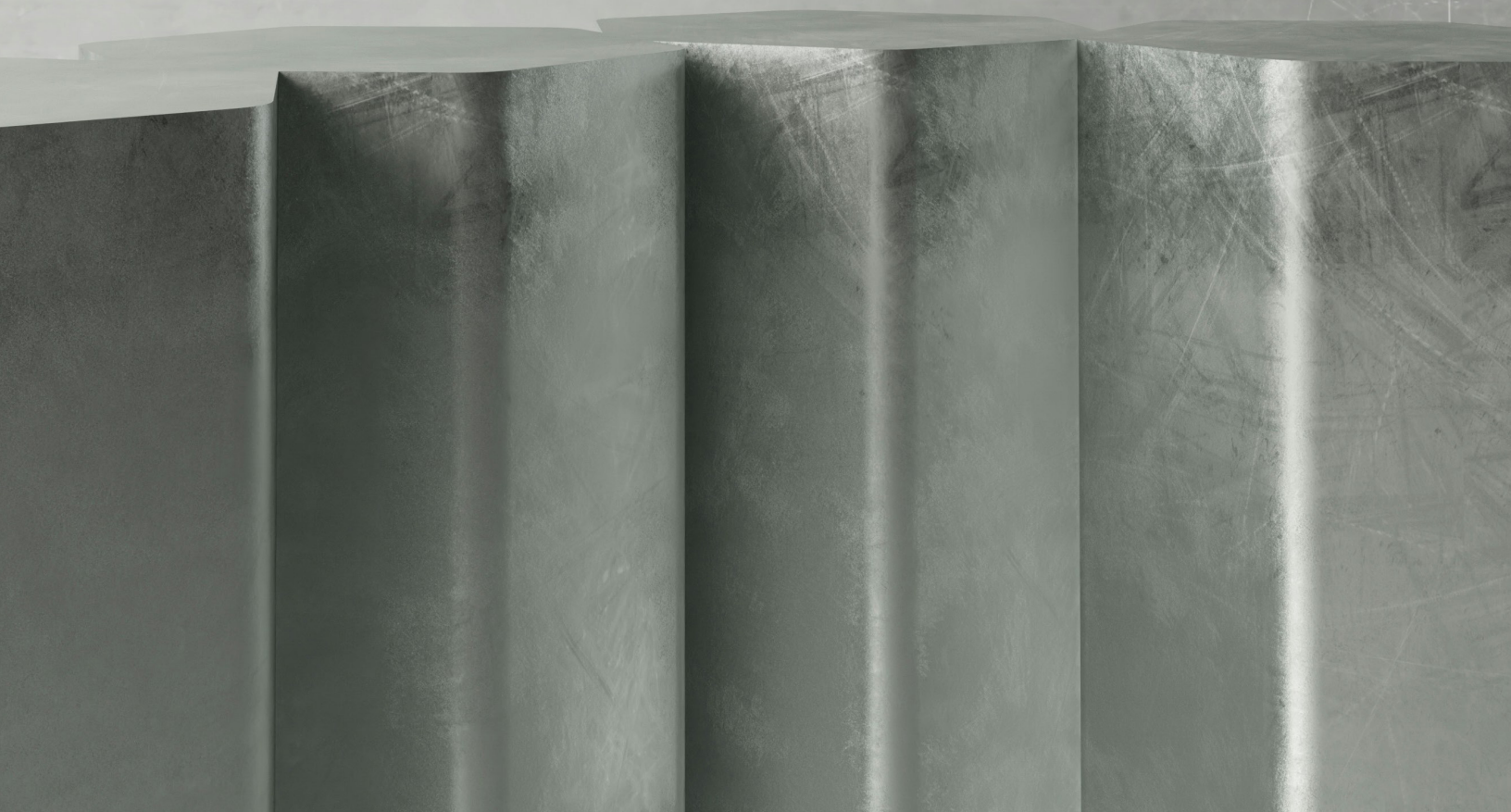


# Multifunctional, Phosphorous-Free Additives to Enhance Metal Treatment

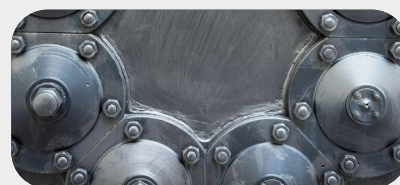


Solugen®

Metal Treatment Solutions



# Overcoming Challenges with using P-Based Additives for Metal Treatment



Phosphorous-based additives, such as phosphate esters (PEs) and zinc phosphate (ZnP), are commonly used in metal treatment processes across a variety of different applications, such as anti-staining, cleaning, and corrosion prevention. These additives, while effective, present several challenges.

## Increased Spend and Safety Risk

PEs, for example, are a commonly used anti-staining additive that can cause foaming, thus necessitating the use of anti-foaming additives. They can also demonstrate instability or be ineffective in hard water, leading to increased formulation costs to compensate for performance degradation.

In surface cleaning, metal component cleanliness prior to coating with a ZnP solution is critical to ensuring long-term corrosion resistance and coating adhesion. However, typical metal surface cleaning involves a high alkaline solution (pH > 11) applied at high temperatures (>120°F) prior to applying a rinse conditioner and phosphating solution. These harsh conditions can compromise worker safety and increase energy costs.

## Decreased Productivity

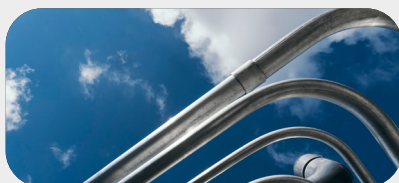
In anti-corrosion applications, ZnP is used to convert the metal surface into a polycrystalline coating to improve corrosion resistance and adhesion to paint prior to packaging or painting metal parts that go into automobiles and appliances. This process, although effective, requires multiple rinse steps and scrupulous monitoring of the quality of fresh rinse conditioning solution to ensure efficacy, thus decreasing productivity.

## Harmful to the Environment

Furthermore, both PEs and ZnP create a biological and environmental problem associated with their waste discharge, causing algae bloom that's harmful to the environment. As such, companies must meet a phosphorous specification prior to discharging their wastewater, thus creating an ongoing monitoring and regulatory challenge for metal processing facilities to ensure compliance.



## Multifunctional P-Free Solutions

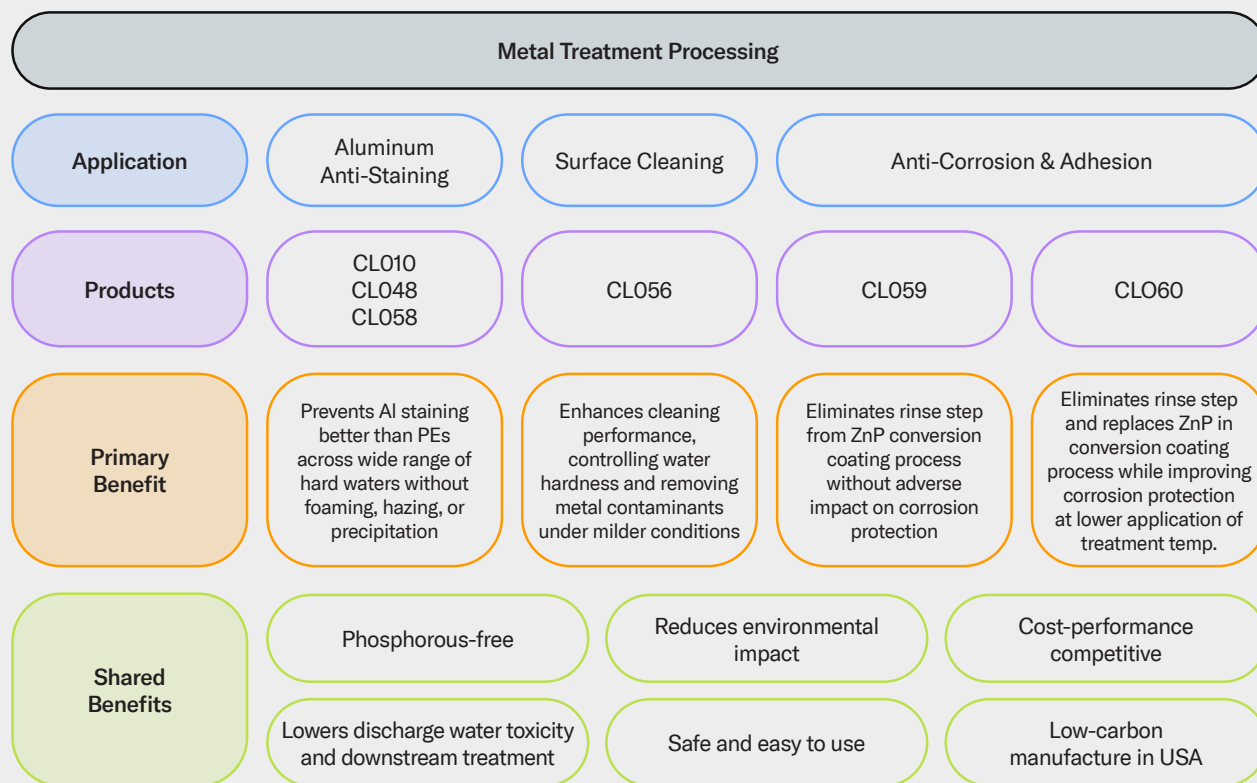


Solugen has developed a series of multifunctional, phosphorous-free additives, that improve cost-performance and productivity across anti-staining, cleaning, anti-corrosion, and adhesion applications while lessening the regulatory burden.

Locally manufactured using Solugen's unique and proprietary chemienzymatic process, these sugar-derived additives are non-toxic, biodegradable, and provide a more favorable greenhouse gas (GHG) emission profile that serve as an environmentally friendly alternative to incumbent P-based additives.

The infographic presented in Figure 1 summarizes the benefits of using this product range across multiple applications in metal treatment processing.

Fig 1. Infographic summarizing Solugen's product range and benefits for metal treatment processing.



## Solugen Products in Action

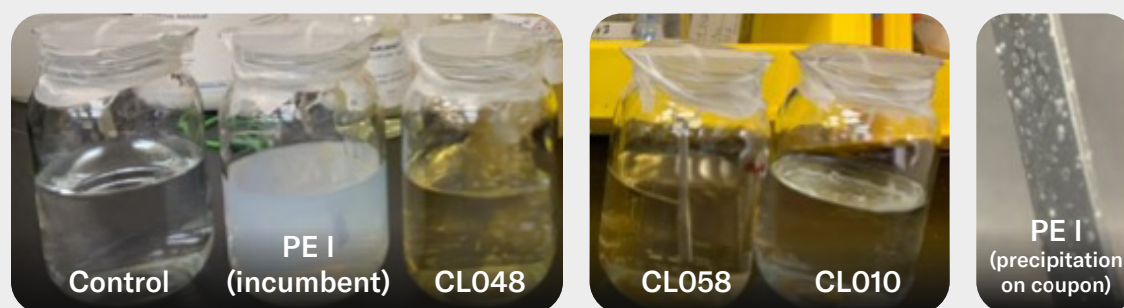
### Aluminum Anti-Staining Performance

Improved anti-staining cost-performance and environmental profile over PEs across a wide range of water hardness levels and with no adverse effects, such as foaming, hazing, or precipitation.

#### Solugen Products vs. PE

In a series of tests, evaluating Solugen's line of metal treatment additives against an incumbent phosphate ester (PE I) across a variety of alloys in hard water, Solugen's products provided better hardness control, enabling less stains and precipitation on the coupons and in solution compared to the incumbent (Figures 2 and 3).

Figure 2. Al 6061 coupons in hard water treated with Solugen products vs. PE I



Test Conditions: 500 ppm hard water, pH 9.5-10, 0.1% product dosage

Solugen products yielded clear and foam-free solutions, improved hardness control over PE I and enabled less stains and precipitation on coupon

Figure 3. Various coupons after treatment with Solugen products vs. PE I

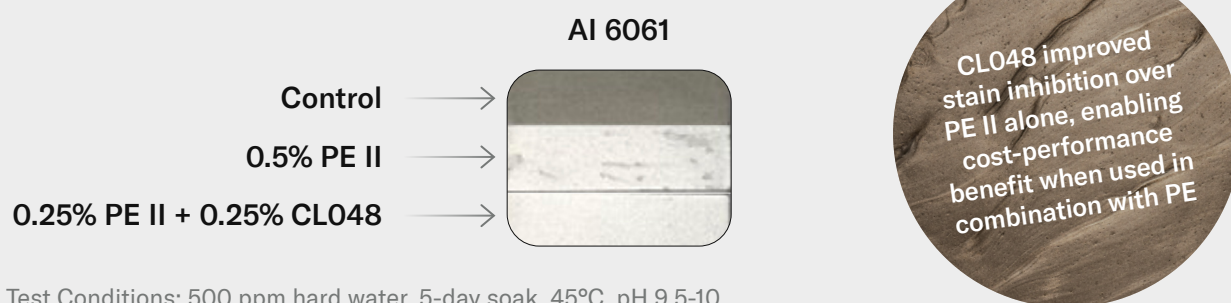


Test Conditions: 500 ppm hard water, 24-hour soak, 20°C, pH 9.5-10

## Solugen/PE Combo Product vs. PE

When evaluated in combination with another phosphate ester (PE II), Solugen's product (CL048) enabled better stain inhibition than PE II alone, preventing any salt formation on the coupon (Figure 4). As such, formulating PEs with Solugen's products can help reduce total cost of formulation without compromising performance.

Figure 4. Al 6061 coupon after treatment with PE II/CL048 combo product vs. PE II



Test Conditions: 500 ppm hard water, 5-day soak, 45°C, pH 9.5-10

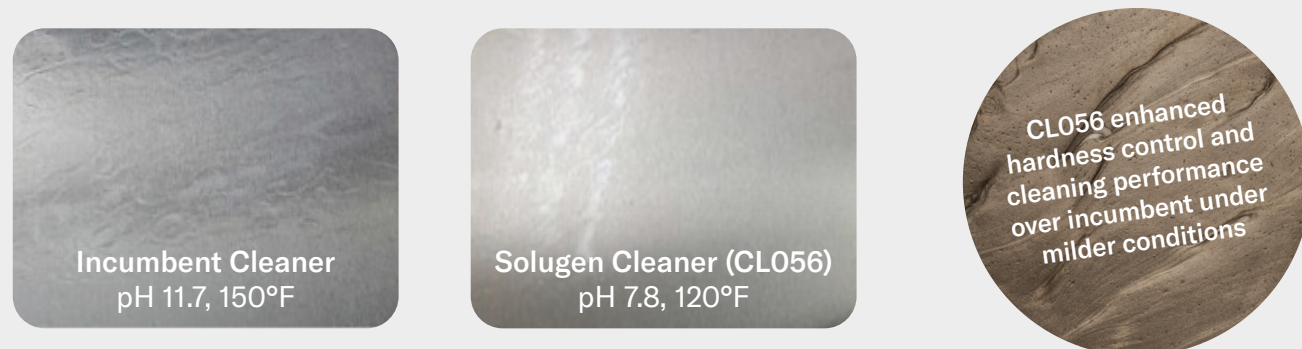
## Surface Cleaning Performance

Enhanced hardness control and cleaning performance under milder conditions, enabling a safer work environment, energy savings, and better long-term corrosion resistance and coating adhesion.

### Solugen Product vs. Incumbent

When evaluated against an incumbent cleaner, Solugen's product (CL056) provided better hardness control and superior cleaning performance over the incumbent under milder/safer conditions i.e. lower pH and temperature (Figure 5). Solugen's product further reduced or eliminated the risk of hydrogen embrittlement failure.

Figure 5. Al 2024 surface after cleaning treatment with CL056 vs. incumbent



## Anti-Corrosion & Adhesion Performance

**Eliminated rinse conditioner and/or ZnP from conversion coating process to increase productivity and enhance anti-corrosion and adhesion cost-performance while improving environmental profile.**

The standard ZnP conversion coating process used today converts the metal surface into a polycrystalline coating to improve corrosion resistance and adhesion. A rinse conditioner (RC) is used in this process to improve the growth of ZnP crystals and thus increase adhesion to the metal surface. However, the quality of the RC must be monitored and refreshed frequently as its quality can impact the quality of the final coating, thus decreasing process efficiency. Further, ZnP, while effective at inhibiting conversion, may leach phosphate into the environment, especially water ways, and lead to eutrophication.

### Solugen Product Eliminates RC Step

When introducing Solugen's product (CL059) into the ZnP formulation, the rinse conditioning step is eliminated without adverse impact on corrosion protection, enabling time and cost savings (Figures 6 and 7).

Figure 6. Infographic demonstrating elimination of RC step with ZnP/CL059 combination

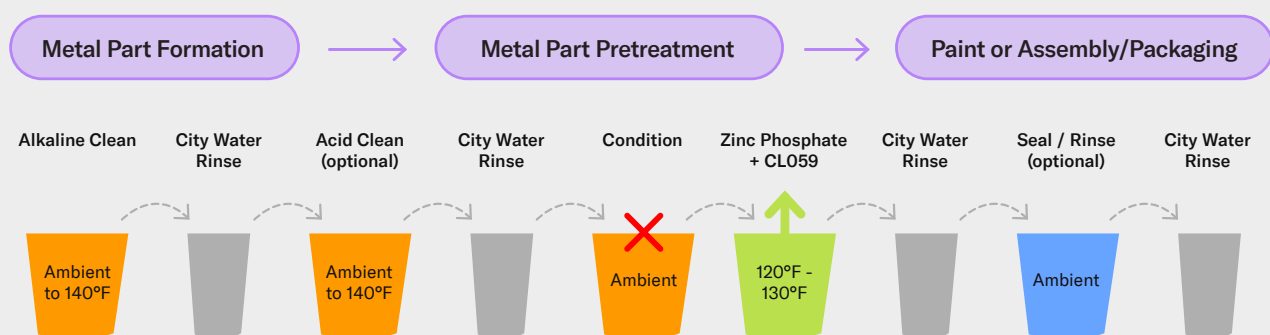
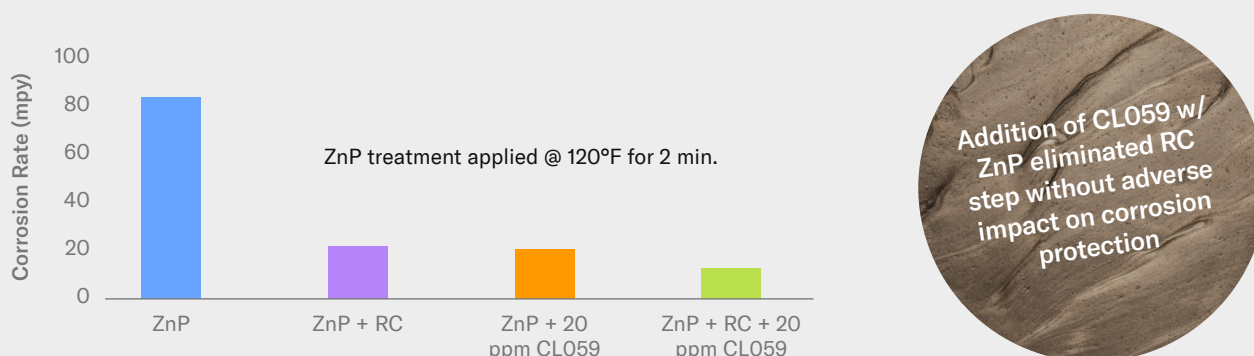


Figure 7. Corrosion performance of C1018 coupon using various combinations of ZnP, RC, and CL059



## Solugen Product Eliminates RC Step PLUS Replaces ZnP

In another instance, when used in place of ZnP, Solugen's product (CL060) enabled a lower corrosion rate without the need for any rinse step (Figures 8 and 9). Furthermore, CL060 allowed application of treatment at a lower temperature than ZnP (i.e. room temperature vs. 120°F), enabling a safer work environment and energy savings.

Figure 8. Infographic demonstrating elimination of RC step plus ZnP replacement with CL060

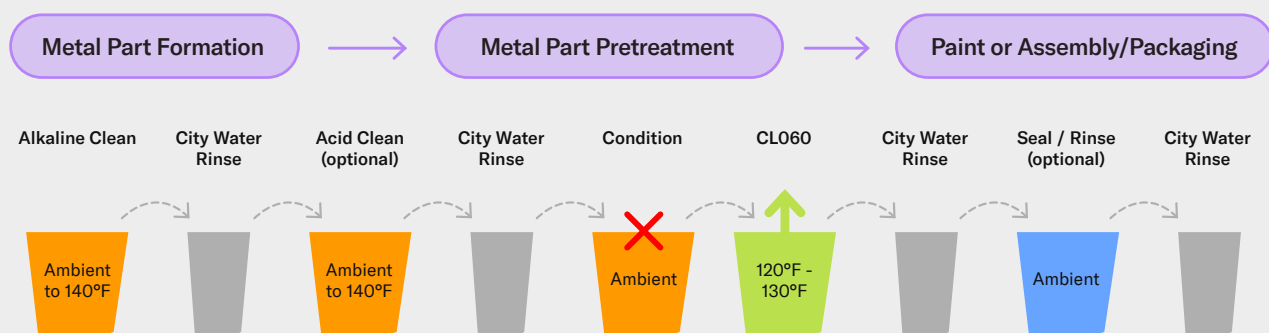
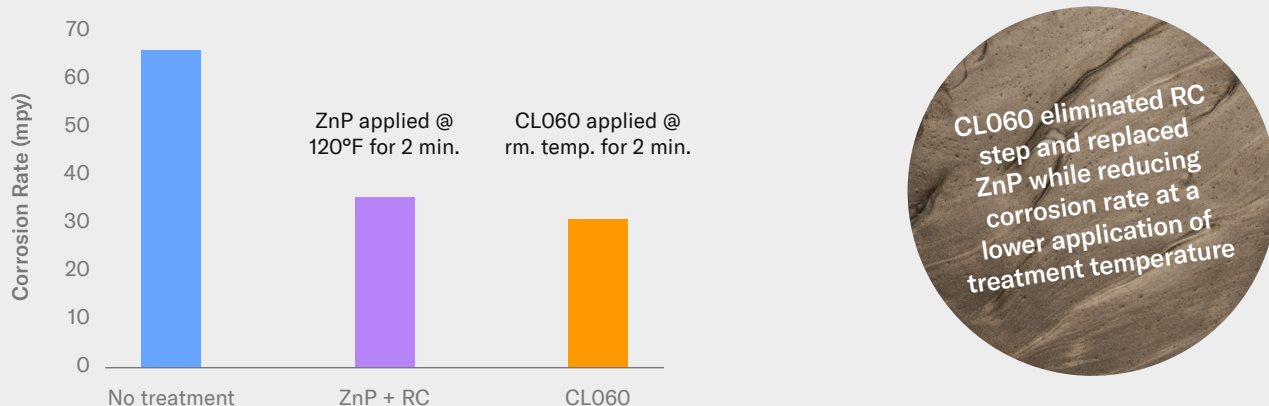


Figure 9. Corrosion performance on C1018 coupon using various combinations of ZnP, RC, and CL060



Corrosion Test Conditions: Electrochemical cell with 3% NaCl, 60°C, 24-hr. contact time

## Overall Value Delivered

For metal treatment companies concerned about alleviating the regulatory burden that comes with using P-based additives, Solugen's multifunctional, P-free additives can help relieve this concern while providing cost-performance advantages across various applications to yield higher quality metal for use.



## About Solugen

Solugen is a bio-based specialty chemicals manufacturer and supplier whose mission is to decarbonize the chemical industry by revolutionizing the way chemicals are made for use across a variety of industries and applications. To learn more, visit [www.solugen.com](http://www.solugen.com).

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