Summertime Corrosion: Humidity is the Enemy

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Corrosion is an issue that plagues all manufacturing processes involving metal substrates – especially during the summer months. However, since corrosion is a common problem, there are many ways to see it coming, prevent it from occurring, and even correct parts after corrosion has already occurred. Manufacturers always need to be cognizant of corrosion, though it isn't something to fear if proper preparations are made. As we move forward, we will discuss particular types of metal and what corrosion looks like for each substrate, how it can be avoided, and how it can be corrected. There are many similarities between the corrosion forms on each type of metal but there are also important differences between them.

Aluminum

Aluminum oxide is the product of corrosion on aluminum parts. Aluminum oxide is created through the chemical/electrochemical reaction between a material and its environment producing a deterioration of the material and its properties. This type of corrosion typically appears whiteish in color, and it will never be black. This color distinction is made because if an aluminum part is darkening or becoming black, that is likely due to the part coming into contact with high alkalinity in a completely different chemical reaction.

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In select cases, aluminum oxide is the desired outcome. Depending on the end use of the aluminum parts, the surface finish may not be as important. Some high reliability markets like aerospace or automotive will purposely create a layer of aluminum oxide on the surface of their parts to prevent any surprise instances of corrosion generation further down line. This intentional layer of aluminum oxide serves as the protective barrier.

Yellow Metals

In this case, yellow metals primarily refers to brass, bronze, and copper but not gold. These three types of yellow metal are more commonplace in manufacturing and more susceptible to corrosion. Here we will discuss two possible types of corrosion processes that can occur on yellow metals. The first is called patina corrosion and it is a similar process to creating aluminum oxide from the last section. Like aluminum oxide, patina corrosion is also sometimes the desired outcome. It creates an inactive metal oxide layer on the surface of the part that protects the rest of the active layers underneath. This can make the surface finish appear "dull" so the end-user should be asked for approval regarding this appearance.

The second type of yellow metal corrosion is called dezincification. When this form of corrosion occurs, the zinc is chemically removed from the makeup of the metal. Brass is only made up of copper and zinc meaning after dezincification, the former brass part is left as an unprotected copper part. This is the form of yellow metal corrosion seen most often appearing greenish and is very destabilizing for the metal part making it the least desired outcome.

Steel

Steel corrosion, or iron oxide development, is likely the most well-known example of corrosion – commonly referred to as rust. Iron oxide generation is the result of iron reacting with oxygen and water. Rust is

typically reddish in hue and eats away at each layer of the metal part as it spreads. Rust is never the desired outcome for a manufactured steel part.

Steel corrosion does not have as much nuance as the other types of metals discussed so far. Moving forward into causes and preventions, those sections will be especially important when steel is present in the manufacturing process.

Causes

Galvanic Corrosion

One lesser-known cause is called galvanic corrosion. This is when two dissimilar metals become electrically connected. One of the metals will serve as the cathode and is protected while the other metal will serve as the anode and receives the galvanic energy that causes the corrosion. This can occur when two different types of metals are physically touching through processing or even when two different types of metals are being cleaned in the same bath. It is possible to force galvanic corrosion in some cases by "sacrificing" a part that is higher on the anode scale than a part that a manufacturer wants to protect. See the following galvanic chart for reference.

Heat and Humidity

Heat and humidity are the more well-known and common causes for corrosion on metal parts. They are not only the leading causes of corrosion for steel parts but are also the leading cause for aluminum and yellow metal corrosion. Though, as previously mentioned, aluminum and yellow metal corrosion may not be as destabilizing as steel corrosion.

The summer months can be especially challenging for every factory producing metal parts – the direct reason being that heat and humidity levels are increased during this time of the year. It's worth noting that manufacturers in locations closer to the equator likely experience more corrosion year-round because of the high temperatures and higher relative humidity than in the rest of the world.

When dealing with steel especially, there are additional factors contributing to the heat and humidity of the environment. In many cases, aqueous cleaning processes are what make the most sense when cleaning manufactured metal parts. With this type of process, manufacturers are not only bringing more water into the mix but must also be cognizant of the temperature of the water with which parts will be cleaned. When the latent heat of the parts increase, so does the risk of corrosion. Furthermore, after the parts are cleaned, they are then likely left exposed to the environment.

Preventions

Improving Warehouse Conditions

An effective way to decrease the risk of corrosion is to improve overall warehouse conditions. One way to do this is to make the facility more of a temperature-controlled environment. Temperature control should be thought of as a continuum for this topic; any improvement is better than no improvement.

An entire air conditioning system could be installed for the warehouse producing higher results, or faces could simply be placed at the spot where

parts come out of the washer producing lower results. Similarly, decreasing overall humidity in a warehouse is another way to improve warehouse conditions. Dehumidifiers could be installed all around the facility producing higher results, or the doors leading to the outside on the production floor could simply be closed producing lower results. Improving warehouse conditions can be an expensive venture, but a high reject rate is equally as expensive. It is up to the manufacturer's own cost analyses to decide what makes the most sense for their facility.

Product Protection

Protecting manufactured parts in process is another effective way to decrease the risk of corrosion. Aqueous-based dry films can be applied to parts in the final wet stage of the cleaning process. This practice is a highly recommended, especially when dealing with metals that are highly susceptible to corrosion like mild steel or cast iron. This will prevent flash rusting in the short term and, based on the concentration of corrosion protector in the product, the parts may also be protected for several months.

Oil and oil based wet films are another way to protect parts in process. These types of products are usually more visible and can be physically felt when the parts are touched. Much longer protection levels can be achieved with a wet film as opposed to a dry film, but most end users of the product will not be looking for a wet part. This makes sense when more processing/cleaning is expected down the line.

Sealed bags or paper are two of the best ways to protect machined parts for the long term. VCI paper and bags seal in the parts and air can be vacuumed out to give the part in the bag a "new" environment not containing heat or humidity. If done correctly, parts in this condition can last a very long time without corroding.

Corrosion Removal

If all else fails and corrosion is still experienced in a facility, there are still ways to remove that corrosion. One way is with an acid-based aqueous chemical. Citric and phosphoric acids are some of the safer types of acid proven effective at removing corrosion that has formed. Citric acid is also safe on aluminum and brightens yellow metal parts. However, these processes can be lengthy.

A manufacturer could also use blasting or vibratory bowl machines to remove corrosion that has already formed. Softer medias are recommended so the parts aren't harmed and to reduce the risk of causing galvanic corrosion with the use aluminum oxide or something similar.

With both corrosion removal options, it's worth noting that while the corrosion is removed, the part is also cleaned down to the bare metal. Immediate protection is needed to prevent the parts from developing new corrosion. If this removal step is needed, consider adding a final rinse with a corrosion protecting chemical or quickly put parts into a protected environment.

Summertime Corrosion

Corrosion/rust can be a challenge to combat, especially in the summertime and taking steps to prevent corrosion is always advised. Potentially improve warehouse conditions, make use of corrosion protecting products, and don't be surprised when the threat or evidence of corrosion returns each June. However, if the mark is missed, there are still ways to save corroded parts.

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