MGNewell
We Make It Work Better.




Electropolishing vs. Passivation – Addressing Common Misconceptions

One of the most frequently asked questions online, “Which is better, passivation or electropolishing?” is driven by a misunderstanding of the two processes and the different roles they play. In fact, the two processes are frequently complementary and doing one without the other can result in an unreliable system requiring constant maintenance.

For some applications, treating stainless steel with both electropolishing and passivation may be necessary to maximize the metal’s resistance to corrosion and meet specific standards. Two major industry standards with stringent surface chemistry requirements that may necessitate both treatments are:SEMI (Semiconductor Equipment and Materials International) standard, which is widely used in the semiconductor and electronics manufacturing industries.

ASME BPE (American Society of Mechanical Engineers Bioprocessing Equipment) standard, which is commonly applied in the bioprocessing, pharmaceutical, and personal-care industries.

Other organizations, such as ASTM (American Society for Testing and Materials) and SAE (Society of Automotive Engineers), typically allow either electropolishing or passivation, depending on the specific application and requirements.

Understanding Electropolishing and Passivation

The key to understanding why it’s not “electropolishing vs. passivation” is understanding what each process is and what it does. Both processes are chemical in nature, sharing the common goals of preventing corrosion and, by extension, promoting the longevity of the equipment and the system being treated. But that’s where the similarities end.

What is Electropolishing? Superior Finish and Performance

Electropolishing does exactly what its name implies – it utilizes a combination of electricity and chemistry to smooth the metal’s surface by removing the metal from the peaks of any raised surfaces on a microscopic level. The metal removal rate is controlled by the electrical settings of the electropolishing equipment, the process is repeatable for a given alloy, electrolyte concentration and conductivity, and current density combination. A well-electropolished surface significantly reduces locations where contamination can become caught on the surface and become a point where corrosion will flourish.

What is Passivation? Enhancing Corrosion Resistance

Passivation, on the other hand, is a chemical treatment to enhance stainless steel’s natural passive layer which protects the underlying metal from corrosion. The passivation chemistry removes free iron or other metallic impurities on the surface which would become a source of corrosion. The result is a contaminant-free, chromium-rich oxide layer that is chemically inactive, or “passive.”

Greensboro Division
Phone: 336.393.0100 / 800.334.0231
Fax: 336.393.0140

Louisville Division
Phone: 502.459.7475 / 800.459.7475
Fax: 502.459.7633

Nashville Division
Phone: 615.822.3030 / 855.749.4820
Fax: 615.822.3031

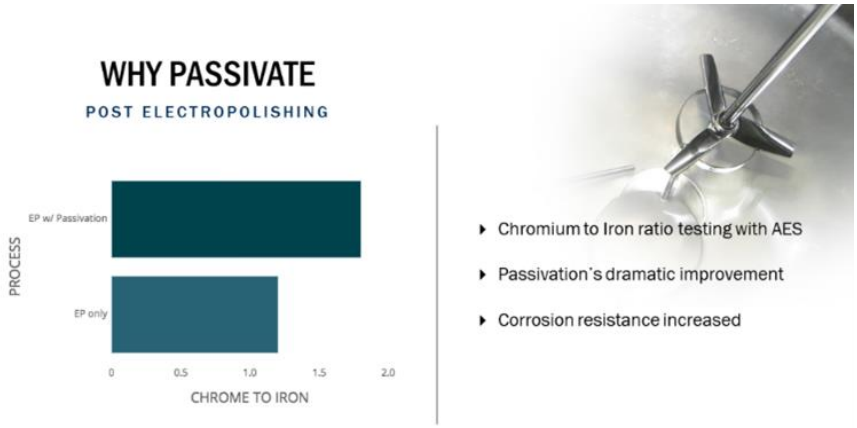
www.mgnewell.com

sales@mgnewell.com

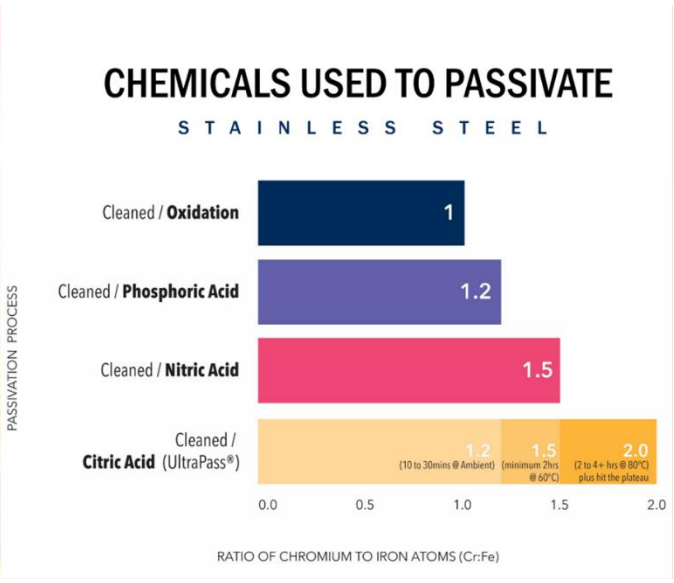
www.newellautomation.com

Benefits of Electropolishing, Passivation, and Doing Both

By itself, electropolishing goes a long way towards ensuring that a system will operate reliably with less chance of damage to itself or the product due to contamination. As mentioned before, the process smooths the metal's surface. This results in a much more cleanable surface, allowing for easier and more effective regularly scheduled cleaning cycles. The surface is more cleanable because less locations exist where contamination can become entrapped or embedded into the surface. And likewise, it makes it harder for biological organisms to find a place to anchor and colonize the surface.



Passivation, as previously mentioned, enhances the stainless steel's passive layer by removing metallic impurities. The leading metric of passivation efficacy is the ratio of chromium atoms to iron atoms at the immediate metal surface, a higher chromium-to-iron ratio means more free iron was successfully removed from the metal surface and the surface is more chemically resistant. Citric acid-based passivation consistently provides a chromium-to-iron ratio of 2-to-1 or higher. Electropolishing, being both a cleaning and smoothing process, also removes the same metallic contaminants that passivation chemistries target. This is why some standards consider Electropolishing an adequate substitute for passivation. However, data shows passivation following electropolishing is required to meet chromium-to-iron ratios at or above 2-1. For components with stringent chromium-to-iron requirements, electropolishing is not a strong enough passivation process, and passivation must be performed on the electropolished surface.



Routine Maintenance and Preventative Measures

In most cases, electropolishing will need to be performed only once and then passivated as part of commissioning a system. The result is a smooth surface, meeting the surface roughness requirement of the system, presenting fewer opportunities for internal corrosion or contamination to spread through the system to other locations, or into the product itself. A regularly scheduled regimen of passivation should be considered as part of routine preventative maintenance just as regularly scheduled cleanings are. By including passivation as part of a maintenance plan, plant owners can be proactive in preventing corrosion or other contamination buildup. This decreases the likelihood of unscheduled remediation services and aids in the longevity of the system itself.

Identifying and Addressing Contamination or Corrosion

Early warning signs of contamination or corrosion are typically found during the regular quality control sampling and inspection of a system and, depending on the situation, can be addressed by remediation, cleaning and a passivation treatment. However, in situations where the symptoms are missed, or not addressed, both metallic and biologic surface contamination can result in accelerated corrosion through the underlying metal. In the most serious cases, the part fails and will have to be replaced. It goes without saying that any product that has passed through this system risks being seriously compromised.

Even if the situation is caught before failure, the pitting that occurs due to corrosion will need to be repaired. This will involve mechanical polishing, followed by electropolishing and then passivation of the affected area to bring it up to the same level of protection and cleanliness as the rest of the system.

Final Words: Proactive Measures Save Costs

Contamination, downtime, or physical failure of a system can be financially devastating. For that reason, it is more economical to reduce the chances of those events as much as possible. As has been shown, the choice of "electropolishing vs. passivation" should not be considered a choice, as the two processes together provide the cleanest, most reliable product contact surface. For the vast majority of systems, the real choice boils down to "do both now, or wish you had done both then, later."

Author: Bradley Hostetler, Senior Metallurgist, AstroPak

For more information on electropolishing or passivation, contact your local M.G. Newell rep or email us at sales@mgnewell.com.