

Electropolishing of Stainless Steel (300 Series)

The Basics

Electropolishing is an electrochemical process by which surface material is removed by anodic dissolution. Sometimes referred to as “reverse plating”, electropolishing actually removes surface material, beginning with the high points within the microscopic surface texture. By removing these points, electropolishing will improve the surface finish, leaving a smoother and more reflective surface.

Electropolishing is accomplished by creating an electrochemical cell in which the material to be polished is the anode. A cathode is formed to mirror the geometry of the work-surface and the two are submerged in a heated electrolyte bath. When a DC current is applied, the electrical charge forces metal ions to be dissolved from the work-surface.

Electropolishing delivers a smoother, more reflective surface, which will reduce contaminant adhesion and improve the surface clean-ability. Perhaps more importantly, electropolishing preferentially dissolves free iron, inclusions, and embedded particles from the surface of the work-piece. This process improves the near surface chemistry of the material, and promotes the formation of an improved corrosion resistant surface layer.

Benefits

i. Improved Corrosion Resistance:

All forms of corrosion begin on or near the surface. Unfortunately all fabricating and handling practices invariably degrade surface conditions and surface properties. Surface contaminants, including grease, dirt, iron, and other metallic particles are inherent to the metal machining, welding and fabrication process. Mechanical cutting, machining, handling and polishing will leave iron and abrasive particles embedded within a material surface. These surface contaminants disrupt the formation of stainless steels' (and other corrosion resistant materials) naturally corrosion resistant oxide layer and are the origin of future corrosion. Electropolishing removes surface material and surface contaminants. Electropolishing dissolves free iron, inclusions, and embedded particles from the surface of the material steel.

Electropolishing preferentially dissolves Iron (Fe) from the material matrix and leaves the surface with a higher relative concentration of Chromium (Cr). Upon exposure to oxygen, this improved surface will form a thicker and more uniform oxide layer with enhanced corrosion resistance properties. The improved oxide layer resulting from electropolishing will have a Chromium to Iron ratio greater than 1.5 and a Chromium oxide to Iron oxide ratio greater than 2.0. The oxide layer will be thicker than 30 Angstroms.

Electropolished stainless steels are better suited to resist the onset of pitting corrosion, crevice corrosion, localized galvanic corrosion, stress corrosion cracking and microbiologically influenced corrosion.

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ii. Reduced Product Adhesion & Ease of Cleaning:

The improved micro finish produced by electropolishing reduces product adhesion and contamination build-up. Reduced adhesion can limit product build up and significantly lengthen duty cycles. When cleaning is necessary, cleaning operations can be completed in less time and with less effort.

Electropolishing facilitates sterilization and maintenance of hygienically clean surfaces. Research has indicated that electropolishing reduces the build-up of bacterial bio films.

iii. Deburring:

Electropolishing is naturally suited for deburring. During the electropolishing process, the current density is greater at high points and lesser at the low points within the surfaces profile. The rate of the electrochemical reaction is directly proportionate to the current density. The increased current density at the raised points forces the material to dissolve faster at these points and thus tends to level the surface material. Electropolishing will simultaneously deburr and polish the surface.

iv. Appearance:

The most striking benefit of electropolishing is the resulting lustrous surface. Electropolishing is a non-mechanical process. No tools come in contact with the piece so there is no risk of creating directional polishing lines. The material is treated electrochemically, leaving a microscopically smooth surface that is highly lustrous.