



ELECTROPOLISHING PROCESS

Electropolishing is used as a replacement for mechanical finishing, polishing, buffing and mass finishing. In addition to making a part's surface smoother, it is a more visible means of brightening, deburring, passivating, stress relieving and otherwise improving the physical characteristics of most metals and alloys.

HISTORY: This first reference to electropolishing was found in 1912, when the Imperial German Government issued a patent for the finishing of silver in a cyanide solution.

Further experimentation continued, however, the next significant advancement was not made until 1935 when copper was successfully electropolished. Following this, stainless steel and other metals also were successfully electropolished. During World War II new formulas and results were registered between 1940 and 1955.

THE PROCESS: In electropolishing, metal is dissolved in an anodic film highly saturated with chemicals that dissolve basis metal at a current density allowing a steady transfer of solid (basis metal) into the adjacent film as a metallic salt of the chemicals.

Because of the high voltage (six to 10 volts) and amperage (25 to 1000 asf), microscopic high points (peaks) are selectively "deplated" faster than lower-current-density areas (valleys). Electropolishing is basically reverse plating, and, since high-current density areas on plated parts are characterized as burn areas, it follows that high-current density areas dissolve faster in electropolishing.

Metal removal is controllable and can be held to 0.0001 to 0.0025 inch. After electropolishing, the metal surface is bright, clean and microscopically smooth.

The part's surface condition prior to electropolishing and process controls determines smoothness and reflectivity. Conditions that may result in a poor electropolished finish include improper annealing over pickling, heat scale, large grain, size, directional roll marks, insufficient cold reduction or excessive cold working, because electropolishing removes metal, these flaws are exposed and more pronounced after processing.

Process control determines the quality and consistency of the finish. Using the proper electrolyte is imperative. Temperature control and bath monitoring are also essential. Temperature should be maintained at 120F. This can be achieved by covering the tank when not in use. Critical chemistry factors are specific gravity, acid concentration and metal content. Clean, ripple-free DC current is needed to drive the process.

The real "art" of electropolishing lies with the operator who must configure a cathode for optimum polishing in accessible areas, corners and areas of low-current density. The operator must also know where, when and how to agitate either the electrolyte or the part to prevent gassing streaks, flow marks, wash lines and other imperfections.

Heating and/or cooling coils in the tank are best located behind the cathode but care must be taken to allow good solution flow around and across the coil's surface. Stainless steel coils are best protected from stray current by having them hooked up to the source of cathode current at 5 asf.

THE BATH: Many chemical combinations are used for electropolishing, depending on the basis metal. The most widely used are the sulfuric-phosphoric acid combinations with or without chromic acid. The chromic acid buffers the chemical attack and provides more latitude in subsequent rinsing after electropolishing.

For solutions not containing chromium, copper racks can be used. Titanium racks may be used if not connected to the cathode. For solutions that use chromium or its salts, contacts may be spring steel, copper plated or cold-worked copper. However, in either case, the contacts should be tin or tin-lead plated 0.00025 to 0.0005 thick to prevent copper contamination of the bath.

Properly controlled electropolishing enriches the stainless steel surface with chromium. A consistent chromium-rich oxide layer is possible when the atomic concentrations of chrome exceeds the iron in the surface layer. This is measured using an Auger Electron Spectroscopy (AES). AES analysis also measures depth and extent of surface passivation.

Electropolishing maximizes surface passivation because the source contains low levels of iron in zero oxidation states.

Sulfide, precipitated carbides and other impurities are also measured using AES. The end grain surfaces of free-machining stainless grades such as Type 303 and 416 will appear frosty after electropolishing because sulfide is removed. Type 302 stainless steel will pit if the annealing process fails to re-dissolve the precipitated carbides.

PROPERTIES OF ELECTROPOLISHED SURFACES

SURFACE ROUGHNESS: A profilometer measures surface roughness using Ra (roughness average) or Rq (equal to RMS, root mean square). Both are measured in microinches and denote the smoothness of ground or machined surfaces. However, the profilometer cannot accurately read the distance between the "peaks" and "valleys".

Electropolishing processes may reduce peaks from substantial points to insignificant mounds without changing the peak-to-peak distance at the same ratio. However, microscopic examination of the electropolished surface will show up to a 90 percent reduction in surface area and up to a 50 percent improvement in profilometer readings.

FRICION REDUCTION: Electropolishing reduces the coefficient of friction of metals. the process removes or rounds off the small surface projections, yielding a coefficient of friction that measures approximately one-fourth of the coefficient restored by a mechanically finished surface.

ELECTROPOLISHED CASTINGS: Various alloys are used in most castings, making them less suitable for electropolishing. The major exception is stainless steel.

Electropolished stainless steel castings will be brightened but will be neither as smooth as strip stock nor obtain the same mirror finish. The process decontaminates and passivates the metal surface, however, it may remove the surface of the casting, exposing sub-surface porosity.

Electropolishing cannot smear over or conceal defects such as seams and non-metallic inclusions in metals. Heavy orange peel, mold-surface texture and rough scratches are not removed and require an initial cut down with abrasives.

APPLICATIONS: Electropolishing can be used on difficult and hard-to-handle parts and those with deep recesses. It is also good for applications where cathodes can be used and where individual processing becomes labor intensive. Specific applications include jet aircraft turbine compressor blades, bearing, smoothing heating coils, hypodermic needles, pipe, tubing, stampings, wire goods, valves, spinings, forgings, fittings, fasteners, sheet metal, castings and drawings.

When used for storage tanks, reactor vessels, heat exchangers and agitators, it reduces part wear, reduces adhesions, contaminations, corrosion and friction, while improving heat-transfer efficiency.

DEFECTS: High quality electropolished parts should have a brilliant luster and reflectivity. The smoother the part surface, the higher the brilliance and reflectivity after electropolishing. Finished parts should be free from frosting, shadows, irregular patterns, streaks, water spots, pits, orange peel, erosion and a pebbly appearance. Under high magnification the surface should show no grain boundaries.

HOW TO SPECIFY ELECTROPOLISHING

STEP 1: Specify the correct metal alloy. For example, a general materials specification to manufacture a part from 300 series stainless steel alloy can create problems. Some 300 steels are better to electropolish. Type 316 generally polishes better than 304. Type 303 has sulfide that may not allow for high-grade electropolishing.

STEP 2: Use sample coupons to help determine the exact final finish. You may find you need an intermediate stop of mechanical abrasive polishing prior to electropolishing.

STEP 3: Decide if any mechanical polishing will be required. Multiple passes of finer abrasive grits are recommended for best results. Course grits of less than 80 should be avoided. Electropolishing does not remove digs, gouges, scratches or other distortions.

RECOGNIZING A QUALITY FINISH. High-quality electropolishing can usually be identified by visual inspection. A microscopic evaluation is necessary where a "maximum" finish is required and where the surface condition must be documented.

For example, a buffed surface often appears to be electropolished. Either finish yields the same surface finish profilometer readings. Only photomicrographs of the two surfaces would be featureless, while the buffed surface would show layers of smeared, disturbed and damaged metal, as well as embedded abrasive and buffing compound.

Electropolishing removes metal. It does not move it or wipe it. The surface of the metal is microscopically featureless, with no torn surface remaining. The basic surface of electropolished metal is bright and clean.



Thanks to our Customers
ISO 9001:2000 & ISO-14001 Compliant

MAY 2008

Some exciting changes have taken place at KEPCO. We have moved into our new 25,000 sq.ft. facility located in Vicksburg, Michigan. We are continuing to grow, change, and improve, yet, one fact remains the same.....we are committed to customer service and satisfaction. We offer your business:

- 25,000 SQ./FT. UNDER ONE ROOF TO SERVE YOUR ELECTROPOLISHING AND PASSIVATION NEEDS
- LARGE VOLUME, SMALL PARTS SPECIALIST WITH PROCESSING CAPACITY OF OVER 20,000 PARTS PER HOUR
- ISO 9001:2000 & ISO-14001 COMPLIANT TO ASSURE CONSISTENT QUALITY AND SAFE ENVIRONMENTAL PRACTICES
- THREE TO FIVE WORKING DAY TURNAROUND ON MOST ORDERS
- SAMPLES - NO CHARGE
- EXCELLENT QUALITY, FAST FRIENDLY SERVICE AND COMPETITIVE PRICES

We value your business and will continue to grow, change and improve our process to better serve you. If you have a stainless steel finishing question, or and electropolishing or passivation need, give KEPCO a call today! We also offer metal degreasing and cleaning. Please visit our new web site:

www.kepcoinc.com



GENERAL INFORMATION:

• Processes -

KEPCO provides the following: ELECTROPOLISHING, PASSIVATION, DEGREASING, CLEANING, AND PICKLING in accordance with ASTM A967 and A380 Standards:

1. **ELECTROPOLISHING:** Pre-cleaning, electropolishing, post cleaning.
2. **PASSIVATION and PICKLING:** Pre-cleaning, passivation and/or pickling, post-cleaning (degreasing is part of this process).

• Customer Pre-cleaning or Mechanical Finishing -

Pre-cleaning and/or mechanical finishing of parts prior to electropolishing, may enhance the appearance of the finished part and minimize processing costs. Customers should consider the following preliminary process before shipment:

- Electropolishing will improve an existing RA finish by 40-50%.
- When mechanically finishing parts, use sanding methods which "cut" the metal cleanly.
- Maintain correct surface speeds.
- Avoid using oils and greases as lubricants
- Avoid using materials with increased surface contamination.
- Avoid "smearing" the metal surface when buffing or lapping.

• Pricing -

KEPCO has a minimum order requirement of \$100.00, per release. However, samples are done at no charge. When pre-cleaning is required to go above and beyond the standard (due to excessive grease or oils) an additional charge may be applied. *NOTE: THESE CHARGES ARE NEVER CONSIDERED UNTIL THE CUSTOMER IS CONTACTED FOR APPROVAL. Prices are valid for 90 days and are based upon information provided by the customer. Prices are also subject to part inspection.

• Delivery -

Orders are normally processed within 3 to 5 business days, depending on volume. A premium charge is applied to expedited orders required within 2 days (normally \$100.00). Terms are 2%, 10 days; net 30 upon credit approval. FOB: Vicksburg, MI.