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Product Bulletin

Product Name: ENE Electropolish #9
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ENE Electropolish #9

The **ENE Electropolish #9** is a proprietary electrolyte formulated and designed to process, when utilized under proper conditions and in conjunction with suitable equipment, non-magnetic stainless steels. The ENE Electropolish #9 is a stable, easily controlled and economic solution readily adaptable to obtain the many advantages inherent in the electropolishing process.

In electropolishing, the work piece is made anodic in the strongly acidic ENE Electropolish #9. As current is passed through the part, metal is dissolved from the surface of the part at a rate dependent on the current density applied and the temperature of the electrolyte. In the electropolishing process, metal is removed more rapidly from the high points of the metal surface and this produces the effect of smoothening and brightening the metal surface. This preferential metal removal rate also permits the electropolishing process to be effectively utilized for the deburring of metals. Electropolishing by removing surface inclusions, surface skin and through the formation of anodic oxide film, increases the corrosion resistance and passivity of the metal, as well as serving to reduce surface stresses and strains. Similarly, electropolishing will produce a clean, uncontaminated surface well suited for subsequent plating or for applications where exceptionally clean surfaces are required.

Electropolishing being both a surface and anodic phenomenon, does not cause hydrogen embrittlement nor does electropolishing change the basic composition or properties of the metal or alloy being processed.

The amount of surface metal which must be removed to obtain the desired effect from electropolishing is determined by initial surface quality of the part, the metallurgy of the part and the intended application for the electropolishing process.

As a rule, fine grained metals or alloys having a clean, scale free surface will electropolish best. Parts which have deep scratches, gouges, dents or are fabricated from non-homogenous or multi-phase alloys will not electropolish well or may require extended electropolishing times.

Features & Benefits

High quality raw materials	Product consistency and performance
Rigorous quality assurance	Product consistency and performance

Operating Conditions

Cleaning Before Electropolishing

Cleaning is necessary to remove surface soils such as grease, oil, fingerprints, drawing compounds, etc. Surface residues must be removed, otherwise they will interfere with the subsequent electropolishing and may cause an etched, pitted or non-uniform surface finish.

Vapor degreasing is a very satisfactory method of cleaning. Degreasing units commonly used for cleaning prior to electroplating are suitable. Alkaline cleaners, used with or without current, emulsion or solvent type cleaners or detergent type cleaners are also suitable systems for cleaning prior to electropolishing. Where necessary, thorough water rinsing after cleaning should be provided for to ensure that no cleaning material is dragged into the electropolishing solution. Likewise, excessive dragin of water into the electropolishing electrolyte is detrimental and is to be avoided. Therefore, where aqueous systems are being used for cleaning, care must be taken to provide adequate drain and run off time so that excessive water will not be dragged into the electropolishing electrolyte.

For most applications in the electropolishing of stainless steels, descaling prior to electropolishing will not be required. However, where parts to be processed have heavy heat-treating scale, are scorched, have heavy weld scale or other tenacious surface oxides: it may be necessary to descale such parts prior to electropolishing to insure consistent, high quality results. Suitable descaling solutions will depend on the metals or alloys being processed and may be based on nitric, hydrochloric, hydrofluoric or sulfuric acids. Molten salt descales, alkaline descaling systems, or other suitable methods may also be utilized. The descaling method chosen should not produce excessive attack on the basis metal. Parts being de scaled in aqueous systems should be thoroughly rinsed after the de scaling operation and contamination of the electropolishing electrolyte with de scaling solution must be avoided.

<u>Electropolishing</u>
The operating conditions for the ENE Electropolish #9 are relatively wide and the most preferred parameters will depend on the metal or alloy being processed, the nature and geometry of the part and the finish and/or application required. It is advisable to experimentally determine these optimum operating parameters on trial samples prior to the design and installation of any electropolishing system. For most applications, and as a rule, the following operating conditions will apply to the processing of stainless steels with the ENE Electropolish #9 and they may be used as a guide:

Temperature	110°F – 190°F
Current Density	150 – 450 Amps/ft^2 (250-350 Amps/ft^2 preferred)
Operating Voltage	9 – 18 volts
Time	3 – 20 minutes
Maximum Current Input	5 Amps/gal
Cathode to Anode Ratio	10:1 to 1:1
Metal Removal Rate	0.00005 - 0.0001 inches per exposed surface per minute electropolishing time; dependent on operating current densities.

Distance of Work from Cathode	2 – 6 inches
Distance of Work from Tank Bottom	> 6 inches

Current loads more than 5 amperes per gallon causes an overheating of the electrolyte and necessitates cooling of the electrolyte. Electropolishing time is dependent on the initial condition of the surface, the finish and results desired and the dimension tolerances for the part. The electropolishing time is also dependent on operating current densities. Higher operating current densities will generally produce the desired results in shorter electropolishing times than when low operating current densities are utilized.

The voltages necessary to obtain the needed current densities will depend on the temperature the electrolyte is being operated at, the geometry of the part being processed and the distance of the work piece to the cathode.

<u>Equipment for Electropolishing</u>
Processing tanks for electropolishing should be constructed of steel, chemical lead lined. The thickness of the lead lining should be the same as that generally utilized in chromium plating tanks (8 lb lead). High temperature polypropyl ENE tanks protected with a 300 series stainless steel shell are also satisfactory. The weight of the ENE Electropolish #9 is approximately 14 lb./gal and tanks should be constructed to handle this weight.

Heating facilities of enough capacity to heat the electropolishing solution to operating temperature in a reasonable time may utilize steam, electric heat or external gas fired heat exchangers. Steam heating coils should be constructed of chemical lead and equipped with steam traps, strainers, as well as safety devices to prevent possible solution back-up into boiler; electric immersion heaters should be made of quartz and external heat exchangers should be fabricated from graphite, quartz, 316 stainless steel or other suitable acid resistant materials. Temperature may be manually or thermostatically controlled. Sensing elements used with automatic and thermostatic control systems should be encased in Teflon or chemical lead.

A DC power source capable of providing the necessary amperage and working voltage is required. Rectifiers or DC generators should be provided with variable voltage control and capable of producing the needed amperage per workload at 6 to 18 volts at the electropolishing tank.

Cathodes should be made of chemical lead. It is advantageous to have the cathodes mounted on sliding cathode bars so that the cathodes can be positioned as close to or as far from the work as might be required by the shape of the work piece. Provision should also be made for easy removal of the cathodes from the cathode bar. This will simplify maintenance and cleaning of the cathodes when necessary.

Anode and cathode bars, bus bars and auxiliary electrical connections should be made of copper, brass or other electrically conductive material. Care should be taken to ensure that adequate crosssectional area is available in the electrical system to carry the intended current loads. As a rule, one square inch of copper will conduct 1000 amperes of current. All electrical connections and joints should be kept clean and tight to insure proper conductivity.

Agitation, either air or work bar, will in some applications, be advisable to prevent gas streaking or to increase the electropolishing effect. Work bar agitation can be accomplished by a tank mounted agitator motor. The motor should be capable of producing a 1 – 3-inch stroke at 15 to 30 cycles per minute. Air agitation of the solution is helpful to prevent solution stratification and to maintain uniform bath temperature. Air agitation may be achieved by means of an air blower or by compressed air fed through a U or H shaped chemical lead air coil mounted on the bottom of the" electropolishing tank. The air entering the electropolishing solution should be filtered and oil free. A regulating valve should be installed on the air line to provide control and regulation of the air pattern. Air agitation may be used in conjunction with work bar agitation.

The electropolishing tank should be ducted and exhausted so that the oxygen and hydrogen, as well as the slight acid spray produced during electropolishing are drawn off. Exhausting requirements for electropolishing are like those necessary in chromium plating. Two- or three-sided duct casings or slotted hood type ducts may be used. Exhaust capacities required are in the order of 1800 to 2500 cubic feet per minute. Ducts, blowers and exhaust fans should be constructed of acid resistant material such as 300 series stainless steel, PVC, fiberglass, asphalt covered steel, rubber, etc.

Racking

The parts to be electropolished must be firmly and securely fixtured on suitable contacts for introduction into the electropolishing tank. The design of these fixtures should provide for adequate electrical conductivity, provide for proper positioning in the electropolishing tank and be designed to permit adequate draining of the electropolishing solution.

Racks may be constructed of copper, titanium or plastisol coated copper with titanium contact tips. Titanium is unaffected by the electropolishing solution and titanium racks give exceptionally long service life. However, because of the relatively low electrical conductivity of titanium and because of its cost, the initial costs for this type rack will be high. Copper is passivated during electropolishing by the ENE Electropolish #9 However, under neutral or cathodic conditions, there is some dissolution of the copper by the electrolyte and copper racks will eventually require replacement. Copper splined racks, plastisol coated with titanium contact points, are excellent both in terms of initial cost and service life.

In the construction of the racks, attention must be given to the total current the rack and contact points will carry, and the necessary cross-sectional area provided~ 0.001 square inches of copper will carry approximately one ampere. The number of parts to be mounted on rack should be considered in terms of the eventual weight of the rack and the geometry of the part. Parts should be positioned on the rack so that they do not shield or overlap one another~ so that they do not offer areas for gas pockets or gas streaking~ and so that the electropolishing solution can readily be rinsed and drained from the part.

Rinsing After Electropolishing

After the work is removed from the electropolishing bath, it should be rinsed free of the electrolyte as quickly as possible. Running cold water rinses with or without spray attachments are suitable. Rinse water turbulence, either through air agitation of the rinse water, countercurrent· water flow or by introduction of the rinse water through a multi-outlet pipe on the rinse tank bottom, will improve the effectiveness of the rinsing cycle. Where required, rinse tanks should be equipped with safety devices to prevent siphoning of the rinse back into the water line in the event of an accidental drop in water pressure. Rinsing must be complete and thorough to remove all acid residues, since these residues may cause subsequent staining and/or corrosion. Complex shaped parts having blind holes, folds or similar areas for solution entrapment may require, in addition to water rinsing, an additional neutralization in a 3 to 5% solution of soda ash or proprietary alkaline neutralizer. Following this neutralization, the parts must again be thoroughly rinsed in running water.

Rinse tanks should be constructed of acid resistant materials, such as PVC, polyethylene, polypropylene, 300 series stainless steel, fiberglass, etc.

Drying After Electropolishing

After water rinsing, the parts may be dried by any of the common methods usually employed in plating, such as:

a. Dipping in hot water and air drying.
b. Drying in sawdust.
c. Centrifuging.
d. Forced hot or compressed air.
e. Solvent vapor drying.
f. Dipping in water displacing oils and degreasing.

Maintenance and Control

The ENE Electropolish #9 is ready for use as received and requires no adjustments and little or no break-in period. The specific gravity of the solution as received is 1.71 to 1.75 at 70°F. As the bath is operated, the specific gravity will normally increase, and no additions are required at this point other than to maintain solution level with fresh ENE Electropolish #9. When the specific gravity of the solution has reached 1.73 to1.76 at operating temperature, the dissolved iron from the work will be about 3.0%. At this point, some sludging of the bath will begin and a loss of finish may be encountered on certain alloys. The electropolishing solution is now at an equilibrium point and a definite decantation schedule should be instituted. Depending on drag-out and the alloy being treated, this decantation rate will be 5 to 10 gallons per 10,000 ampere hours of operation.

An alternate method of operation is to continue operating the ENE Electropolish #9 past the 3.0% iron content with additions of fresh electrolyte to maintain solution level until no further electropolishing effect is obtainable or until the sludge build-up in the tank becomes excessive. At this point, the sludge may be hoed or decanted off, a portion (40 to 50% by volume) of the electropolishing solution discarded and replaced with fresh electrolyte.

Depending on the pre-cleaning cycle and the operating temperature at which the electropolishing solution is being utilized at, it may be necessary to add small amounts of water to maintain the specific gravity of the electropolishing solution. Daily checks of the specific gravity will assist in maintaining the solution at its proper level with additions of water and fresh electrolyte. Excessive drag-in or addition of water is extremely detrimental to the ENE Electropolish #9 and will cause pitting, etching and loss of finish. The electropolishing solution is also hydroscopic and if the tank is to be idle for long periods, the tank should be well covered, or the solution should be removed and stored in containers to prevent excessive water pick-up.

As in all electrochemical processes, good housekeeping is important. Equipment should be kept clean and in good working order. Bus bars, contacts and other electrical connections should be periodically cleaned to insure good conductivity. Cathodes should be periodically inspected and cleaned of any salt deposits. Tank levels should be maintained and the ENE Electropolish #9 and equipment should not be operated or utilized outside of the recommended ranges.

<u>Process</u>
A typical cycle for electropolishing is as follows:

1. Degrease.
2. Descale if necessary.
3. Electropolish.
4. Water rinse.
5. Water rinse.
6. Neutralize if necessary.
7. Water rinse.
8. Dry.

Waste Disposal

Disposal of the electrolyte, sludge and/or rinse effluents should be in accordance with local and regional requirements and should consider the acidic nature of the solution and the metallic salts produced during electropolishing, namely; iron, nickel, tri-valent chromium and other elements which may be an integral component of the alloy being processed. The ENE Electropolish #9 contains no chromic acid.

Caution

The ENE Electropolish #9 is a strongly acidic solution. Instructions and safety precautions normally used in the handling of concentrated acids should be applied in the handling of the ENE Electropolish #9. Protective clothing: including rubber gloves, aprons and face shields or goggles should be worn when using or handling this solution. In case of accidental skin contact, flush affected area with large quantities of water; in case of contact with eyes, flush thoroughly and immediately with water and obtain medical attention.

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