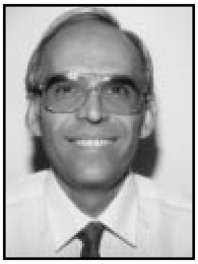

Finishers’ Think Tank

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Electrocleaning ... The Right Choice

Last month, this column’s focus was on the soak cleaning operation. Having taken that first *big* step in the finishing process, the parts now proceed to a critical electrocleaning treatment. Technically, this is another cleaning step, one of at least three types, before the parts are suitably conditioned for deposition of electrolytic or electroless coatings. Electrocleaning uniquely combines mechanical and chemical action to remove soils, such as organic (oils and grease) and metallic (oxides, smuts, scale, rust and certain electroplating coatings). It is necessary to identify what soils must be removed, metals processed (mixed metals?), the fixed cycle parameters/limitations, the progression of surface preparation baths and the quality of rinsing. These suggestions are valid for barrel, rack or continuous coil/strip operations, and must be considered before making the “right choice.”

Understanding the Process

By its name, electrocleaning uses a DC source (rectifier), providing an electrical circuit to permit mechanical scrubbing of the parts. This action makes electrocleaning a powerful cleaning method. A simple, yet critical, electrochemical redox (oxidation/reduction) reaction occurs. Water, the carrier solution in the electrocleaner bath, is composed of hydrogen and oxygen atoms. During operation, the water is electrolyzed, releasing these atomic constituents. Oxygen gas, the product of oxidation, is generated at the anode, where oxidation takes place. Hydrogen gas, the product of reduction, is generated at the cathode, where reduction takes place. This is the electrochemical redox reaction. There can never be a reduction without an oxidation—both occur unconditionally.

Because water has the molecular formula H_2O, there are two volumes of hydrogen gas formed for each volume of oxygen gas in the redox reaction (2:1) ratio. In most applications, the parts are positively charged (+) and cleaned anodically. In some cleaning requirements, the parts are negatively charged (-) and cleaned cathodically. Some requirements need periodic/reverse, where the charge of polarity on the parts is alternated between positive and negative. If, however, cathodic cleaning generates twice the scrubbing action to clean as does anodic cleaning, shouldn't cathodic cleaning be preferred? It would be nice to lobby for "more is better," but this isn't a true advantage. We'll cover this as each electrocleaner type is described.

Operating Parameters

Base Metal	*NaOh, oz/gal	ASF	**Temp., °F	Time, min
Steel	4-8	50-120	140-195	1-5
Stainless steel	5-9	40-80	140-195	1-5
Brass	1-1.5	10-30	130-160	1-3
Copper	4-8	40-60	140-195	1-5
Zinc	1-1.5	15-35	130-160	1-3
White metal	0.75-1.0	10-20	120-140	1-3

**Sodium hydroxide. Multiply by 7.5, converting to grams/liter.*
*** (°F - 32) x 0.56, converting to °C.*

Electrocleaner blends can be classified into three groups, which meet most process applications. The tables that follow these descriptions provide basic formulatory information for the application, suggested operating parameters and troubleshooting tips.

1. If preceded by a soak cleaner, the electrocleaner's main function should be effective removal of the metallic films and oxide deposits. Oil and grease removal should be secondary, because an effective soak cleaner removes these soils as a primary function. The electrocleaner concentrate can be either liquid or powder. The main ingredient is caustic, either sodium hydroxide or potassium hydroxide (liquid or powder form, depending on the concentrate blend). As the caustic level increases, so does the conductivity. The conductivity also increases with increasing solution temperature. Steel, brass, copper and zinc are anodically cleaned in rack and barrel. Blended concentrates also contain desmutters and water-hardness conditioners, such as gluconates, EDTA, NTA, complex amines, phosphates and silicates. The first four constituents are also effective for descaling and derusting. Depending on the type of steel (*e.g.*, low-carbon stamping or hardened high-carbon type), smut removal is very critical, because anodic treatment raises

smut on the surface. If the electrocleaner is part of a zinc or brass plating line, the rack tips are anodically stripped of zinc or brass with each cycle pass. As the cleaner ages, the stripped coatings may leave a smut, which also must be removed. Typically, low concentrations of anionic, nonionic surfactants or mixtures together are added to electrocleaners. This serves three purposes: Lowers surface tension to improve penetration of soils and scrubbing action; provides secondary cleaning to remove any oils or greases that the soak cleaner has not completely removed; and generates a light foam blanket, significantly reducing corrosive mist and spray. A hexavalent chromium reducer is a *very important* constituent. In nickel/chrome and zinc plating lines, the rack tips are continually stripped of chrome. In solution, the hexavalent chrome hurts the process three ways: Chemically bonds to surfactants, reducing effective cleaning; diminishes the favorable light foam blanket, causing corrosive misting; and passivates metals, such as steel, brass and copper, leading to plated deposit blisters. It only takes 25 ppm of hexavalent chromium to cause trouble. Unique organic sugars, blended in the electrocleaner, selectively react with hexavalent chrome (redox type). The hexavalent chrome is reduced to its trivalent state, forming insoluble trivalent chrome hydroxide, which precipitates irreversibly in the solution. The sugar is oxidized to an innocuous carbon species. A “sweetened” electrocleaner is your best defense against the scourge of hexavalent chromium. For electrocleaning zinc, silicate—in the right ratio to caustic—becomes an important buffer, preventing overcleaning and etching, commonly seen as white corrosion spots. Brass is effectively protected by specific ratios of borates to silicates. These species inhibit attack on the surface that would lead to green- or pink-colored surfaces, indicative of dezincification.

2. Periodic reverse (PR) is a specialized treatment for descaling and derusting steel. This procedure uses an automatic switch that changes polarity on the work between anodic and cathodic, in specific time cycles for optimum cleaning. Parts usually exit the bath anodic, to deplate any metallic smuts deposited in a previous cathodic mode. This redox treatment acts to soften scale, rust and oxides, permitting chelates and complexors in the electrocleaner to dissolve them. For many years, cyanides were added to the electrocleaner to adequately waste-treat ferricyanides, a by-product of the cleaning step. A special class of complexors are now effectively used in place of cyanides. Another benefit is the ability to increase operating temperature of the electrocleaner by up to 50 percent vs. cyanide-containing solutions, for better scrubbing and conductivity. This class of electrocleaners is also called alkaline descalers.
3. Cathodic electrocleaning is not as prevalent. Two detrimental condi-

tions can occur. Metallic and other positively charged smuts or organic compounds, attracted to the negatively charged part, deposit as barrier films. This condition may not be sufficiently removed in an acid dip, resulting in plating rejects, such as blisters, peeling or haze. The other problem is generating hydrogen gas on the part, which could produce hydrogen embrittlement. Cathodic cleaning, however, is favored for processing sensitive parts, such as buffed brass, copper and white metal. This prevents oxidation, such as etching, tarnishing and pitting, that would mar the buffed/polished finish. Cathodic electrocleaners are either replaced frequently or kept clean and optimized.

4. A combination soak/electrocleaner meets the requirements of soak and electrocleaning in one tank, or in separate process tanks. In many applications, this provides three advantages:

   - Simplifies inventory of product,
   - Permits eliminating a rinse between soak and electrocleaner
   - Both cleaning steps can be accomplished in one tank.

   A disadvantage would be shorter life of the electrocleaner because of oil and grease buildup.

Troubleshooting Tips

Etching

On steel, there are three common problems. The reserve caustic concentration is too low. Rapid oxidation speeds formation of iron hydroxide on the surface. Parts exiting the bath exhibit red/brown patches and etch patterns, especially in high current densities. Increase caustic level of decrease current density to correct. Grease etch is another problem. Oily grease, not removed in the soak cleaner, forms nonconductive spots, resulting in uneven distribution of current, causing surface etching. A third problem is formation of brown etch spots in the second electrocleaner following a hydrochloric acid dip. This phenomenon is chloride etching, caused when chlorine gas is formed and liberated off the part. Improve rinsing, change to a non-chloride acid or use a specially inhibited electrocleaner. For nonferrous metals, too high temperature, not using an inhibited cleaner, oil or grease on the surface, or wrong polarity can result in etching.

Plating Defects

Pitting, Blisters, Poor Adhesion

Hexavalent chrome contamination (as discussed), wrong current density or polarity, poor rinsing, organic soils on the part, under-concentrated cleaner, and under- or overcleaning. Start with the cleaner itself. Analyze for concentration and contaminants. Is this the right cleaner to use? Is the cleaner being maintained and operated as it should be? If water breaks occur, the parts are not free of oily soils (especially after the acid dip). Solvent-clean parts before racking, or place cleaned steel Hull cell panels in the

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