# **Finisher's Think Tank**



Stephen F. Rudy, CEF Hubbard-Hall Inc. 563 South Leonard Street Waterbury, CT 06708 E-mail: sfrudy@optonline.net

# **Electrocleaning Roundup**

This specialty surface treatment process will be found in almost all plating operations. Why so prevalent? Simply, it has proven its importance to surface preparation, time and again. The process tank can be found in rack, barrel and continuous strip lines. Electrocleaning combines mechanical and chemical action, to remove organic and inorganic soils dynamically. These unwanted materials include oils and grease, as well as metallic oxides, smuts and scales. The first half of effective surface preparation would include soak and electrocleaning, removing the surface contaminants, and preparing the basis metal for activation. Let's clarify some basic operating dynamics of electrocleaning.

#### Nuts & bolts

A DC rectifier is connected to the anode and cathode bars on the electrocleaner tank. Parts are predominantly anodically (positive) charged during treatment. The cathode (negative) connection is typically to steel or stainless bars suspended from the cathode rod. In some setups, the tank walls may be cathodically charged. By turning on the rectifier, a powerful electrochemical redox reaction occurs. Water, the carrier solution, is electrolyzed, breaking down into its separate oxygen and hydrogen components. Oxygen is generated at the anode (parts) in an oxidation reaction. Hydrogen is generated at the cathode (bars or tank) in a reduction reaction. Oxygen formed on the parts, scrubs the surface. as it is formed and liberated. This action combines with the chemical components in the electrocleaner to clean and condition the parts. Hydrogen forms at the cathode and is liberated. Since water is composed of a 2:1 ratio of hydrogen to oxygen molecules, twice the scrubbing action occurs at the cathode versus anode (parts). One assumes that more scrubbing is better. Why aren't parts cathodically charged during treatment? Trace metal contaminants and smuts, positively charged; steadily build up in the electrocleaner bath during its service life. Since opposite charges attract, these positively charged contaminants would deposit as barrier films on negatively charged parts. Activation in an acid treatment does not sufficiently remove these "plated on" contaminants, detrimentally affecting subsequent plating cycles. That is why anodic treatment is so effective, in that contaminants are "de-plated" off the metal surface, causing them to move away, depositing on the cathode. Over time, or when an electrocleaner is dumped, inspect the cathodes and observe the amount of metallic smuts that have been plated on. These are the charged soils that have been removed from the parts. Another problem associated with cathodically charging parts in the electrocleaner would be the potential problem of hydrogen embrittlement.

Anodic electrocleaning of parts is predominant, but not all inclusive. Cathodic electrocleaning is preferred for sensitive parts, such as highly buffed finishes on brass, copper and white metals, as examples. This treatment prevents oxidation which can result in excessive tarnish, etching and pitting.

#### Process operation

As a first treatment, soak cleaning is expected to remove the bulk of oils and grease. The electrocleaner follows, where metallic films and oxides are removed. This should be the main function of a stand-alone electrocleaner. The concentrated formulation can be either liquid or powder. Sodium hydroxide (caustic soda) or potassium hydroxide (caustic potash) are the main constituents, providing sufficient solution conductivity. Additives are included, which are also very important. These include: buffers, inhibitors, wetting agents, hard water softening and conditioners for metallic smuts, oxides and rust. The wetting agents lower solution surface tension. This permits the working solution to penetrate surface soils effectively, thereby removing them. This provides secondary capability to remove residual oils and grease, while generating a thin surface foam blanket, suppressing corrosive mists. There are many proprietary electrocleaner concentrate formulations. The various types have been formulated to address specific surface treatments in a stable, long bath service life. In many instances formulations also address specific process limitations or other conditions that would normally affect the electrocleaning process. Considerations include contaminant levels, processing of mixed metals, grades of steels and tenacious metallic soils.

Sometimes, based on process line layout or space constraints, a combination soak / electrocleaner is required. In this application the soak and electrocleaner formulations are combined, permitting effective treatment in the same process tank. The advantages are simplifying product inventory, conservation of rinse water and a double soak and electrocleaning in two separate tanks without an intermediate rinse.

Periodic reverse or PR electrocleaning is a specialized treatment for scale and rust removal off steel. The polarity on parts is automatically changed from anodic entry to cathodic to anodic exit. It takes advantage of the cathodic scrubbing, then switching to an exit anodic treatment de-plating any charged contaminants deposited in the previous treatment.

Continued on page 26.



While the text of the CASS specification indicates that wax is a suitable maskant for cut edges, past experience with this test in our laboratory and at GM's laboratory has found wax unsuitable, as it tends to decompose and leave residuals beyond the original border. A thick layer of high quality stop-off lacquer is far more suitable.

### Exposure of test specimen

Practices that contribute to reproducible salt spray results include the following:

## Salt Spray Test

ASTM B117 has the following exposure guidelnies for the salt spray test:

"7.1.1. Unless otherwise specified, the specimens shall be supported or suspended between 15 and 30° from the vertical and preferably parallel to the principal direction of flow of fog through the chamber, based upon the dominant surface being tested.

7.1.2. The specimens shall not contact each other or any metallic material or any material capable of acting as a wick.

7.1.3. Each specimen shall be placed to permit unencumbered exposure to the fog.

# 7.1.4. Salt solution from one specimen shall not drip on any other specimen."

To the above, I would add the following additional guidance:

- Expose test panels that have drilled holes so that the holes are at the bottom (prevents runs of corrosion residuals over the test surface).
- Expose test panels parallel to the fog flow pattern. This allows free fog flow between panels in accordance with paragraph 7.1.3.
- Support the test specimen from the bottom whenever possible. Use plastic hooks or plastic coated string only when necessary.
- Do not allow test specimens to touch each other.
- Do not permit spray to impinge directly on the test specimen.

#### CASS Test ASTM B368 indicates:

" 8.2.1 Support or suspend the specimens  $15 \pm 2^{\circ}$  from the vertical and preferably parallel to the principal direction of horizontal flow of fog through the chamber, based upon the dominant surface being tested. Support or suspend automobile parts, however, so as to expose all

significant surfaces at the general level of the condensate collectors. If the position on the automobile is vertical, place the part in an incline position 15° from vertical to allow surface wetting by the condensate. If the position on the automobile is facing down, rotate the part approximately 180° to test the significant surface. If there are several significant surfaces at different angles, expose each surface of one or more specimens.

8.2.2. Make sure the specimens do not come in contact with each other or any other metallic material or any material capable of acting as a wick.

8.2.3. Place each specimen so as to permit free settling of fog on all specimens.

8.2.4. Make sure the salt solution from one specimen does not drip on any other specimen.

8.2.5. Place the specimens in the chamber just prior to bringing the test chamber to the required temperature.

Note that the CASS specification is much stricter on exposure angle. Unless you are unusually talented and have the eyes of an eagle, the  $15 \pm 2^{\circ}$  requirement can only be met through the use of a protractor. **PESF** 

# **Finisher's Think Tank**

Continued from page 24

Electrocleaning operating parameters

Basis Metal	NaOH (oz/gal)	A/ft <sup>2</sup> (anodic)	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

The anodic current densities are given for rack processes. In barrel treatments the anodic current densities would be much less, of a range of 10 to 20% of the values given in the table. NaOH denotes sodium hydroxide. The other source of caustic, potassium hydroxide, can also be used.

### Typical electrocleaning problems

• *Etching of steel with brown filming.* The electrocleaner concentration may be low, or a formulation modification to a higher caustic level is required. The etch appearance would resemble burning, due to lack

of conductivity and the brown film is iron hydroxide not dissolved due to low reserve alkalinity.

• *Corrosive pitting*. This usually occurs if an acid pickle containing hydrochloric acid is dragged in, such as the second electrocleaner in a double cleaning cycle. Chloride is oxidized to chlorine gas on the parts forming the corrosive pits. Change to a non-chloride containing acid or use an electrocleaner with a specialized inhibitor to address the problem.

• *Plated deposits blister*. There could be several factors. But if the electrocleaner is considered, hexavalent chromium could be the culprit. The basis metal surface is passivated by the chromium contaminant. Add a hexavalent chromium reducing agent or switch to a formulated electrocleaner that contains this additive. If the electrocleaner solution turns yellow accompanied by lack of foaming, it is usually a positive sign of hexavalent chromium contamination.

• *Dezincification of brass*. Electrocleaner buffering is out of balance or one is using the wrong electrocleaner formulation for the in tank requirement.

• White pits and corrosion of zinc. The electrocleaner concentration is out of balance or one is using wrong formulation. Use a formulation with correct caustic to inhibitor balance. P&SF