"CLEANING" AND SURFACE PREPARATION OF ALUMINUM AND ALUMINUM ALLOYS

As with any metal finishing process on metals, cleaning is the single most important aspect for quality metal finishing. Cleaning can be obtained with use of various chemicals available today. Parts configuration, alloys, available processing facilities and desired end results influence the selection of chemicals and process method. To assist ease of selection, we would like to discuss various process chemicals and methods that are widely employed today as follows:

A. IMMERSION CLEANING

a. Alkaline Cleaning

Alkaline Cleaning will remove drawing oils, dirt and all types of shop soils. There are two types of alkaline cleaning compounds that are popularly used today.

1. Silicated Alkaline Cleaner-Sometimes known as non-etch aluminum cleaner with substantially high alkaline pH of 11-13 range and is considered a heavy duty cleaner for waxy soils.

2. Non-Silicated Cleaner-Low alkaline cleaner of pH range of 8-10, is most commonly used as a cleaner prior to caustic etch for chromating or anodizing. Non-Silicated cleaner is an excellent cleaner and poses least problem of cleaner drying on parts. Mostly, it is considered a non-etch cleaner at recommended concentration, temperature and time, however, it is capable of micro-etching most aluminum alloys.

b. Organic Acid Cleaner

Organic acid cleaner is made of high concentration of organic wetting agents to aid in removal of process and stains found on aluminum as well as blending of streaks, blemishes, etc.

Although it is relatively more expensive to charge tank initially, tank life may justify its use for special applications.

B. SPRAY CLEANING

Alkaline Cleaners, both Silicated and Non-Silicated are commonly used on cleaning only or cleaning prior to phosphatizing, micro-etching or chromate conversion coating. Low Temperature Cleaners of high quality are efficient cleaners, and they are used at relatively low operating temperatures of 100-130°F in most applications. Occasionally, low temperature cleaners are as effective on temperature sensitive soils such as wax, heavy rust preventive film, and baked on drawing compounds. When low temperature cleaners are used at high operating temperatures indiscriminately, oiling out of wetting agents may take place, showing poor cleaning performance. Should this be the case, high temperature cleaners are recommended.
C. ETCH-CLEAN OR ALKALINE ETCHING

Etch-Clean is employed to remove lightly soiled parts by using acidic cleaners containing phosphoric acid, hydrofluoric acid, glycol solvents, and wetting agents. It is a convenient method of preparing aluminum surface for chromating or painting. An acid etch cleaned surface will provide a smooth micro-etched surface that is extremely suitable for depositing chromate conversion coating.

Alkaline Etching is done by using a strong caustic soda solution containing chelates and a foam blanket producing wetting agent, under heated solution. It readily provides a macro-etched surface after smut removal. To obtain good working conditions from alkaline etching baths, one has to maintain a good foam blanket, but not excessive, to suppress alkaline fumes arising from the reaction of caustic and aluminum. Introduction of high foam wetting agents through carryover of cleaner is highly undesirable. Should the foam blanket disappear due to introduction of free oil through soiled parts, then it could be restored by introducing a small amount of high foam cleaner. Parts should be reasonably clean prior to etching to obtain uniform, not blotchy, surface finish.

D. SMUT REMOVAL

After alkaline etching of aluminum, dark grey or blue-black smut is a natural occurrence that has to be removed with special acidic chemicals. There are several methods for the removal of smut, as follows:

a. One simple method is to use 50:50 cut water solution of commercially available 42°Be Nitric Acid.

b. Partially neutralized sulfuric acid, chromic acid, and others are used for smut removal with certain degrees of efficiency. However, its action and performance can be improved by adding equal amounts of sulfuric acid to the bath. In this way, smut removal bath life will be extended tremendously.

c. Non-Chromate smut removers are available in both powder and liquid forms. For powder, it is most efficient when an equal amount of sulfuric acid is added to the bath. Liquid smut remover is most effective on certain controlled alloys in contrast to job shop applications.

NOTE: Compounded smut removers are not at all effective on most high silicone castings that can only be processed consistently in a bath mixture containing Nitric and Hydrofluoric acids.

E. RINSING

Aluminum parts should be rinsed with water at room temperature. A cold water rinse minimizes the chance of inconsistent chromate film formation which could be caused by temperature variations of the metal. A cold water rinse is commonly used after chromating; however, a hot water rinse up to 150°F may be used to speed drying.
F. DRYING: AFTER CHROMATING

Drying is usually accomplished with forced air blasts or with circulating hot air. Special care must be exercised so as not to abrade soft, wet films. Oven drying may be employed, but temperatures in excess of 150°F should be avoided or exposure time carefully controlled. (Limiting the protective quality of the chromate coating through over heating is a common problem. However, this does not hold true after painting and runs through paint baking or curing ovens.) A color change to purplish-violet and a powdery appearance will be noted when over-exposure to high temperature occurs.

CHROMATE CONVERSION COATINGS FOR ALUMINUM AND IT'S ALLOYS

INTRODUCTION

Chromate conversion coatings are produced on aluminum and it's alloys by immersion, spray, (under adequate ventilation for worker safety), brush, or flow-on, and consist primarily of trivalent and hexavalent chromium compounds which are integral parts of the aluminum and it's alloys. Chromate conversion coatings are widely used in the metal finishing industry to retard corrosion, as a base for paints and as decorative finishes.

1. FORMATION OF CHROMATE CONVERSION COATINGS

Chromate conversion coatings on aluminum are produced from an acidic solution containing hexavalent chromium-bearing chemicals, mineral or organic acids, activators and accelerators. When exposed to this solution, aluminum is attacked by the mineral or organic acid. At the same time, some hexavalent chromium is reduced to the trivalent state and the solution's pH is increased at the liquid-metal interface. During this process, trivalent and some hexavalent chromium is precipitated on the aluminum. The activators in the solution control the nature of the coatings formed, i.e., porosity, hardness and color. Accelerators tend to make metal more susceptible to the coating and also speed up deposition. Additionally, surface roughness of metal, influences the rate of deposition also.

2. GENERAL PROPERTIES OF CHROMATE FILMS

Conversion coatings are prone to abrasion damage immediately after film formation. Amorphous chromate films produce no crystal pattern when subjected to X-ray diffraction examination, unless they have been dehydrated. Maximum corrosion protection is found in coatings which contain both trivalent and hexavalent chromium. Unpainted metal surfaces which have been coated with a chromate film are protected from moisture due to the film's non-porous nature. When painted, it provides a barrier which helps maintain adhesion by sealing the metal from paint and moisture.

The slightly soluble hexavalent chromium in the chromate film provides a self healing action which prevents lateral corrosion of bare metal. The life of a chromate part depends upon the rate of consumption of hexavalent chromium from the film and its transfer to bare metal.
3. TYPES OF CHROMATE CONVERSION COATINGS

A. Clear Films

Clear conversion coatings contain relatively little hexavalent chromium and therefore exhibit limited protective properties. The appearance and corrosion resistance of clear films is usually enhanced by treatment with a transparent organic protective coating.

B. Iridescent Yellow-To-Tan Films

Chromate conversion coatings ranging in color from light iridescent yellow to tan are commonly used as paint bond bases or as a decorative finish. Several factors determine the color of chromate coatings on metal surfaces: (1) pH of the bath solution, (2) concentration, (3) type of activator, (4) temperature, (5) impingement, (6) surface roughness, and, (7) time.

4. GENERAL PROCESSING DATA

A. Clear Film: Immersion

1. Non-Silicated Cleaner
   Powder 4-8 oz/gal or
   Liquid 5-10% by volume
   100-140°F, 3-10 minutes.

2. Water Rinse. overflow.

3. Deoxidizing compound
   Non-Etch Phosphoric Acid type is preferred,
   one part acid in five parts of water
   unheated, 1-2 minutes.

4. Water Rinse, overflow, unheated, ½-1 minute.

5. Chromate Conversion Coating Compound
   Example: Fremont 3008 recommended at 20-40 oz.
   per 100 gallons of water plus 1/5 pint of commercial
   42°Be Nitric Acid per 100 Gallons of chromating solution.
   Unheated, ½-4 minutes.


7. Dry.
B. Yellow to Tan Film: Immersion

1. Non-Silicated Cleaner
   Powder 6-8 oz/gal
   Liquid 5-10 % by volume
   120-180°F, 5-10 minutes.

2. Water Rinse, good overflow.

3. Deoxidizing compound.

   a. Acid Etch
      Phosphoric-Hydrofluoric
      1 part acid in 10-15
      parts of water.
      Unheated, 1-3 minutes.


5. Chromating Compound.
   Example: Fremont 3008
   recommended at 1 oz/gal
   of water plus ½ oz. of
   commercial 42° Be Nitric
   Acid per 1 gal of chromating
   solution. Unheated ½-3 minutes.

   Dry-room temperature or low
   heat forced air dry is recom-
   mended. Long exposure to excessively
   high temperatures will convert chromate
   coating to purplish color indicating deteriora-
   tion of protective quality of chromate film.

   b. Alkali-Etch
      Caustic Aluminum Etch
      6-8 oz/gal
      Temperature up to 150°F
      1-3 minutes.


5. Smut Remover
   Powder 1 lb/gal or
   1 lb. powder plus
   1 lb. Sulfuric Acid
   per 1 gal. water.
   Unheated, 1-3 minutes.
   Liquid 10-20% by volume
   in water.
   Unheated, time as needed.


7. Follow a., steps 5-6 for
   chromating.

* Water Rinse after cleaning should have good overflow to avoid
  buildup of high foam cleaner. Otherwise, excessive carry over of
  such solution into Alkali-Etch bath results in an undesirable high
  foam blanket.

Water rinse after Alkali-Etch bath should have good overflow to avoid
buildup of alkalinity that would neutralize acidic smut remover bath.

Water rinse after Smut Remover bath should have good overflow to
avoid buildup of acidity that would increase the acidity of the
chromating bath and rate of coating deposition.
C. Yellow To Tan Film: Spray

Limited industry use. Used in spray power washers that are equipped with stainless steel tanks and have good positive ventilation for worker safety.

1. Low Foam Alkaline Spray Cleaner
   2-3 oz./gal., 100-130°F., 60 seconds

2. Water Rinse, good overflow.

3. Chromate Conversion Coating Compound
   Example: Fremont 3008 recommended at 1-2 oz./gal., unheated, 60 seconds. Optionally, ½ oz. of Nitric Acid may be added to speed up chromate coating formation, if needed.

   Dry.

V. BATH MAKE UP AND CONTROL OF CHROMATE

A. Bath Make Up

A powdered compound should be dissolved in a small amount of water and added to the tank with the full volume of water. Nitric Acid, or another recommended acid, should then be added directly to the tank to complete the working solution. The powdered compound solution and the nitric acid should not be mixed together before being added to the tank.

B. Bath Control

Bath solution is controlled by comparing processed parts to control panels, by checking the pH, and by titration.

1. Control Panels: Preclean panels manually, then chromate conversion coat by varying colors and treatment conditions and use as quality control standards. Record concentration, pH, time and temperature on the panels.

2. pH: pH is controlled by the addition of Nitric Acid. When the pH of the solution is too low, ammonium hydroxide or other alkaline chemicals may be used to neutralize excess acidity.

3. Titration: It is necessary to titrate at certain intervals to maintain proper compound concentration. Compound replenishment is based on titration results. The pH should be checked after each addition and adjusted if necessary.
VI. EQUIPMENT

The Following materials may be considered for the construction of processing tanks, heating coils, crates, baskets, conveyors, racks, etc.

Alkaline Cleaners

Mild Steel (Min. 3/16 inch).

Acidic Cleaners

Rubber or vinyl lined steel tanks. Polyethylene or polypropylene tanks. Stainless steel tanks.

Acidic Etch-Cleaners & Non-Chromated Smut Removers

Rubber or vinyl lined steel tanks. Fiberglass tanks or stainless steel. Polyethylene or polypropylene tanks.

Alkaline Etch

Mild Steel (Min. 3/16 inch).

Chromating Compounds & Chromated Smut Removers


Heating Coils

Stainless steel (316).

Handling Parts

Crates, baskets, racks, hooks, conveyors, should be acid-resistant materials or mild steel, that has been suitably coated with plastisol, polyethylene, etc.

Rinsing Tanks

Mild steel (Min. 3/16 inch).
The top aluminum panel shown here was cleaned only and subjected to 5% salt spray for 24 hours. The bottom aluminum panel was chromate-coated with Fremont 3008 only and subjected to a 5% salt spray for 168 hrs.

The top aluminum panel shown here was cleaned, painted and scribed with an X. It was then subjected to a 5% salt spray for 500 hours. The bottom aluminum panel was chromate-coated with Fremont 3008, painted and scribed with an X. It was then subjected to a 5% salt spray for 500 hours.
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<tr>
<th>IMMERSION CLEANERS</th>
<th>FORM</th>
<th>GENERAL DESCRIPTION</th>
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<th>TEMPERATURE</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>FREMONT 770</td>
<td>Powder</td>
<td>Non-Silicated, low temperature soak cleaner with exceptional cleaning power due to a special blend of biodegradable surface active agent system. Low alkaline product.</td>
<td>4-8 oz/gal</td>
<td>100-130°F</td>
<td>Foam, Moderate, Low alkaline pH.</td>
</tr>
<tr>
<td>FREMONT 3025</td>
<td>Powder</td>
<td>Non-Silicated, high temperature soak cleaner with good tank life for cleaning temperature sensitive soils. Low alkaline product.</td>
<td>6-8 oz/gal</td>
<td>130-180°F</td>
<td>High Foam, Low alkaline pH.</td>
</tr>
<tr>
<td>FREMONT 775</td>
<td>Powder</td>
<td>Low silicated, low to medium temperature cleaner with good cleaning power and contains water soluble glycol solvent. Moderately alkaline product.</td>
<td>4-8 oz/gal</td>
<td>100-150°F</td>
<td>Moderate Foam</td>
</tr>
<tr>
<td>FREMONT 772</td>
<td>Powder</td>
<td>Silicated, heavy duty aluminum cleaner that can be classified as multi-purpose, multi-temperature and contains some chelates. Moderately high alkaline product.</td>
<td>4-8 oz/gal</td>
<td>100-180°F</td>
<td>Moderate Foam</td>
</tr>
<tr>
<td>FREMONT 3094</td>
<td>Powder</td>
<td>Silicated, high temperature soak cleaner that has been a standard multi-purpose cleaner and contains most high temperature stable wetting agents. Moderately high alkaline product.</td>
<td>6-8 oz/gal</td>
<td>140-180°F</td>
<td>High Foam</td>
</tr>
<tr>
<td>FREMONT 773</td>
<td>Liquid</td>
<td>Non-Silicated, mild organic acid cleaner, with high detergency that removes tough drawing or stretching compounds on aluminum while removing oxidation and stains.</td>
<td>5-10% by volume in water</td>
<td>120-140°F</td>
<td>High Foam Use pH is 5.0-5.5</td>
</tr>
<tr>
<td>SPRAY CLEANERS</td>
<td>FORM</td>
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<td>REMARKS</td>
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<tr>
<td>FREMONT 771</td>
<td>Powder</td>
<td>Non-Silicated, low temperature cleaner with exceptionally low foaming feature. Low alkaline product. Low powder deposit on no rinse.</td>
<td>1-4 oz/gal</td>
<td>90-140°F</td>
<td>Low Foam, Ease of handling due to low alkalinity.</td>
</tr>
<tr>
<td>FREMONT 776</td>
<td>Powder</td>
<td>Silicated, low temperature cleaner with moderately high alkalinity, suitable for use in power washers, turbulators and vibratory finishing machine. Works on steel.</td>
<td>1-4 oz/gal</td>
<td>90-140°F</td>
<td>Low Foam, Counters acidic soils.</td>
</tr>
<tr>
<td>FREMONT 753</td>
<td>Liquid</td>
<td>Extremely low-silicate, low temperature cleaner, high solids and wetting agents, Moderate alkalinity. Consists of four different biodegradable wetting agents.</td>
<td>1.5-3.0% by volume in water</td>
<td>90-135°F</td>
<td>Low Foam Liquid</td>
</tr>
<tr>
<td>FREMONT 767</td>
<td>Liquid</td>
<td>Silicated, highly built, heavy duty temperature cleaner that is similar to 753 and contains higher solids and alkalinity.</td>
<td>1.5-3.0% by volume in water</td>
<td>90-160°F</td>
<td>Low Foam High Solids Liquid</td>
</tr>
<tr>
<td>FREMONT 764</td>
<td>Liquid</td>
<td>Non-built, neutral low temperature cleaner additive, stable in both acid and alkaline solutions. Low foam in use. Reduces surface tension of cleaning solution.</td>
<td>1 qt. to 1 gal per 250 gals of solution</td>
<td>90-160°F</td>
<td>Low Foam Wetting</td>
</tr>
<tr>
<td>ACID-ETCH CLEANERS</td>
<td>FORM</td>
<td>GENERAL DESCRIPTION</td>
<td>HOW USED</td>
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<tr>
<td>FREMONT 329</td>
<td>Liquid</td>
<td>Phosphoric base with a small amount of hydrofluoric acid for cold cleaning, deoxidizing and etching of aluminum in one step for chromating and painting. Works good on galvanized steel, also.</td>
<td>1 part in 3-15 parts of water.</td>
<td>Room</td>
<td>High Foam Multi-purpose Galvanized Steel</td>
</tr>
<tr>
<td>FREMONT 329LF</td>
<td>Liquid</td>
<td>Phosphoric base with a small amount of hydrofluoric acid to give slight etch... contains low foam for processing of large volume of parts of water.</td>
<td>1 part in 5-10 parts of water.</td>
<td>Room</td>
<td>Low Foam Paint-Prep</td>
</tr>
<tr>
<td>FREMONT 329M</td>
<td>Liquid</td>
<td>Phosphoric base with a small amount of hydrofluoric acid for cold etch cleaning...does not contain water soluble degreasing glycol.</td>
<td>1 part in 10 parts of water.</td>
<td>Room</td>
<td>High Foam No Solvent</td>
</tr>
<tr>
<td>FREMONT 3044</td>
<td>Liquid</td>
<td>Phosphoric base etch cleaner that is used in a heated bath to remove stains off aluminum sheet metals.</td>
<td>1 part in 5-10 parts of water</td>
<td>120-140°F</td>
<td>High Foam</td>
</tr>
<tr>
<td>FREMONT 328R</td>
<td>Liquid</td>
<td>Hydrofluoric based aluminum etch cleaner. High etch rate. Wear all protective equipment when handling this acid.</td>
<td>1 part in 10-20 parts of water.</td>
<td>Room</td>
<td>High Foam US Patent</td>
</tr>
</tbody>
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<tr>
<th>ALKALINE-ETCH CLEANERS</th>
<th>FORM</th>
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<tbody>
<tr>
<td>FREMONT 82</td>
<td>Powder</td>
<td>Highly caustic aluminum etch that has some tolerance for very light soil without losing foam blanket to suppress unpleasant alkaline fumes coming off etching.</td>
<td>6-8 oz/gal</td>
<td>Up to 150°F</td>
<td>Moderate Foam</td>
</tr>
<tr>
<td>FREMONT 182</td>
<td>Powder</td>
<td>Highly caustic aluminum etch that contains controlled foam to handle large volume work load for small tanks.</td>
<td>6-8 oz/gal</td>
<td>Up to 150°F</td>
<td>Low Foam Controlled Foam Chelated</td>
</tr>
<tr>
<td>SMUT REMOVERS</td>
<td>FORM</td>
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<tr>
<td>FREMONT 335</td>
<td>Powder</td>
<td>Chromated sulfuric acid smut remover with good tank life. Completely soluble in water.</td>
<td>1 lb/gal. or use with sulfuric acid.</td>
<td>Room</td>
<td>Low Foam</td>
</tr>
<tr>
<td>FREMONT 3106</td>
<td>Powder</td>
<td>Non-chromated, sulfuric type acid with limited water solubility. Requires moderate agitation in use.</td>
<td>1 lb/gal or use with sulfuric acid.</td>
<td>Room</td>
<td>Low Foam Agitation Ease of disposal</td>
</tr>
<tr>
<td>FREMONT 3107</td>
<td>Liquid</td>
<td>A new unique non-chromated smut remover with limited tank life. Excellent for use with controlled aluminum alloys. Not for job shop use.</td>
<td>10-15% by volume or higher in water.</td>
<td>Room</td>
<td>No Foam Liquid controlled alloy pretest.</td>
</tr>
<tr>
<td>CHROMATING</td>
<td></td>
<td>Chromate conversion coating that is specially formulated for use on aluminum alloys.</td>
<td>1 oz/gal and ½ oz/gal Nitric Acid</td>
<td>Room</td>
<td>No Foam Clear Coating Yellow Coating</td>
</tr>
</tbody>
</table>

PHOSPHATIZING

Refer to "Guide to Quality Phosphatizing"