Pretreatment and Surface Preparation for Liquid Paint Systems

Gale Seamons
Fremont Industries
(612) 445-4121
QUALITY PHOSPHATIZING

PREPARATION OF METALS BY PHOSPHATIZING

Phosphate coatings are produced on ferrous and non-ferrous metal surfaces and are composed of tiny crystals of iron, zinc or manganese phosphates. The inorganic coatings produced on metal surfaces retard corrosion and promote better paint bonding. Phosphate coatings are produced after precleaning or formed in a combination bath known as cleaner-phosphate. Phosphate coatings are generally used by the metal finishing industry for the following reasons:

1) To provide a base for bonding organic finishes such as paints, lacquers, plastics, rubber, adhesives, etc.

2) To provide a base for oils, waxes and rust preventives to reduce metal corrosion.

3) To provide a base for lubricant on bearing surfaces to reduce friction.

4) To aid in drawing and forming of metals.

However, phosphate coatings are used primarily for the bonding of paint. Coatings produced on metal are not only stable and chemically inert toward organic finishes, but they are also absorptive and bind organic finishes to the metal. The most important aspect for use of a phosphate coating is to prevent or retard the spread of corrosion under paint including the areas near ruptured film.

I. THE CHEMICAL THEORY OF FILM FORMATION

Phosphate coatings consist of crystalline salts of the metal which is being treated and/or crystalline salts of metal ions added to the phosphatizing solution.

When the metal comes in contact with the phosphatizing solution, some pickling occurs which results in a reduction of acid concentration at the liquid-metal interface. At this point iron is dissolved, hydrogen is evolved, and phosphate coating is deposited. Should the solution contain additional metal ions such as zinc or manganese, phosphate coatings of these ions will also be deposited.

Accelerators such as nitrite, nitrate, chlorate, peroxide or special organic chemicals may be added to increase the rate of coating deposition.

In general, iron phosphate coating weights of 25-90 mg/ft² and zinc phosphate coating weights of 100-300 mg/ft² are commonly accepted as bases for paint bonding.
As with any good quality-metal finishing, proper selection of cleaner and phosphatizing compound requires careful consideration. For instance, an automated line and fixed line speed demand good cleaning in the shortest time possible to allow full use of the remaining time for phosphate coating formation. Poor cleaners tend to lessen the quality of phosphate coating and promote flash rusting, streaking, or powdering.

II. TYPES OF PHOSPHATE COATINGS

A. IRON PHOSPHATES

Iron phosphate coatings are usually derived from solutions which contain very little iron. They are produced on ferrous metals through the combined use of acid phosphate salts, free phosphoric acid plus accelerators. For non-ferrous metals such as aluminum or zinc, micro-etched surface is produced in place of iron phosphate coating formation.

1. Various Types of Compounds Available

a. Metal Conditioners

There are a number of metal conditioning products available as liquid concentrates. These products consist of phosphoric acid, grease cutting solvents and organic detergents in water. Some products may contain a small amount of acid fluoride or salt to enhance acid activity on aluminum or galvanized steel surfaces. Metal conditioning compounds are applied by wipe-on, dip, or spray with various concentrations at ambient temperature. In addition to use as paint bonding bases, metal conditioning products have the capability to remove rust, scale or weld flux deposits.

b. Iron Phosphate Compounds

There are two types of iron phosphate compounds in use today. First type is an iron phosphate that does not have cleaning capability and is used on previously cleaned metal surfaces. Second type is an iron phosphate that does clean and deposit iron phosphate coating in the same bath and is also known as cleaner-phosphate. Both types of iron phosphates are capable of depositing phosphate coating weights of 25-90 mg/ft².
Iron phosphate compounds are generally used at concentrations varying between 1.5 to 3.0% by volume for liquids or 2 to 4 oz./gal. for powders at temperatures ranging from 90 to 130°F in most spray applications. For immersion iron phosphatizing, 3.0 to 5.0% for liquids or 4 to 6 oz./gal. for powders at temperatures of 120 to 160°F is used. Iron phosphate coatings can be applied with high pressure spray wand equipment with 1.0% by volume of liquid cleaner phosphate for most large parts.

Major advantages of most iron phosphate compounds are that there is a minimum of sludge formation, ease of solution maintenance, no heavy metal disposal problem and economical to operate. Most good iron phosphate compounds meet the Federal Specification TT-C-490, Type II.

2. General Processing Data

Thorough understanding of available water for processing will help to minimize sludge formation in tanks and prolong tank life. Water should be analyzed for its hardness and dissolved solids in micromhos. For extremely hard waters, select alkaline cleaners or phosphate compounds with hard water stabilizers.

It will be especially important for phosphate compounds to have a hard water stabilizer system built in to minimize sludge formation as well as frequent operating pH adjustment for quality phosphate coating formation.

Operating pH will vary widely with type of phosphate compounds and some will favor pH range of 3.5 to 5.0, while others will favor 4.8 to 6.0. It is more economical to use pH adjustment acid concentrate than use of phosphate compound. pH will tend to rise in operation in most instances.

Proper selection of energy conserving alkaline cleaners or phosphate compounds will generate cost savings with BTU consumption, especially with spray washers. There are many fine proven low temperature cleaners, cleaner-phosphates and phosphates in use today.
Additional consideration should be given to handling metals properly. Generally, steels - cold rolled, hot rolled, hot rolled cold pickled and oiled or cast iron will not require special consideration for selection of alkaline cleaners. However, it will be important to select proper alkaline cleaners or phosphates to be able to handle aluminum, zinc, galvanneal, galvanized or terneplated steel to effect good cleaning and painting. For mixed metal processing, the proper selection of cleaners and phosphates become of paramount importance. Likewise, type of paint employed such as high solids or powder coatings demand proper preparation of metal surfaces.

3. **Iron Phosphate – Recirculation Spray Process**

**Three Stages:** (Most widely used method.)

a. **Cleaner-Phosphate**  
   1.5-3.0% by vol. (liquid) or  
   2-4 oz./gal. (powder)  
   90-130°F  
   60 sec. or time may vary with line speed

b. **Water Rinse**  
   Overflow recommended  
   30 sec.

c. **Seal-Rinse**  
   (Maintain suspended and dissolved solids low.)  
   Chromate – 70 to 130°F, 30 seconds  
   Non-Chromate – 100 to 160°F, 30 sec.

Force dry or dry-off oven is recommended to get rid of water to prepare them for painting.

Water quality for seal-rinse makeup can play an important role. Softened water is no longer recommended as it always contains some residual sodium chloride salt (corrosive). Deionized water is helpful to use, however, it is very corrosive to steel tanks, unless used with seal-rinse compounds. Hard waters with low to medium water hardness and dissolve solids are commonly used.
Five Stages: (Most efficient and economical method.)

a. Alkaline Spray Cleaner
   1.5-3.0% by vol. (liquid) or
   1-2 oz./gal. (powder)
   100-130°F
   60 sec. or time may vary with line speed

b. Water Rinse
   (Monitor pH of rinse water periodically.)
   Good overflow is recommended
   30 sec.

c. Phosphate
   90-130°F
   60 sec. or time may vary with line speed

d. Water Rinse
   Overflow
   30 sec.

e. Seal-Rinse
   (Maintain suspended and dissolved solids low.)
   Chromate - 70 to 130°F, 30 sec.
   Non-Chromate - 100 to 160°F, 30 sec.

For E-coat system, additional stages to employ deionized water rinse as well as deionized halo mist rinse is required to prevent carryover of unwanted solids into paint tanks.

4. Iron Phosphate - Immersion Process

Three Stages:

a. Cleaner-Phosphate
   3.0-5.0% by vol. (liquid) or
   4-6 oz./gal. (powder)
   120-160°F
   3-5 minutes

b. Water Rinse
   Overflow
   30-60 sec.

c. Seal-Rinse
   (Maintain suspended and dissolved solids low.)
   Chromate - 70 to 160°F, 30 sec.
   Non-Chromate - 130 to 160°F, 30 sec.
Five Stages:

a. Alkaline Soak Cleaner
   5.0-7.0% by vol. (liquid) or
   6-8 oz./gal. (powder)
   130-160°F
   5-10 min.

b. Water Rinse
   (Monitor pH of rinse water periodically.)
   Good overflow is required
   60 sec.

c. Phosphate
   1.5-3.0% by volume
   2-5 min.

d. Water Rinse
   Overflow
   30-60 sec.

e. Seal-Rinse
   (Maintain suspended and dissolved solids low.)
   Chromate - 70 to 160°F, 30 sec.
   Non-Chromate - 130 to 160°F, 30 sec.

Most alkaline soak cleaners are capable of removing oily soils, however, they find it difficult to remove particulate inorganic soils in a static water rinse. Employment of some form of spray water rinse will improve the uniformity of phosphate coating deposition drastically.

5. High Pressure Spray Wand Phosphatizing

Iron phosphate can be efficiently deposited with high pressure spray wand equipment with spray pressures ranging from 500-1500 psi at the nozzle by using quality liquid cleaner-phosphates.

Advanced technology in equipment design helped to produce spray wand equipment with a capability to generate instant temperature up to 185°F on demand with energy efficient operation. Use of downstream injector will positively deliver exact phosphatizing concentration to the nozzle and parts being cleaned and phosphatized simultaneously. Generally, 0.5-1.0% by volume of iron phosphate is used to prepare metals for good paint bonding.
B. ZINC PHOSPHATE

Fine grain zinc phosphate coatings are generally used for paint bonding and rust proofing purposes. Carefully controlled fine grain zinc phosphate coatings offer superior corrosion resistance than iron phosphate coatings in general. With ever increasing environmental regulations pertaining to disposal of rinse waters containing heavy metals and sludges, its popularity is confined to those large operations with elaborate waste treatment facilities.

Zinc phosphate coatings are produced on ferrous and non-ferrous metal surfaces in solutions prepared from compounded liquid concentrates. The liquid concentrate contain zinc-bearing salts and free phosphoric acid. They may also contain such accelerators as chlorate, nitrate, or organic compounds. Nitrite or peroxide can be added directly to working solution.

Certain zinc phosphate compounds may contain bivalent metal ions in order to refine the crystalline structure of the phosphate coating. Addition of fluoride or salts may be needed to promote coating deposition on non-ferrous metals.

1. General Processing Data for Zinc Phosphating

Zinc Phosphate - Spray Process

a. Alkaline Spray Cleaner
   1.5-3.0% by vol. (liquid) or
   1-2 oz./gal. (powder)
   120-140°F
   60 sec.

b. Water Rinse
   (Monitor pH of rinse water periodically.)
   Good overflow

c. Zinc Phosphate
   1.5-3.0% by volume
   100-140°F
   60-90 sec.

d. Water Rinse
   Overflow
   30 sec.

e. Seal-Rinse
   Chromate - 70-130°F, 30 sec.
   Non-Chromate - 100-140°F, 30 sec.
A minimum of 5 stages are used to obtain coating weights of 150-300 mg/ft², however, 7 stages or more are common for larger volume operations or E-coat paint systems.

Use of titanated cleaner or titanium grain refining conditioner is employed to speed up uniform zinc phosphate coating with fine grain structure.

**Zinc Phosphate-Immersion Process**

a. Alkaline Soak Cleaner
   6-8 oz./gal.
   130-160°F
   5-10 min.

b. Water Rinse
   Good overflow
   60 sec.
   (Monitor pH of rinse water periodically.)

c. Zinc Phosphate
   3.0-5.0% by volume
   140-160°F
   2-10 min. for paint bonding
   15-30 min. for corrosion protection

d. Water Rinse
   Overflow
   30 sec.

e. Seal-Rinse
   Chromate - 70-130°F, 30 sec.
   Non-Chromate - 100-140°F, 30 sec.

Heavy crystalline zinc phosphate coatings of 1500-3000 mg/ft² can be obtained for use as a wear resistant, corrosion resistant or cold forming aid.

C. **MANGANESE PHOSPHATE**

Manganese phosphate coatings are produced on ferrous metals from baths which contain manganese bearing salts. The solution may also contain other metal ions as well as nitrate to promote crystal growth. Manganese coatings serve to resist wear and corrosion and are used as a cold forming aid. Manganese phosphate coatings are most commonly applied by immersion for periods ranging from 10-30 minutes.
III. SEALING OF PHOSPHATE COATINGS

A final and important step in the phosphating process is the sealing rinse. It is accomplished by using a dilute chromic acid solution, a chromic-phosphoric acid solution, a blend of chrome solution of hexavalent and trivalent chromium, or proprietary non-chromate compounds of inorganic or organic polymers. Concentrations are kept low as not to dissolve the coating. The primary function of seal-rinse is to passivate or seal areas of porosity around phosphate coating. Additionally, it is absorbed by the phosphate coating to enhance resistance to rusting by the formation of complex coating. Although many claims are made for non-chromate seal-rinse, it is as good as the chromic only on the basis of phosphate or paint coating specifically. Overall, chromic seal rinse cannot be matched for underfilm corrosion protection of paints in corrosive environment by non-chrome seal rinses.

As a good practice, irrespective of what type seal-rinse is used, elimination of corrosive salts or unreacted phosphate salts by using halo mist of clean water or deionized water will further improve corrosion resistance of all paint films, air dry, high solids bake, powder coatings or E-coat finish.

IV. SOLUTION CONTROL

Phosphatizing solution control is done by titration to determine true chemical concentration. Sometimes, additional tests are done to determine free acidity, total acidity, accelerator, activator, or iron concentration. pH of phosphatizing solution is extremely important. Use of automatic monitor/control units will automatically monitor a bath for various constituents and replenish the depleted ones to maintain the bath within the prespecified operating range.

Use of tote bulk-pac will minimize personnel handling of hazardous chemicals and eliminate drum disposal problem.

Record keeping solution chart or automatic solution concentration recorder will maintain uniform working solutions and aid in trouble shooting.

V. COATING QUALITY CONTROL

More or less, phosphate coating weights do not have a direct influence on the degree of corrosion resistance, paint adhesion, or salt spray hours. However, the type of phosphate coating, such as highly accelerated iron phosphate or heavy metal phosphate, has a direct influence over corrosion resistance or salt spray hours.
some frequently performed tests are as follows:

1. Phosphate Coating Weight Determination per Gov. Spec. TT-C-490A.
2. Cross Hatch Test  ASTM D-3359
3. Reverse Impact Test  ASTM D-2794
4. Conical Mandrel Bend Test  ASTM D-522
5. Relative Humidity Test  ASTM D-1748
6. Water Immersion Test  ASTM D-870
7. Salt Spray (Fog) Test  ASTM B-117
<table>
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<tr>
<th>PURPOSE</th>
<th>FORM</th>
<th>USE CONC. &amp; TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZINC PHOSPHATE (Meets Gov. Spec. TT-C-490C, Type I.)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>602 E.C. -620</td>
<td>Up-to-date fine textured zinc phosphate coating of controlled coating weight to suit modern paint technology for steel and electrogalvanized steel. 602 E.C. is a makeup and 620 is a replenisher.</td>
<td>Acidic Liquids</td>
</tr>
<tr>
<td>602M</td>
<td>602M is a single package calcium modified zinc phosphate that offers varying degrees of coating weights with operating parameters. Best suited for use with powder coatings on electrogalv. steel and steel.</td>
<td>Acidic Liquid</td>
</tr>
<tr>
<td>605</td>
<td>605 is best suited for dip tank operation for heavier coating weights.</td>
<td>Acidic Liquid</td>
</tr>
<tr>
<td>604</td>
<td>Titanated conditioner promotes sights for deposition of fine grained zinc phosphate coating uniformly at lower operating temperatures.</td>
<td>Alkaline Powder</td>
</tr>
<tr>
<td>603-603L</td>
<td>Accelerators are used to control dissolved iron concentration to speed coating formation as well as suppress coarse crystal formation.</td>
<td>Alkaline Liquids</td>
</tr>
<tr>
<td>213</td>
<td>Source of liquid caustic soda - controls free acidity or pH of effluent.</td>
<td>Alkaline Liquid</td>
</tr>
<tr>
<td>214</td>
<td>Source of soda ash - controls free acidity.</td>
<td>Alkaline Powder</td>
</tr>
<tr>
<td><strong>IRON PHOSPHATE (Meets Gov. Spec. TT-C-490C, Type II.)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>748-758</td>
<td>Improved paint adhesion and superior underfilm corrosion protection can be achieved with this class of super accelerated iron phosphate system. 758 is a bath makeup. Use as a single package or use with 748 pH control aid.</td>
<td>Acidic Liquids</td>
</tr>
<tr>
<td>607</td>
<td>High tech phosphate that deposits higher phosphate coating weight and improved salt spray resistance.</td>
<td>Acidic Liquid</td>
</tr>
<tr>
<td>738-738M</td>
<td>Iron phosphate with built in metal surface wetting capability to insure uniform deposition of coating for good paint bonding. 738M is a product with preneutralized free acidity to show proper operating pH.</td>
<td>Acidic Liquid</td>
</tr>
<tr>
<td><strong>CLEANSER PHOSPHATE (Meets Gov. Spec. TT-C-490C, Type II.)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>607-CL</td>
<td>Combination cleaner-phosphate for use with limited number of stages. When used in 3 stages with a proper seal-rinse. 607-CL meets spec.</td>
<td>Acidic Liquid</td>
</tr>
<tr>
<td>METHOD OF APPLICATION</td>
<td>METALS</td>
<td>COATING WEIGHTS</td>
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<tr>
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</tr>
<tr>
<td>Spray 5-Stage Washer</td>
<td>Steel, Galv. Steel</td>
<td>100-300 mg/ft²</td>
</tr>
<tr>
<td>Spray 5-Stage Washer</td>
<td>Steel, Galv. Steel</td>
<td>150-300 mg/ft²</td>
</tr>
<tr>
<td>Dip 5-Stage Dip Tank</td>
<td>Steel, Iron</td>
<td>Min. 1000 mg/ft²</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>604 can be used with no precleaner for treating reassembled clean metals.</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>Strong oxidizing chemicals. 603L is concentrated then diluted.</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>Caution should be exercised when neutralizing electroplated zinc as it will precipitate severely in alkaline pH.</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>Slow acting but easier to handle. Avoids sharp up downs.</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>Suitable for use with E-Coat System or Powder Coating with Fremont chemical strength monitor/control system combined with alkaline cleaners 765 or 752.</td>
</tr>
<tr>
<td>Spray or Dip Steel</td>
<td>5-Stage Dip Tank</td>
<td>Versatile product with wide operating temperatures at lower operating temperatures with 604.</td>
</tr>
<tr>
<td>Spray 5-Stage Washer</td>
<td>Steel, Zinc, Galv. Steel</td>
<td>25-40 mg/ft²</td>
</tr>
<tr>
<td>Spray 1 or 2-Stage Washer</td>
<td>Steel</td>
<td>30-40 mg/ft²</td>
</tr>
<tr>
<td>PURPOSE</td>
<td>FORM</td>
<td>USE CONC. &amp; TEMP.</td>
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<tr>
<td>--------------------------------------------------</td>
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</tr>
<tr>
<td>ZINC PHOSPHATE (Meets Gov. Spec. TT-C-490C, Type I.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>737-1 High Tech, highly built combination cleaner-phosphate that favorably competes against the powdered cleaner-phosphate. Extremely low sludging, lower operating concentration, and longer tank life is possible with use of 737-1.</td>
<td>Acidic Liquids</td>
<td>2.0-3.0% b.v. 110-130°F pH 3.5-4.8</td>
</tr>
<tr>
<td>727 Alternative product of 737-1 for those washers with limited rate of overflow in the rinse stages. Lower operating temperature is possible with use of 727.</td>
<td>Acidic Liquid</td>
<td>2.0-4.0% b.v. 100-140°F pH 3.5-4.8</td>
</tr>
<tr>
<td>717 Versatile high concentrate liquid product that can be used in 3 or 5 stages and with or without Fremont chemical strength monitor/control system.</td>
<td>Acidic Liquid</td>
<td>2.0-3.0% b.v. 100-140°F pH 3.5-4.8</td>
</tr>
<tr>
<td>726 General purpose energy saving low temperature cleaner-phosphate for good cleaning while producing uniform phosphate coating.</td>
<td>Acidic Powder</td>
<td>2-4 oz./gal. 90-130°F pH 3.5-5.0</td>
</tr>
<tr>
<td>801 Versatile combination cleaner-phosphate that can be operated at wide temperature ranges of 90-160°F and pH of 3.5-4.8 while offering high coating weight.</td>
<td>Acidic Powder</td>
<td>2-4 oz./gal. 90-160°F pH 3.5-5.0</td>
</tr>
<tr>
<td>601P Specially formulated product to handle most mixed metals especially aluminum and electrogalvanized steel. Handles extremely hard waters.</td>
<td>Acidic Powder</td>
<td>2-4 oz./gal. 90-130°F pH 3.5-4.8</td>
</tr>
<tr>
<td>342 Combination cleaner-phosphate with high cleaning power to handle oils, shop soils and light smuts while developing phosphate coating.</td>
<td>Acidic Powder</td>
<td>4-6 oz./gal. 130-150°F pH 3.5-4.5</td>
</tr>
<tr>
<td>342L Combination cleaner-phosphate with high cleaning power to handle oils, shop soils and light smuts while developing phosphate coating. Suitable for use with Fremont chemical strength monitor/control system.</td>
<td>Acidic Liquid</td>
<td>3.0-5.0% b.v. 140-160°F pH 3.5-5.0</td>
</tr>
<tr>
<td>SPRAY WAND PHOSPHATE (Meets Gov. Spec. TT-C-490C, Type II)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>631 Heavy duty, high active soids with sufficient free acidity to clean and phosphatize metals too large for dip or power washer spray machines. Good paint bonding base is formed with high efficiency spray wand phosphatizing equipment at very low operating cost.</td>
<td>Acidic Liquid</td>
<td>1.0-3.0% b.v. 100-180°F</td>
</tr>
<tr>
<td>626TP High tech combination cleaner-phosphate that can be used on metals with or without water rinse.</td>
<td>Acidic Liquid</td>
<td>1.0-2.0% b.v. 100-180°F</td>
</tr>
<tr>
<td>608 True time tested one-step no rinse cleaner-phosphate with no sodium salt deposit when not rinsed for good protection.</td>
<td>Acidic Liquid</td>
<td>1.1-1.5% b.v. 120-180°F</td>
</tr>
</tbody>
</table>

### SPRAY WAND EQUIPMENT

- **System 900**: A machine designed from the floor up to meet the rigorous demands of the metal pretreatment industry. Fremont units feature our exclusive all stainless steel custom calibrated fixed orifice injection systems nonadjustable for dependable and precise chemical metering. A total package source for high performance equipment custom designed for the metal finishing industry and performance matched phosphatizing chemicals.
- **System 1100**: Equipment 800 psi nozzle up to 180°F
- **System 1600**: Equipment 1000 psi nozzle up to 180°F
- **System 1600**: Equipment 1500 psi nozzle up to 180°F
<table>
<thead>
<tr>
<th>METHOD OF APPLICATION</th>
<th>METALS</th>
<th>COATING WEIGHTS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray 3-Stage Washer</td>
<td>Steel, Zinc, Galv. Steel, Aluminum, Terneplated Steel</td>
<td>30 - 40 mg/ft²</td>
<td>Exceptionally good degreaser and smut remover for phosphatizing cold rolled steel, hot rolled steel, galvanized steel, and electrogalvanized steel for powder coatings. Contains almost 50% active phosphatizing solids.</td>
</tr>
<tr>
<td>Spray 3-Stage Washer</td>
<td>Steel, Galv. Steel</td>
<td>30 - 40 mg/ft²</td>
<td>Good for use on heavy gauge metals at substantially energy saving operating temperatures.</td>
</tr>
<tr>
<td>Spray 3 or 5-Stage Washer</td>
<td>Steel, Galv. Steel</td>
<td>30 - 40 mg/ft²</td>
<td>When used in 5-stage operation, 717 will provide additional cleaning when the line speed is increased and contact pressure is decreased.</td>
</tr>
<tr>
<td>Spray 3-Stage Washer</td>
<td>Steel, Galv. Steel, Terneplated Steel</td>
<td>30 - 45 mg/ft²</td>
<td>Time tested true low temperature operating combination cleaning cleaner-phosphate without sacrificing cleaning power or quality of phosphate coating for good paint bonding on cold rolled, hot rolled, galvanized, and electrogalvanized steel.</td>
</tr>
<tr>
<td>Spray 3 or 5-Stage Washer</td>
<td>Steel</td>
<td>30 - 50 mg/ft²</td>
<td>Removes smuts and resists flash rusting when operated at low operating pH and high operating temperature.</td>
</tr>
<tr>
<td>Spray 3 or 5-Stage Washer</td>
<td>Steel, Aluminum, Galv. Steel</td>
<td>30 - 50 mg/ft²</td>
<td>Provides microetched surface for good paint bonding on aluminum. Buffered to resist pH shifts in hard water uses.</td>
</tr>
<tr>
<td>Dip 3-Stage Dip Tank</td>
<td>Steel</td>
<td>30 - 50 mg/ft²</td>
<td>Appearance of coating improves when spray water rinses are employed.</td>
</tr>
<tr>
<td>Dip 3-Stage Dip Tank</td>
<td>Steel</td>
<td>30 - 60 mg/ft²</td>
<td>Appearance of coating improves when spray water rinses are employed.</td>
</tr>
<tr>
<td>Spray Wand 3-Stage Dip Tank</td>
<td>Steel, Galv. Steel</td>
<td>25-35 mg/ft²</td>
<td>Fremont Industries, Inc. has been producing many quality finishing chemicals since 1954. Although these products will perform with other trade equipment, they are most suited for use with fine line Fremont Spray Wand Phosphatizing Equipment. Fremont products are developed from the ground level up through extensive testing to achieve maximum performance and wet parts compatibility of equipment.</td>
</tr>
</tbody>
</table>

**440,000 B.T.U. Burner Input**
4 H.P. 4 G.P.M. Available for use with natural gas or liquid propane gas.

**550,000 B.T.U. Burner Input**
6 H.P. 5 G.P.M. Quality cleaning and phosphating demand instantaneous generation of high heat. This ensures use of less chemical and energy. Fremont spray wand phosphatizing machine injects chemicals into the heated high pressure stream, and the water has exited the coils through our patent pending injection system. IN-SERVICE DESCALER is available with pre-packaged 213-223 for hard water scale removal.
### CHROMATE SEAL-RINSE

<table>
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<th>PURPOSE</th>
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<tbody>
<tr>
<td>343</td>
<td>Acidic Liquid</td>
<td>10 - 12 oz. / 100 gallons room temp. to 130° F</td>
</tr>
<tr>
<td>344</td>
<td>Acidic</td>
<td>0.16% b.v.</td>
</tr>
</tbody>
</table>

### RECYCLE-SEAL™

U.S. patented Fremont Recycle Seal™ System afford the use of chromated seal-rinse for best corrosion protection without generating hazardous waste for disposal.

### NON-CROMATE SEAL-RINSE

<table>
<thead>
<tr>
<th>NON-CHROMATE SEAL-RINSE</th>
<th>FORM</th>
<th>USE CONC. &amp; TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>745</td>
<td>Acidic Liquid</td>
<td>1-3 qt./100 gallons 130° F</td>
</tr>
<tr>
<td>719</td>
<td>Acidic Liquid</td>
<td>Maintain pH 5.5-6.0 room temp. to 130° F</td>
</tr>
<tr>
<td>739</td>
<td>Acidic Liquid</td>
<td>1-2 pt./100 gallons 130-160° F</td>
</tr>
<tr>
<td>742</td>
<td>Acidic Liquid</td>
<td>1-4 pt./100 gallons 100-160° F</td>
</tr>
</tbody>
</table>

### METAL PREP PRODUCTS

<table>
<thead>
<tr>
<th>METAL PREP PRODUCTS</th>
<th>FORM</th>
<th>USE CONC. &amp; TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>71-72</td>
<td>Acidic Liquid</td>
<td>1 part product to 3-5 parts water unheated</td>
</tr>
<tr>
<td>329</td>
<td>Acidic Liquid</td>
<td>1 part product to 7-10 parts water unheated</td>
</tr>
</tbody>
</table>

### ADDITIVES (PHOSPHATIZING)

<table>
<thead>
<tr>
<th>ADDITIVES (PHOSPHATIZING)</th>
<th>FORM</th>
<th>USE CONC. &amp; TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>764</td>
<td>Neutral Liquid</td>
<td>0.1-1.0% b.v. 90-160° F</td>
</tr>
<tr>
<td>3077</td>
<td>Acidic Liquid</td>
<td>Maintenance of pH provides more uniform cleaning or powder free phosphate coating formation. Other benefits include better paint adhesion on non-ferrous metals, less sludge formation and longer tank solution life.</td>
</tr>
<tr>
<td>METHOD OF APPLICATION</td>
<td>METALS</td>
<td>WEIGHS</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>Spray, Dip</td>
<td>Steel, Galv. Steel, Aluminum</td>
<td>Predominantly made of hexavalent chromium that is suited for use with patented Fremont Recycle Seal™ System.</td>
</tr>
<tr>
<td>Spray</td>
<td>Galv. Steel, Steel</td>
<td>Predominantly made of trivalent chromium that is effective on zinc phosphatized galvanized steel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A completely self-contained equipment supported with analytical services and startup assistance for EPA compliance.</td>
</tr>
<tr>
<td>Spray, Dip</td>
<td>Steel, Galv. Steel, Aluminum</td>
<td>Purpose of use of seal-rinse is to seal off bare spot between phosphate coating while removing hard water and unreacted water soluble phosphatizing chemicals. Seal-rinse provides added corrosion protection to painted parts in most cases. Most paints favors slightly acidic neutral surface for good dry paint adhesion.</td>
</tr>
<tr>
<td>Spray</td>
<td>Steel, Galv. Steel</td>
<td></td>
</tr>
<tr>
<td>Spray</td>
<td>Iron Zinc, Galv. Steel, Aluminum</td>
<td></td>
</tr>
<tr>
<td>Spray Wand</td>
<td>Steel, Galv. Steel</td>
<td></td>
</tr>
<tr>
<td>Manual Swab or Dip</td>
<td>Steel</td>
<td>10-25 mg/ft²</td>
</tr>
<tr>
<td>Manual Swab or Dip</td>
<td>Aluminum, Galv. Steel, Stainless Steel</td>
<td>Excellent choice for cold cleaning and micro-etching aluminum sheet stocks and extrusions for chrom conversion coating with 3008.</td>
</tr>
<tr>
<td>Spray</td>
<td>All metals</td>
<td>Periodic addition of organic detergent restores depleted cleaning surface active agents especially for process heavy work loads and varying soil conditions.</td>
</tr>
<tr>
<td>Spray, Dip</td>
<td>Steel, Galv. Steel, Zinc, Aluminum, Terneplated Steel</td>
<td>Stabilizes varying source of water quality and conserves use of phosphatizing chemicals.</td>
</tr>
</tbody>
</table>
### PURPOSE

**FREMONT PRODUCT STRENGTH MONITOR/CONTROL SYSTEMS**

Fremont automatic metering system is suitable for use with most all alkaline cleaners and liquid phosphatizing compounds that are used in 3 to 5 stage spray washers.

Fremont provides titration kits at no charge. No guess work or down time is possible with Fremont approach.

### TOTE BULK-PAC PROGRAM

Another convenient way to avoid headache created by drum disposal. Provides better material handling.

Available in D.O.T. Approved 330 gallon capacity.

### WASTE CONTROL

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Form</th>
<th>Use Conc. &amp; Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7067</td>
<td>Oil separation in spent phosphatizing solutions can be expedited by using 7067 clarifier. Pretesting is required per steam.</td>
<td>Liquid</td>
<td>Waste stream should be pretested via &quot;Jar Mixer Tester.&quot;</td>
</tr>
<tr>
<td>212-216</td>
<td>pH adjuster-chrome reducer, 212-216 are fast acting chemicals for the treatment of chromate seal rinse and zinc in phosphatizing solutions. Works best when they are treated together in batch process.</td>
<td>Liquid Powder</td>
<td>Predetermine as per chrome concentration to be treated.</td>
</tr>
<tr>
<td>261-262</td>
<td>Coagulating aids for treated chrome and zinc.</td>
<td>Liquids</td>
<td>Predetermine as per chrome and zinc concentration to be coagulated.</td>
</tr>
</tbody>
</table>

### CHROMATE CONVERSION COATING (3008-Approved under MIL-C-81706, Class IA, Form II. and Method C.)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Form</th>
<th>Use Conc. &amp; Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3008</td>
<td>Excellent chromate conversion coating for use on aluminum and aluminum alloys for paint adhesion and corrosion protection to decorative finish. Listed in current QPL-81706-13.</td>
<td>Acidic Powder</td>
<td>1 oz./gal. with 1/4 - 1/2 oz./gal. Nitric Acid 70-90° F pH 1.60-2.10</td>
</tr>
<tr>
<td>3006-3007</td>
<td>Chromate phosphate conversion coating for use on aluminum extrusions as paint adhesion base. Chromic phosphate shows olive drab finish.</td>
<td>Acidic Liquids</td>
<td>2%b.v. 3007 and 1%b.v. 3006 in 1 gal. water. 100-110° F</td>
</tr>
<tr>
<td>369-1</td>
<td>Chromate conversion coating for magnesium alloys or zinc die castings. Works exceptionally good on Zamak #3.</td>
<td>Acidic Liquid</td>
<td>0.5%b.v. Unheated</td>
</tr>
</tbody>
</table>

### TECHNICAL ASSISTANCE PROGRAM

Fremont commitment to quality products and service start immediately before and after installations.

**Field Service**

Technical sales representative works hand in hand with our metal finishing specialists, tech support groups, to keep you abreast with technical advancement in metal finishing field.

**Lab Service**

Technical evaluation of phosphatized panels, unpainted or painted, are provided at no charge to our customers with minimum delay.

No long waiting period is required. Minimum delay is encouraged.

**Training**

Technical application seminars are provided upon special requests.

Training includes safe handling of chemicals, OSHA, SARA, and other related topics.
<table>
<thead>
<tr>
<th>METHOD OF APPLICATION</th>
<th>METALS</th>
<th>COATING WEIGHTS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Treatment Tank</td>
<td></td>
<td>Fremont Product Strength Monitor/Control System capable of checking concentration and pH. Metering systems restore previously set operating parameters automatically.</td>
<td></td>
</tr>
<tr>
<td>Waste Treatment Tank</td>
<td></td>
<td>Each waste stream has to be pretested to determine the suitability of Fremont chemicals. Fremont conversion treatment is very simple and fast, not requiring heavy investment.</td>
<td></td>
</tr>
<tr>
<td>Dip</td>
<td>Aluminum, Aluminum 40-60 mg/ft² Alloys</td>
<td>3008 and MIL-C-81706 is applicable for use in MIL-C-5541D process specification.</td>
<td></td>
</tr>
<tr>
<td>Spray, Dip</td>
<td>Aluminum Extrusions</td>
<td>Phosphate coatings or non-chromated conversion coatings cannot provide the comparable corrosion protection of chromate conversion coatings in most cases.</td>
<td></td>
</tr>
<tr>
<td>Dip</td>
<td>Zinc, Zamak #3, Magnesium</td>
<td>369-1 is an alternative process to Dow recommended on magnesium alloys for paint adhesion.</td>
<td></td>
</tr>
</tbody>
</table>

Fremont metal finish testing laboratory is fully equipped to apply powder coatings, E-Coat (Electrodeposition) and wet paints as per specifications.

Laboratory service includes coating weight determinations, spray test or humidity test as per ASTM or others. Q-panels and customer production stocks are used for testing. (ACT panels are available upon request.)

Application training includes video, slides, or demonstration of parts treatment.
FREMONT APPROACH
TO
SOLVENT SUBSTITUTION

By

ED CHANG

August 26, 1991
Solvent substitution has been a popular topic in recent days due to the revised Clean Air Act and the Pollution Prevention Act of 1990 which requires reporting of annual release of Toxic Chemicals into environment in EPA FORM R. EPA is currently formulating a rule requesting to those who reported TRI (Toxic Release Inventory) to provide a written pollutant source reduction program.

The June 1991 amended Montreal Protocol of 1987 designed to protect the earth’s ozone layer sets forth the general reduction of production of Chlorofluorocarbons (CFCs) and 1,1,1-Trichloroethane (Methyl Chloroform) and phaseout schedule in a more accelerated manner than the previously agreed schedule.

Availability of Chlorofluorocarbons and 1,1,1-Trichloroethane poses no particular problem at this time as so many of large users have eliminated uses of such solvents. The Federal Excise Tax (The amended Omnibus Budget Reconciliation ACT of 1990) was applied to ozone-depleting chemicals since January of 1990 for Chlorofluorocarbons (i.e. CFC-113 $1.10 per pound) and 1,1,1-Trichloroethane in January 1991 to $0.137. This additional tax base will increase until they are completely banned for their uses or phaseout of production.

Chlorofluorocarbons are most popularly used by printed circuit assembly or electronics industries whereas 1,1,1-Trichloroethane (Methyl Chloroform) is primarily used in metal cleaning and degreasing by general metal processing industries.

Its complete elimination is not likely in the foreseeable future unless appropriate performing substitutes can be found. Until then, we will have to work toward a source reduction approach wherever solvent uses can be converted to alternative methods. Voluntarily, many major corporations have taken positive steps to eliminate uses of smog causing volatile organic compounds and CFCs and 1,1,1-Trichloroethane in recent years.

1. **ALTERNATIVES**

To this date, there have been several alternatives as solvent substitutes, however health and environmental trade offs are far too great for their popular acceptance by solvent users.

DuPont AXAREL™ 38 Cleaning Agent for printed circuit boards or AXAREL™ 52 Cleaning Agent for metal cleaning are classified as semi-aqueous meaning they contain oil like water insoluble hydrocarbon solvent in water mixture. Its uses require extensive purchase of equipment that eliminate most medium to small users. Additionally, cost of products are rather high.
For several years, terpene cleaners containing d-Limonene were considered promising substitutes for solvents. However, further investigation of d-Limonene by governmental agencies have shown positive carcinogenicity tests in male rats.

Terpenes are considered extremely toxic to aquatic life and have high biological oxygen demand (BOD) and chemical oxygen demand (COD) respectively, the waste streams will likely require pretreatment before discharge to POTW, if used extensively.

II. **FREMONT APPROACH - AQUEOUS CLEANERS**

Fremont approach is rather unique in their approach to finding solvent substitutes. Fremont approach is limited to utilization of chemicals that have ample test data on health and environment.

Fremont approach relies heavily on their past proven experience such as development of patented performing low temperature cleaners for energy conservation during energy crisis & patented non-phosphate cleaners during phosphate ban and other proven experience. Fremont approach relies on better utilization of proven chemicals and understanding of customer needs.

Fremont engineered aqueous cleaning chemicals will be job matched with customer needs rather than a generalized approach. By selecting a right product, one can reduce or eliminate use of hazardous and toxic solvents. Currently available Fremont products will be presented at the end of this article. Fremont continues to support this substitution program with on going research and development effort.

III. **WHAT ....... Before ...... Substitute Cleaner**

Establishment of cleaning standard will be necessary to minimize undue amount of testing. A substitute cleaner can be selected via cleaning efficacy tests. Additional consideration can be given to other areas of importance such as health, waste treatment, corrosion, and economy. Other items of importance are listed below with no particular order of importance.

**Water Quality**

Good water quality, low water hardness, means a longer chemical solution service life. Quality of rinse water, especially the final rinse is very important. In fact, deionized water is highly recommended. Otherwise, softened water can be considered.
Soils to be Removed

Soils to be removed can be analyzed from a more precise way or more generally categorized way. Unless soil is a known source, most cleaning tasks deal with soils of fairly unknown origin. The soils can be categorized as follows:

a. Oils and soils with fluidity.
   Machining, stamping, and forming oils are relatively easier to remove although they may contain chlorinated paraffins or sulfurized oils.

b. Soils with waxy film, oxidized rosin, paste and other soft film are more difficult to remove and requires elevated temperature with higher use concentration of chemicals.

c. Soils with abrasives, hard carbonized film, buffing compounds, smut, rust and heat scale demand job matched specialized chemicals.

Cleaner selection has to be made based on a simple assessment of overall soils to be removed. The cleaning efficacy of a given cleaner relies largely on proper selection of application method and equipment as well.

Parts to be Cleaned

Parts to be cleaned can be metallic or non-metallic. In this article, we will limit our discussion to metallic substrates only.

Metallic parts may consist of stainless steel, steel, iron, aluminum, zinc, galvanized steel, copper, brass, and others. Most cleaning deals with multi-metal work loads. Effective soil removal and corrosion protection, during cleaning cycle and after entire cycle, are paramount importance.

Solvent cleaned parts do not necessarily exhibit water break-free surfaces in most cases. In fact, metallic smut or particulate soils are evenly distributed over the substrate and not readily noticeable after cleaning. Aqueous cleaners, on the other hand, are able to provide water break-free surfaces with free of smut or particulate soils when used properly.
IV. **Cleaning Method**

Cleaning method can only be considered after evaluation of parts to be cleaned with the following points in mind.

- Metals
- Soils to be removed
- Configuration of parts
- Process time cycle
- Work load
- Frequency of equipment use
- Available equipment, space, and capital
- Drains and waste disposal method

Cleaning method is selected to satisfy a proposed "Cleanliness Standard". Certain cleaning situations, visual inspection of water break-free surface is further aided by the instrument called "Photo Acoustic Surface Quality Monitor" for quantitative numerical measurement of cleanliness before and after cleaning.

a. **Immersion Cleaning**

Dip tank cleaning can be to use a bucket or small tank when operator slushes parts in solvent as one-step cleaning. Since no water is involved, flash rusting is not encountered. When aqueous cleaner is employed, potential for flash rusting increases due to presence of water. Rust inhibitive cleaner is highly recommended as a replacement and used at ambient temperature.

Dip tank cleaning of a larger size is effective when sufficient heat and agitation are available. Source of agitation may be of submerged jet spray, air, impeller, or others. Retrofitting of available tanks may be considered. Some form of spray rinse may be of great importance to effect complete removal of particulate soils. The bath temperature may vary within 130 - 180°F.

b. **Spray Cleaning**

Spray cleaning can be a single stage or multi-stage equipment. Due to highly efficient spray impingement, both oils and particulate soils are removed. Blind holes & hidden areas may not obtain sufficient cleaner contact. Spray pressures of 25 to 100 psi and the bath temperature of 100 - 140°F may be considered.
c. **Electrolytic Cleaning**

This method of cleaning is used by platers. Many platers relied on the use of vapor degreasers routinely as a precleaner for heavily soiled parts. This method of cleaning involves the use of heated soak cleaner followed by electrolytic cleaner with electric current - anodic or cathodic. Dip tank soak cleaner removes oily soils while electrolytic cleaner removes particulate soils and smut. Capital investment and return on investment will be questionable when compared to other available methods.

d. **Ultrasonic Cleaning**

Most complete cleaning can be accomplished with the use of ultrasound energy and specially designed aqueous cleaners. Most importantly, it will provide cleaned surface superior to solvent degreased parts. Ultrasonic cleaning can be characterized by having complete cleanliness with reproducible quality for large work loads, shorten cleaning time, low chemical use concentration and long solution service life. Return on capital investment is quite good with modern units. Retrofitting of existing tanks may be possible. The operating bath temperature may vary within 120 - 160°F. Ultrasonic cleaning means ultraclean surfaces of visible areas as well as hidden areas including removal of metallic chips off threaded blind holes. Noise level can be controlled as some units run only when the work loads are in processing. Automation is also possible with larger units.

V. **Fremont Aqueous Cleaners**

**Immersion Cleaning**

Fremont 413... a low alkaline liquid cleaner for one-step slush cleaning of steel parts and in-process rust protection for several days indoors.

Fremont 410... a liquid alkaline cleaner for non-ferrous metals such as aluminum, zinc, copper and brass.

Fremont 770L and 474... new generation alkaline liquid cleaners with different surface active detergent systems. Certain soils are more susceptible to differing surface active wetting agent systems. Used for multi-metal cleaning operations.
Fremont 760LE... a strongly alkaline liquid cleaner system with high detergency for steel, iron, and stainless steel.

Spray Cleaning

Fremont 452... a moderately alkaline liquid low foam cleaner for use in large spray washers or highly agitated immersion tanks used on steel. May be used on multi-metals.

Fremont 771L... a moderately alkaline liquid cleaner with low organic content, especially used on non-ferrous metals such as aluminum and zinc.

Fremont 451... a moderately alkaline cleaner for use on small parts cleaning via self-contained single cell washers. Pre-testing is needed for multi-metal cleaning.

Fremont 426... a liquid cleaner - phosphate for one-step operation to promote paint bonding. Most paints favor slightly acidic surface over alkaline surface for good paint adhesion.

Fremont 440... a strongly alkaline liquid cleaner for removal of buffing compound off polished brass.

Ultrasonic Cleaning

Fremont 410... a liquid cleaner for multi-metal safe operation.

Fremont 706LE... a liquid cleaner for ferrous metals such as stainless steel, steel, and cast iron. Not recommended for use on non-ferrous metals.

Fremont 474... a new generation liquid cleaner with moderate alkalinity for use in multi-metal operations.
Rust Inhibitors

Fremont 7054.. a liquid, non-nitrite organic rust inhibitor. Most effective when used heated on previously cleaned steel and cast iron surfaces for indoor storage protection.

Fremont 7054C.. a moderately alkaline, non-nitrite, liquid rust inhibitor used at ambient temperature. Especially suited for in-process rust inhibition of parts. May be used as a one-step cleaner-rust inhibitor. Low foam when heated.

Most Fremont aqueous cleaners do not rely on the use of high caustic alkalinity or organic solvents. In fact, most cleaners do not contain phosphates, chelating chemicals, heavy metals or other regulated chemicals. All Fremont aqueous cleaners are biodegradable.