Pacific Northwest Pollution Prevention Resource Center (PPRC)
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This section provides information about the key processes and operations within the metal finishing industry, including inputs and waste streams.

Surface Preparation and Parts Cleaning

Surface preparation, cleanliness, and proper chemical conditions are essential to ensuring that finishes perform properly. Without a properly cleaned surface, even the most expensive coatings will fail to adhere or prevent corrosion. Surface preparation techniques range from simple abrasive blasting to acid washes to complex, multi-stage chemical cleaning processes.

- **Material Inputs** - Solvents, emulsifying agents, alkalis, and acids
- **Air Emissions** - Solvents (associated with solvent degreasing and emulsion cleaning only)
- **Process Wastewater** - Solvent, alkaline, and acid wastes
- **Solid/Hazardous Waste** - Ignitable wastes, solvent wastes, metals, and still bottoms

Plating

Plating activities involve applying predominantly inorganic coatings onto surfaces to provide corrosion resistance, hardness, wear resistance, anti-frictional characteristics, electrical or thermal conductivity, or decoration. The process typically uses an electrical (cathode/anode) relationship between the workpiece and the plating bath. The most common forms of plating are:

- Barrel plating which plates many small parts at one time. Parts in a workload are tumbled in a cascading action by a rotating vessel or "barrel" immersed in a plating bath.
- Brush plating brings the plating solution to the surface of a workpiece by an absorbent covering wrapped about a hand-held stylus, functioning as the anode. The workpiece functions as the cathode and the process is driven by a direct current power pack.
- Electroless plating occurs simply by immersion of parts in a plating bath.
- Electroplating is one of the most common processes at finishing shops. In electroplating, metal ions in either acid, alkaline, or neutral solutions are reduced on the work pieces. Metal ions in the solution are usually replenished by the dissolution of metal from solid metal anodes fabricated of the same metal being plated, or by direct replenishment of the solution with metal salts or oxides. Cyanide, usually in the form of sodium or potassium cyanide, is usually used as a complexing agent for cadmium and precious metal electroplating, and to a lesser degree, for other solutions such as copper and zinc baths.
- Mechanical plating is a barrel process for depositing metal on various substrates using mechanical rather than electrical energy.
- Rack plating holds parts in the most advantageous position for exposure to a plating current.
- Pulsed-current plating is commonly used to deposit gold and gold alloys, nickel, silver, chromium, tin-lead alloys, and palladium.
- Hot dip coating is the coating of a metallic workpiece with another metal to provide a protective film by immersion into a molten bath. Galvanizing (hot dip zinc) is a common form of hot dip coating.

  - **Material Inputs** - Acid/alkaline solutions, heavy metal bearing solutions, and cyanide bearing solutions
  - **Air Emissions** - Metal-ion-bearing mists and acid mists
  - **Process Wastewater** - Acid/alkaline, cyanide, and metal wastes
  - **Solid/Hazardous Waste** - Metal and reactive wastes

Anodizing

Anodizing is an electrolytic process which converts the metal surface to an insoluble oxide coating. Anodized coatings provide corrosion protection, decorative surfaces, a base for painting and other coating processes, and special electrical and mechanical properties. Aluminum is the most frequently anodized material. Common aluminum anodizing processes include: chromic acid anodizing, sulfuric acid anodizing, and boric-sulfuric anodizing.

After anodizing, parts are typically rinsed, then proceed through a sealing operation that improves the corrosion resistance of the coating. Common sealants include: chromic acid, nickel acetate, nickel-cobalt acetate, and hot water.

- **Material Inputs** - Acids, sealants

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- **Air Emissions** - Metal-ion-bearing mists and acid mists
- **Process Wastewater** - Acid wastes
- **Solid/Hazardous Waste** - Spent solutions, wastewater treatment sludges, and base metals

Chemical Conversion Coating

- Chromate conversion coatings are used on various metals by chemical or electrochemical treatment. Solutions, usually containing hexavalent chromium and other compounds, react with the metal surface to form a layer containing a complex mixture of compounds consisting of chromium, other constituents, and base metal.
- Phosphate coatings may be formed by the immersion of steel, iron, or zinc-plated steel in a dilute solution of phosphate salts, phosphoric acid, and other reagents to condition the surfaces for further processing.
- Metal coloring involves chemically converting the metal surface into an oxide or similar metallic compound to produce a decorative finish such as a green on copper.
- Passivating is the process of forming a protective film on metals by immersion into an acid solution, usually nitric acid or nitric acid with sodium dichromate.

  - **Material Inputs** - Metals and acids
  - **Air Emissions** - Metal-ion-bearing mists and acid mists
  - **Process Wastewater** - Metal salts, acid, and base wastes
  - **Solid/Hazardous Waste** - Spent solutions, wastewater treatment sludges, and base metals

Mechanical Finishing

- Blast finishing creates matte or satin finishes, frost or decorate part surfaces, and smooths or removes other imperfections.
- Mass finishing is a process by which part surfaces are finished or prepared for other operations by agitating bulk quantities of parts in a mixture of abrasive media, water, and finishing compound.
- Polishing is an abrading operation used to remove or smooth out surface defects (scratches, pits, or tool marks) that adversely affect the appearance or function of a part.
  - **Material Inputs** - Blasting media
  - **Air Emissions** - Minimal
  - **Process Wastewater** - Water containing abrasive residue, metal, and finishing compound
  - **Solid/Hazardous Waste** - Removed surface metal, abrasive media

Painting and Coating

Spray painting is a process by which paint is placed into a pressurized cup or pot and is atomized into a spray pattern when it is released from the vessel and forced through an orifice. Both liquid and powder coatings are sprayed onto the surface and cured. The newest line of coatings include ultraviolet curable powders and liquids.

Physical vapor deposition (PVD) coatings are typically thin coatings between 2 and 5 microns. PVD encompasses several deposition processes in which atoms are removed by physical means from a source and deposited on a substrate. Thermal energy and ion bombardment methods convert the source material into a vapor.

- **Material Inputs** - Solvents and coatings
- **Air Emissions** - Volatile organic compounds (VOC) and hazardous air pollutants (HAP)
- **Process Wastewater** - Solvent-laden water, rinse and cleaning waters
- **Solid/Hazardous Waste** - Still bottoms, sludges, paint solvents, surplus or expired paints or coatings

Etching

Etching produces specific designs or surface appearances on parts by controlled dissolution with chemical reagents or etchants.

- **Material Inputs** - Acids, etchants, reagents
- **Air Emissions** - VOCs
- **Solid/Hazardous Waste** - Sludges, spent acids and reagents

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