Anodizing

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Anodizing, unlike many other metal finishing operations, is commercially unique to aluminum. The finish is readily available worldwide and is relatively inexpensive. The process is used in a wide variety of aluminum products—from aircraft landing gear struts to decorative applications, and from give-away items to architectural buildings.

Applications

Anodizing provides aluminum parts so processed with hard, abrasion- and corrosion-resistant oxide film that is formed from the aluminum substrate. The anodic coating, as produced, is porous and it is this fact that allows the coating to be colored (dyed), or to absorb lubricants. Since the as-formed coating is porous, it must be sealed in order to obtain the requisite corrosion resistance.

Processes

There are a number of commercially available processes, which are listed in the order of their commercial importance.

Sulfuric Acid

Sulfuric acid is by far the most widely used process. In this process, the aluminum parts are made positive (anode) in a solution of about 15 wt/vol percent sulfuric acid contained in a tank. The tank is usually lead-lined, with the lead acting as the cathode to complete the electrical circuit. Newer plants use inert nonconductive tanks with either aluminum, stainless steel or lead cathodes. The area of the cathodes should be smaller than that of the load. The parts are treated and made positive at 15 to 20 VDC, depending on the alloy treated. This results in a current density of about 12 to 15 A/ft^2 of wetted surface in the tank. The thickness of the oxide produced is dependent on a number of processing factors, but under normal conditions, about 1 mil (0.001 in.) 25 microns of coating will form per hour of treatment at 12 A/ft^2 in a 15 percent solution at 70 °F (21 °C).

Chromic Acid

The only other electrolyte of commercial importance in the U.S. is chromic acid, which is specified in some military applications. This electrolyte produces much thinner films, which, however, provide excellent corrosion resistance. If assemblies are to undergo further processing, any entrapped electrolyte that is not well rinsed out of any recesses will not be corrosive to the assembly.

Hard Anodizing

This method is used where extremely hard, thick abrasion-resistant coatings are required, such as in certain engineering and aerospace applications. It is basically a modification of the standard sulfuric acid process, except that higher voltages and lower temperatures are usually used. Typical conditions might be 32 °F and 24 V (or 40 V).

After the coating is formed by any of the methods above, the film can be colored by immersion in a dye solution. If coloring is not desired, the film must be sealed to provide corrosion resistance. Sealing is usually accomplished by treating the part in boiling distilled or deionized water. Colored (dyed) work is generally sealed in a nickel salt solution, which helps prevent leeching or bleeding of the dye.

Hard-anodized parts are usually *not* sealed, since the sealing treatment may have detrimental effects on the hardness or abrasion resistance of the coating.

Environmental Impact

If anodizing is being done in the same shop as plating, then the waste treatment problems are minimal, because plating wastes are no doubt already being treated. In the case of chromic acid anodizing, the solution must be considered to be hazardous since the solution contains hexavalent chromium, which must be treated before discharge. Care must be taken in the handling, and to avoid breathing its vapors. Adequate ventilation and venting are essential in any anodizing facility, due to the fumes given off be some of the process solutions.

If dyed work is done, and nickel sealing is used, the sealing solution must be treated before discharge. Naturally, the acidic and alkaline solutions must also be neutralized before disposal. Some dyes may contain heavy metals, which may require treatment, and the colored solution will need to be decolorized before discharge.

Trends

Because of the protective nature of the coatings produced by the various anodizing processes, it is anticipated that the use of this type of finish will continue and expand. Work is being done to reduce the environmental impact of some of the solutions employed. P&SF