Architectural Aluminum Anodizers Group Sets Out Objectives

Today, anodized aluminum components are used extensively in most modern commercial, industrial, institutional and multiple residential buildings. Architectural Aluminum Anodizing has become a large and important factor in the building materials market.

In April of 1987, representatives from leading Architectural Aluminum Anodizing Companies in Ontario met to discuss mutual problems and concerns facing their operations. Paramount among their concerns was pollution control and government regulations concerning effluent treatment and discharge.

The result was the formation of the AAAG, the Architectural Aluminum Anodizers Group, and the development of goals and objectives.

The objectives set out by the Group were as follows...

(i) To exchange ideas and information regarding effluent discharge and effective control procedures.

(ii) To exchange information regarding pollution control equipment, suppliers and consultants. Also to keep current with the latest developments in pollution control technology and their application.

(iii) To represent this industry segment to all levels of government, the press, and to the public at large; and to make these groups aware of the Architectural Aluminum Anodizers' unique nature relative to other metal finishers.

(iv) To put in place an organization structure in order to take positive action on the above.

Since its inception, the AAAG has been aggressively addressing these objectives. Mutual benefits such as more effective and efficient pollution control measures have been experienced by member companies. And a further development is the publication of this informative bulletin, the AAAG "Point of View".

What is Aluminum Anyway?

To most people aluminum is a light weight, silvery coloured metal used to make a variety of products from doors and windows, boats, airplanes, and baseball bats to aluminum foil and pots and pans.

Aluminum in the form of extrusion or sheet is also used widely in the architectural building industry for building entrances, curtain walls, panels, louvres, lamp standards and a variety of other products associated with the architectural building industry.

Aluminum however, is much more than just a valuable, versatile construction material. Aluminum is a chemical element - one of 90 naturally occurring elements on earth that serve as the building blocks in nature.

As an element aluminum has unique physical and chemical properties. It is the third most abundant element in nature, representing about eight percent of the earth’s crust. Only oxygen and silicon are found in greater quantities. Aluminum is everywhere, it is present in soils and clays, minerals and rock and even in water - but not as a metal. Because of its chemical activity, and particularly its affinity for oxygen, aluminum is not found in its free or metallic state in nature; indeed metallic aluminum was unknown until about 150 years ago. Instead aluminum is always found chemically combined with other elements, particularly oxygen. Aluminum and oxygen combine to form alumina, commonly found in soil and clay. Bauxite, a clay-like substance that is the principal ore of aluminum is a combination of alumina, silica and iron oxides.

While most aluminum compounds will not dissolve in water, some do. A NOTABLE EXAMPLE IS ALUMINUM SULPHATE, COMMONLY KNOWN AS ALUM, EXTENSIVELY USED IN WATER TREATMENT FACILITIES.

Aluminum’s light weight, high strength, corrosion resistance, workability and its ability to accept a variety of surface treatments further enhance its popularity as a versatile, widely used construction material.

The thin, transparent, natural oxide present on the surface of raw or mill finish aluminum does not provide sufficient protection where enduring good appearance is required. Prolonged exposure to the weather results in the natural film being penetrated and although the thin natural oxide continuously reforms, the aluminum surface gradually becomes roughened and takes on an uneven, spotty or chalky appearance. Architectural anodizing provides long term protection for the aluminum plus a range of lightfast colours from clear, bronze tones to black, providing an enduring and pleasing aesthetic appearance to any building.

Architectural anodizing is the finishing system most closely identified with aluminum.
Anodizing of aluminum is an electrochemical process that forms an aluminum oxide coating on aluminum. Unlike plating processes, anodizing is accomplished through the dissolution of the aluminum itself in an acid solution and its combination with oxygen to form a hard, integral, glass-like coating on the surface of the aluminum. Although a few metals can be anodized, none have been developed as extensively for anodic coatings as aluminum.

The process was first developed in Europe during the late 1920’s, primarily for aircraft and marine applications due to its corrosion resistant properties. During the 50’s and 60’s anodizing became the dominant finish for architectural aluminum applications because it was both decorative and weather resistant.

There are three distinctly different processes for anodizing aluminum. All members of the AAAG use one or more of these processes.

**Sulphuric Acid Anodizing**

Sulphuric acid anodizing, sometimes called "clear anodizing", is one of the most widely used processes for architectural applications. A clear, glass-like, oxide film is formed by passing a direct current through a dilute (10-20%) sulphuric acid solution with the aluminum part as the anode. Excellent weather resistance is obtained when the anodized part is sealed in pure boiling water.

**Electrolytically Deposited Colour**

An unsealed sulphuric acid anodic film can be coloured in a number of ways because of its porous nature. One method that has gained prominence over the past 20 years for architectural applications is the electrolytic deposition process, sometimes called the 2-step process. A range of colours from bronze to black can be developed during A.C. electrolysis in an electrolyte containing a metal salt.

**Integral Colour**

This method of producing coloured anodic finishes has been used in architectural applications for almost 30 years. It is identified as integral colour anodizing because the colour is developed during the anodizing process. Bronze to black finishes are developed as an electrical current is passed through a bath consisting of an organic acid with a small amount of sulphuric acid. Typical organic acids are sulfophthalic acid and sulfosalicylic acid. These anodic films are sometimes referred to as "hard colour" because they are more dense than the conventional sulphuric acid films.

Once sealed, integral coloured finishes also provide excellent colour fastness and abrasion and corrosion resistance for architectural applications.

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**Water Treatment In An Anodizing Plant**

In order to put a smooth satin finish on Aluminum, it must be etched in a solution of caustic soda. The reaction, in the solution during etching, produces soluble sodium aluminate and a small amount of hydrogen gas. After sufficient etching, the aluminum products are washed off in a rinse tank. Some of the etching solution (12% to 15% caustic soda) is also drained off and added to the effluent water. The nature of the caustic soda raises the pH level of the effluent. In order to bring the pH level back to acceptable levels, it must be treated with acid. After this is done the neutralized effluent is mixed with Electro-Polymer in a flash mixer and then passed into a gravity settler/clarifier where the flocculation of the suspended solids occurs. Above the flocculation tanks is a cooler overflow box for the discharge of treated effluent to the sewer system. The solids which settle out in the form of sludge are transferred to a filter press and dewatered to reduce volume. The end product is a "cake", which is a non hazardous waste and can be disposed of in a landfill site. To do this the sludge "cake" must pass both a Slump Test and a Leachate Test.
Anodizing’s By-Products Their Treatment & Disposal

The technology for treating wastewater in sulphuric anodizing plants is generally straightforward. On a typical sulphuric acid anodizing line the predominant pollutant in the wastewater is dissolved aluminum. The aluminum is not particularly toxic and does not interfere with the subsequent sanitary sewage treatment process, hence the limits imposed by most regulatory agencies are not as stringent as those for heavy metals considered to be toxic.

The predominance of dissolved aluminum in the typical wastewater effluent makes the removal of tightly regulated heavy metals, originating from aluminum alloys, nearly automatic. The aluminum hydroxide precipitate is an excellent coagulant with a large and very active surface which permits easy co-precipitation of metals such as copper, zinc, cadmium, chromium and nickel keeping these metals to extremely low concentrations which easily meet regulatory limits.

The following highlights some of the commonly used methods for wastewater treatment in anodizing plants.

1. pH Control and Neutralization Process
   All rinse waters are collected and passed through an automatic pH control station for addition of either caustic soda or sulphuric acid, as the situation requires, to maintain the wastewater at a steady pH value between 6.5 and 9.5 as required by the regulatory authority.

2. Sludge Thickening and Removal
   The neutralized waste stream passes through a clarifier to separate the suspended solids and the clear water overflows to the sewer. Sludge precipitates to the bottom of the clarifier and is periodically transferred to a sludge thickening compartment where it is thickened with a suitable polyelectrolyte coagulant. A filter press or rotary vacuum filter is then used to dewater the sludge.

3. Reduction of Waste Stream and Chemical Recovery
   Anodizing plants usually use very large volumes of water. The cost of the water supply is becoming more and more expensive and very often the sewer use charge is being calculated as part of the water supply cost. Furthermore, a large volume of effluent discharge would require a large capacity waste treatment system, which is certainly more costly to build.

   A number of methods have been practiced for the reduction of water consumption such as counter flow of rinse tanks, filtration of sealing tanks, and re-use of the treated water.

   Chemical recovery processes which have been applied in anodizing plants are mainly:
   (a) **Caustic Soda Etch Regeneration**
      There are a number of systems commercially available in North America. The principle of the regeneration process is based on the Bayer’s process of crystallization of crystalline alumina tri-hydrate. By applying such a process, a large percentage of the dissolved alumina tri-hydrate, which can be easily dewatered to achieve a moisture content of less than 10%. The crystallization method offers the following advantages:
      - (i) Reduction of caustic soda consumption.
      - (ii) Reduction of sulphuric acid consumption for dosing in pH adjustment.
      - (iii) Reduction of sludge volume and subsequently a reduction in the waste disposal cost.

   (b) **Sulphuric Acid Recovery Process**
      This process is applied in the batch process. Usually this process is being applied in hand in hand with the caustic recovery process in order to achieve a low content of sulphate in the wastewater being discharged.

   (c) **Organic Acid Recovery Process**
      Due to the high cost of organic acid, a cation exchanger is used for the removal of dissolved aluminum from the organic acid anodizing tank. The anodizers are well experienced with this established process.

The Wastewater Treatment System should be designed to suit the individual anodizing plant’s operating conditions in order to make the design simple, trouble free and effective.

Various researchers have proven that the end products from different types of anodizing processes have different types of waste treatment systems are not significantly different.

There are only two by-products that appear in significant quantity in treated by-products. All treated wastes are approximately 32% to 60% aluminum in the form of either aluminum hydroxide or alumina tri-hydrate. Toxic metals are only present in trace amounts. Other metals are present in very low concentrations. The majority of these metals are contained in suspended form and effectively fixed in the sludges and solids following treatment.

The majority of treated wastewater is returnable to the anodizing process itself.

A certain amount of the treated wastewater is returned to the municipal sewer system.

Solids and sludges are recycled and used in alum, baking powders, cosmetics and water purification systems or are sent to landfill sites.
After several months of meetings, discussions and sharing of information, members of the AAAG have come to realize that there is general agreement concerning pollution control measures and regulations pertaining to Architectural Aluminum Anodizers.

These areas of agreement are reflected in the AAAG Point of View and are as follows:

- Architectural Aluminum Anodizers are different from other types of metal finishers in the processes that are used and the by-products that are produced.
- Architectural Aluminum Anodizers generate essentially non-toxic by-products.
- The Architectural Aluminum Anodizers Group member companies have been pro-active in developing and installing treatment systems for control of effluent.
- All member companies meet or surpass current municipal and provincial pollution control regulations.
- Architectural Aluminum Anodizers should be recognized as a significantly unique group within the larger industry classification of metal finishers.
- Government regulators should have a complete understanding of the Architectural Aluminum Anodizers' processes before implementing new regulations which control all metal finishers in the same manner regardless of their by-products.

### Regulations Governing By-Product Waste Disposal

Effluent from individual anodizing plants must meet the requirements of the municipality. Each municipality has its own individual set of guidelines and limits set out in their relevant by-laws. In Toronto, the municipality of Metropolitan Toronto By-Law No. 148-83, sets the limits for discharge to the sewers.

Effluent parameters that violate the municipal by-laws are defined explicitly. They include temperature, colour, suspended solids, grease, fat, oil, pH and matter in excess concentrations. The list of matter includes aluminum, arsenic, barium, cadmium, chloride, chromium, copper, cyanide, fluoride, lead, mercury, nickel, phenolic compounds, phosphorous, sulphate, sulphide, tin and zinc. Allowable concentrations run from a low of 0.1mg/L for mercury to a high of 1500 mg/L for sulphate.

Offending elements in the processing effluent and other solid wastes that are generated by extraction take the form of sludges which are compressed into a "cake" and are disposed to landfill sites. The transportation and discharge of these wastes must conform to provincial environmental laws detailed in the Environmental Protection Act - Regulation 309. These solid wastes need to be registered with the Ministry of the Environment only if they fall into the hazardous waste category.

Dewatering is common practice prior to disposal to landfill sites. To determine whether waste is solid it must pass a test known as the Slump Test.

Regulation 309 also insists on a Leachate Test to determine whether any toxic or hazardous chemicals will leach out of the solid waste.

### AAAG Members Take Leadership Role

Every member of the AAAG has made a commitment similar to that reflected in the policy statement of PPG Canada Inc. “To work together with all levels of government that are charged with the responsibility of environmental control and to comply with all applicable laws and regulations relating to the environment.”

AAAG members have backed up this commitment by investing substantial time, energy and money in searching out and putting into operation the best possible pollution control equipment available.

For example, Holly’s Anodizing has recently purchased an Eco-Tec Ion Exchange unit to recycle the sulphuric acid electrolyte. Holly’s have also put into operation a method to regenerate the caustic etch bath where aluminum oxide is the by-product.

Alcan Extrusions made a major capital investment to install equipment to neutralize and remove solids from wastewaters prior to discharge.

Indalex have installed a complex chemical recovery system while Alumicor Limited have recently put in place an acid recovery and caustic regeneration system.

Dependable Anodizing Ltd. have installed sludge separation and acid reclamation equipment from Chemical Equipment Fabricators Ltd., and Eco-Tec Limited.

These are examples of steps taken by AAAG member companies. Their commitment to effective and efficient pollution control and concern for the environment are evident by the actions they have taken to date. And the process has not stopped. AAAG member companies continue to assess current available equipment and processes in an ongoing effort to safeguard the environment.