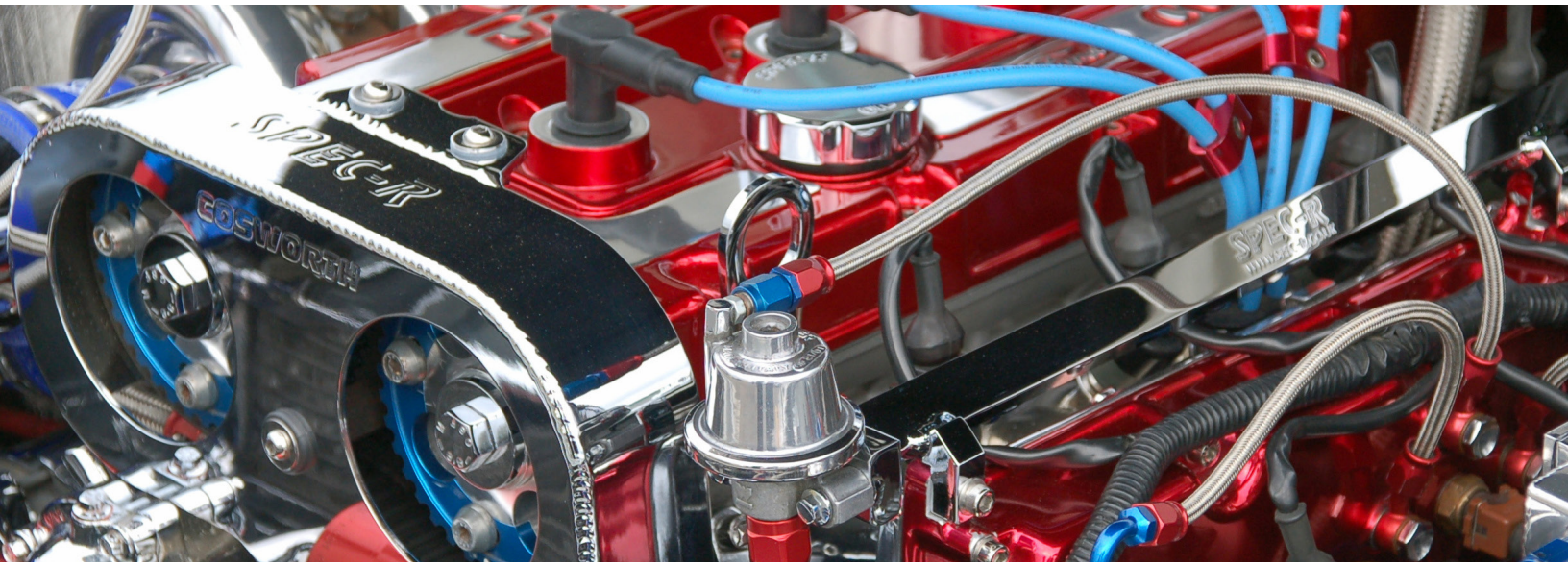
AN #: 05_008_11_001
Market: Plating
Subcategory: Anodizing
Product: HI902C



Measuring Sulfuric Acid and Aluminum in an Anodizing Bath

Description

Aluminum does much more than cover leftovers and provide storage for our favorite beverages. This versatile metal is the second most commonly used in the world, just behind iron. Manufacturers value aluminum for its abundance, light weight, and corrosion resistance. Because of its properties, many objects from cookware to aircrafts are made of aluminum or have aluminum components.

The corrosion resistance of aluminum stems from its ability to form a hard, protective oxide layer. The aluminum oxide layer forms upon exposure to oxygen. Once formed, the aluminum oxide coating is much harder than the untreated aluminum and is highly chemically resistant. The process of forming this protective coating is known as passivation. Although this process happens under ambient conditions, metal finishers use a variety of processes to accelerate the formation of the aluminum oxide coating.

Anodizing is one of the most common methods of passivating aluminum. Anodizing involves connecting the aluminum part to an electrical circuit to drive an oxidation-reduction reaction; a process similar to electroplating. In electroplating, current is applied between two charged terminals called the anode and the cathode. The object being plated is the cathode and the source metal or an inert material is the anode. Unlike electroplating, in aluminum anodizing the treated part is the anode rather than the cathode.

Once electrical current is applied to the solution, oxidation occurs readily on the aluminum piece being treated. The formation of the oxide is controlled by the presence of sulfuric acid in the anodizing bath, which simultaneously etches the anodized surface. The combination of etching and oxidation creates a thick porous surface of aluminum oxide. Once the desired thickness of oxide accumulates, the anodized aluminum piece must be sealed. Sealing closes the porous aluminum oxide surface, inhibiting further oxidation by air or chemicals. Sealing is achieved by submerging the part in hot deionized water. The water and aluminum oxide interact to form a smooth, hydrated aluminum oxide surface.

Chemical analysis of the anodizing bath is crucial to the performance of the anodizing process. The primary components of the anodizing bath are sulfuric acid and dissolved aluminum. The ideal concentration for aluminum is 5 to15 g/L and 10 to 15% for sulfuric acid. If the aluminum content is too low, then the anodizing efficiency goes down due to higher energy consumption required. The sulfuric acid content needs to be within the ideal range to properly balance the oxide formation rate.

Both aluminum and sulfuric acid can be determined via titration with sodium hydroxide (NaOH). NaOH reacts with sulfuric acid to neutralize it. Once all of the sulfuric acid is neutralized, the addition of NaOH will begin reacting with aluminum, forming aluminum hydroxide ($Al[OH]_3$), an insoluble precipitate. This means that both sulfuric acid and aluminum react separately with NaOH to produce two distinct chemical endpoints.

Application

A customer contacted Hanna to automate their analysis on their aluminum anodizing bath. The customer found that manual titrations for aluminum and sulfuric acid were taking up a large portion of their analysts' time that could be better spent elsewhere. They also found that the two work shifts would produce significantly different results, which reduced the confidence in their data. Hanna recommended the **HI902C** Potentiometric Titrator. The customer appreciated that the automatic titrator would take the subjectivity out of their analyses.

The customer was pleased with the HI902's ability to perform multiple equivalence point titrations. Since the two reactions produce two distinct spikes in the pH at their equivalence points, the titrator could distinguish aluminum and sulfuric acid in one sample. The first equivalence point corresponded to the sulfuric acid concentration; the second corresponded to the aluminum content. The HI902 offers customizable calculations for each equivalence point, saving the customer from having to perform any manual calculations. Being able to determine both sulfuric acid and aluminum with one titration meant that the sample preparation and collection was greatly simplified, reducing the time per test.

In addition to the sulfuric acid and aluminum titrations, the customer appreciated how they could add a chloride titration as a linked method in the future. Maintaining low chloride content is important in an anodizing bath, as it can result in pitting and dull finishes on anodized parts. For this linked method, the customer would utilize the ability of the HI902 to support a second analog board, electrode, pump, and burette to perform a chloride titration sequentially after the first titration completed. By incorporating the linked method, the titrator could automate the determination of sulfuric acid, aluminum, and chloride in one sample. Overall, the customer found that the titrator was a complete, all-in-one solution to analyze their anodizing bath.