Fact Sheet

TN13-089
May 2013

Extending Sulfuric Acid Anodizing Bath Life

Background

It has often been theorized that by keeping an acid bath clean, the acid can be re-used continuously without dumping the bath. However, the bath would need to be spiked with fresh acid to maintain its effectiveness. Numerous facilities have tried to extend the life of their acid baths using filtration but have been unsuccessful. U.S. companies treated over 15 million pounds of spent acid off-site in 2004. They treated another 1.9 billion pounds on-site.[1] If it were possible to economically use acid over and over, companies would not need to treat thousand of tons of spent acid and would save millions of dollars in transportation and disposal costs, as well as help protect the environment.

A study by Ellis, Deluhery and Rajagopalan demonstrated that spent acid etch rates can be improved by using sodium silicate filtration, ultrafiltration or carbon filtration.[2] During the same research project, they also demonstrated that the etching properties of acids are very sensitive to organic/colloidal contamination and, to a lesser degree, dissolved metal concentration. If organic and colloidal contaminants could be minimized in acid baths, then it might be possible to realize continuous use of acid baths without dumping the contents.

A commercial acid bath extender, combined with filtration and regular spiking of the acid bath, is advertised to remove colloidal contaminants and dissolved metals.[3] When used at a 1% concentration (volume of extender to volume of spiked acid addition), the manufacturer states that the acid bath can be used indefinitely without partially decanting or fully dumping the bath.

Given this background, the University of Illinois Sustainable Technology Center (ISTC) worked with All-Brite Anodizing, a small job shop anodizer located in Northlake, IL to achieve two goals. The first was to test the effectiveness of the acid bath extender. The second was to determine if sulfuric acid used in the anodizing process could be cleansed sufficiently to continue using it without decanting portions to the wastewater pre-treatment system.

Testing at All-Brite Anodizing

All-Brite provides decorative and protective anodizing services and has a typical sulfuric acid anodizing process. Prior to testing the acid bath extender, the company would discharge part of its acid tanks to its wastewater pre-treatment system and add make-up acid to the tanks about very eight weeks. The tanks were dumped when the aluminum contamination level reached 2.0 oz/gal (15 gm/L). Based on the volume dumped, fresh acid was added to maintain acid strength.

From September 2005 to October 2006, All-Brite tracked acid strength and aluminum concentrations in its two anodizing tanks. The two anodizing tanks were the same size, on the same automatic anodizing line and were filled with fresh acid at the same time. The automatic anodizing line processes large runs of parts and therefore both tanks usually anodize the same types of parts at the same time. The layout of the anodizing tanks' filtration system is shown in Figure 1 below.

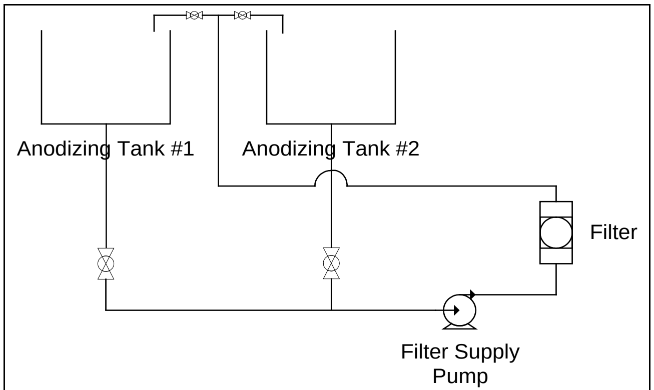


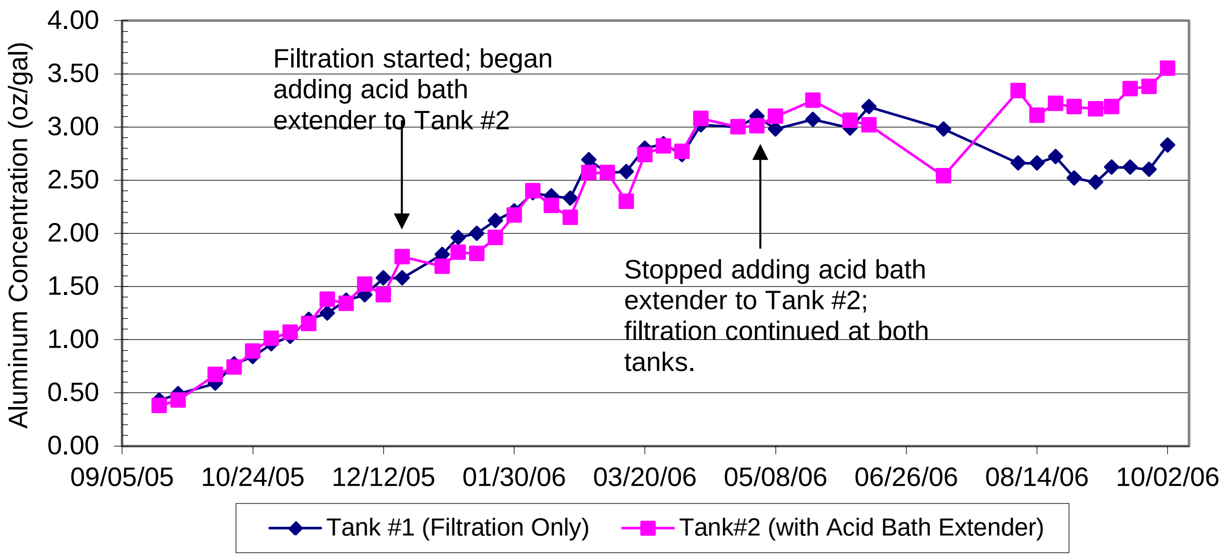
Figure 1 All-Brite Anodizing Filtration System

From September 2005 to December 2005, both anodizing tanks were operated with no filtration and no acid bath extender. The acid pump system was completed in December 2005. At that time, the company began filtering both anodizing tanks, but the acid bath extender was only added to Tank 2. This provided the perfect opportunity for a side-by-side comparison to determine the effectiveness of the acid bath extender. Twenty-micron cartridge filters were used to filter both tanks.

Test Results

With the introduction of filtration, the aluminum contamination levels in both tanks continued to rise along the same approximate slope as prior to filtration. Furthermore, the aluminum contamination level in the tank with the acid bath extender rose at approximately the same rate as the aluminum contamination

Figure 2: Acid recycling with and without chemical addition



level in the tank without the extender. The acid bath extender had no noticeable effect on the aluminum contamination level. Addition of the acid bath extender ceased in May 2006. The results of using the acid bath extender and filtration are shown in Figure 2 above.

Even when the aluminum contamination in both anodizing tanks reached 3.0 oz/gal (22.5 gm/L), the tanks still produced excellent quality parts. This was verified by salt spray tests and the absence of customer complaints. This test proved to All-Brite that its anodizing baths could tolerate aluminum contamination at levels 50% greater than those previously reported in the literature.[4] All-Brite has decided to continue using filtration on its anodizing baths but will no longer use the acid bath extender.

Economics

Prior to implementing acid recycling, All-Brite discharged portions of its two acid tanks to its wastewater pretreatment system on a regular basis and completely dumped the acid to the wastewater pretreatment system every six months. Each anodizing tank contains 150 gallons of sulfuric acid solution. Recharging each tank with acid costs $285. The dumped acid also needed to be neutralized with caustic in the wastewater pretreatment system. The amount of caustic necessary to neutralize the spent acid cost $300. The time involved in dumping the tank and making up a fresh solution of acid was about 12 man-hours, making labor costs about $200 per dump. The total cost for dumping and replenishing each acid tank was $785. Therefore the annual cost for dumping the spent sulfuric baths was $3,140.

Although no dumping was necessary over the course of one year, as a worst-case scenario, it may be necessary to dump half of each acid tank annually. Therefore the maximum cost to replace and neutralize the acid in the anodizing tanks would be $785 annually. The cost for new filter cartridges is $186 per year. The net savings due to recycling and filtering the acid in the anodizing baths is $2,169 annually. The acid pump cost was $600 and the filter housing cost was $1,000. In-house labor was not added to the project cost. Therefore the payback period was about nine months.

The acid bath extender was used at a 2% rate, twice the recommended dosage. At that rate, the extender cost $510. The data indicates that the extender is not necessary. However, even with the added cost of the extender, the acid recycling project paid for itself within one year.

Conclusions

1. Keeping the sulfuric acid anodizing baths clean at All-Brite Anodizing avoided dumping or partially decanting the baths for at least one year.
2. The acid bath extender tested by All-Brite did not remove significantly more aluminum contaminants from the sulfuric acid anodizing bath than filtering alone using a 20-micron cartridge filter.
3. A sulfuric acid anodizing bath can withstand aluminum contaminant concentrations of 3.0 oz/gal (22.5 gm/L) if other impurities are filtered out of the bath. This level is 50% greater than previously reported.
4. The acid filtration and recycling system costs about $1,000 and the system paid for itself in about nine months.

Acknowledgements

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Notes

1. U.S. Environmental Protection Agency. *2004 TRI Public Data Release E-Report*. Washington, DC: U.S. Environmental Protection Agency, 2006 (Available online at http://www.epa.gov/tri/NationalAnalysis/archive/2004_National_Analysis_Overview_Brochure.pdf).
2. Ellis, A., J. Deluhery and N. Rajagopalan (2005). "Effects of Organic and Metal Contamination of the Etch Rate of Acid Baths – Implications for Extended Acid Use," *Plating and Surface Finishing* 92(2), 42-47.
3. *PRO-pHx® Technical Information*. Wagner Environmental Technologies, Inc.: Cornelius, NC.
4. W. Brace & P.G. Sheasby (1968). *The Technology of Anodizing Aluminum*, Technicopy Limited: Stonehouse, Glos. England, p. 121.

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