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Clean, Economical Electropolishing

SHOP REDUCES WASTE, CUTS OPERATING COSTS

By Jim Destefani
Editor

Contrary to popular belief, reducing waste, improving operations and cutting costs can go hand in hand. Case in point: Allbright Stainless Steel Electropolishing Inc. Located in Clearwater, FL, the six-employee, 3,000 sq ft shop simultaneously reduced waste generation and cut operating costs by combining a proprietary chemical addition to its electropolishing tanks with standard filtration techniques.

Owned by the Colina family since 1998, Allbright is currently managed by Dustin Colina, son of original owner Arnie Colina. The company is tightly focused on providing high-quality electropolishing services. "We only do electropolishing," Dustin Colina says. "We have the largest tanks in west-central Florida. Every other electropolisher in Florida also does something else—plating, anodizing. We're the only shop in the state that does nothing but electropolishing."

Allbright's customers are involved primarily in military, aerospace, marine, medical/pharmaceutical, semi-conductor and food processing industries, and include such organizations as the U.S. Navy, Air Force and Marines; Ametek; General Dynamics; Oerlikon; Honeywell and South Coast Marine. Work is processed and certified to standards including ASTM A 967, ASTM A 380 and ASTM B 912.

PROCESS BASICS

Electropolishing is the controlled removal of substrate material in such a fashion as to impart a highly reflective surface to parts, diminishing scratches, burrs and unwanted sharp edges from most metals. The process is most frequently used on stainless steel components, especially alloys relatively high in both nickel and chromium content such as 300- and 400-series grades.

"Most stainless steel passivation is achieved using either nitric or citric acid," Dustin Colina explains. "Electropolishing exceeds both those in the passivation we can achieve.

"Passivation is a chemical process that etches impurities off the metal surface—it's really almost controlled corrosion," he continues. "In electropolishing, we use acids to etch the part but we also add electrolysis. We apply a current to the parts and mechanically etch off surface material at a very controlled rate. The result is a better form of passivation."

According to Dustin Colina, many of Allbright's aerospace customers are looking for the "super passivation" that electropolishing can provide.

"For aerospace, we process a lot of pieces that need to meet military standards of passivation and cleanliness," he says. "Some of our aerospace jobs include tubes, brackets, levers, pulleys—really any components that are fabricated from stainless.

"Processing time depends on the size of the parts and how we rack them," he explains. "If we're running pieces the size of your fingernail, we'll run a couple hundred at a time for two to three min. Larger parts—an example is an exhaust collector for a 50-ft hovercraft used by the Navy SEALS—might be processed for seven or eight min."

Depending on processing time, temperature, current and bath make-up, electropolishing can

Filter cartridges are removed from an electropolishing tank for cleaning or replacement. Operators wipe sludge from the polyspun filter cartridge to enable reuse four to six times.

produce finishes from satin to mirror bright. Surface appearance results also depend on the surface condition of parts before processing. The process typically removes about 0.0002 inch of material per surface, although other amounts can be specified. Electropolishing also creates a super-passivated surface that maximizing corrosion resistance of the finished parts.

Like many other processes—for example, anodizing, electroplating, galvanizing, stripping and metal pickling—electropolishers typically use acids until they become too contaminated. At that point tanks are drained and the spent acid is disposed of by paying a certified waste hauler to remove it for off-site treatment and disposal. The spent acid is manifested as hazardous by pH and/or due to metals content.

Some shops choose instead to use a standard in-house waste treatment consisting of pH adjustment, removal metals in solution, filtration, drying and bagging before manifesting and shipping the sludge by certified waste hauler. Either way, waste disposal and replenishment of the electropolishing tanks with fresh acid are costly and present environmental issues.

FIRST STEPS

In November 2002, Arnie Colina read about a possible way to minimize or even eliminate acid disposal in PRODUCTS FINISHING (see "Long Live Acid Baths!" here: *www.pfonline.com/articles/110205.html*). The story documented companies that extended acid bath life, eliminated acid disposal and eventually continuously reused their rinse water to develop a closed-loop process by using a proprietary reagent chemistry.

One of two, 900-gallon rinse tanks after more than 760 hr of production. Use of filtration and sodium hydroxide to normalize pH eliminates wastewater discharge.

Called PRO-pHx, the catalytic reagent chemistry was developed by Dr. John C. Wagner and first used commercially in 1999. Now supplied by Wagner Environmental Technologies (Cornelius, NC), it is a blend of soluble silicates that effectively immobilize soluble metals by reacting with them to form insoluble metal silicates. Silicon can form special polymers in which sodium oxide is associated with silicon dioxide, generally in ratios varying from 1:1 to 1:3.22. In dilute solution, these compounds depolymerize to form chains of silica and oxygen. Negative charges on some oxygen atoms react with positively charged metal ions to form stable, insoluble metal silicates. Ingredients in the catalytic reagent also react with volatile and non-volatile organic compounds to produce a non-volatile, non-toxic, non-hazardous waste. The chemistry is currently in use by hundreds of anodizing, electroplating, electropolishing, and other applications.

Early in 2004, Allbright began using the chemistry in its two 900-gallon electropolishing tanks. Makeup in these tanks is a proprietary blend of sulfuric and phosphoric acids. Each tank was filtered using an in-tank, dual-cartridge system with a slide-in quick change feature for the filer elements.

"One tank was on its last legs and one tank was completely unusable for electropolishing," Arnie Colina recalls about tank conditions before the company began using the new chemistry. The problem was the large amounts of metals and organic compounds dissolved into the acid solutions, which made consistent electropolishing very difficult.

Within four hr after addition of the PRO-pHx chemistry, both tanks had improved performance. Organics were removed, and metals concentrations were significantly reduced. Within 48 hr, both tanks were running within all normal operating parameters.

ACID REUSE

In September 2005, Allbright took the next step. If the chemistry could rejuvenate a working bath, the Colinas reasoned, it should rejuvenate a spent bath being stored for off-site disposal. They began removing the previously decanted contaminated acids from storage and adding them back into the electropolishing production tanks. Chemistry was monitored as usual, with titrations performed daily and specific gravity maintained at 1.72 to 1.75.

When the electropolishing tanks required acid additions, workers used a combination of 50% contaminated decant and 50% new product. Catalytic reagent was added in an amount equal to 1% by volume of the required acid additions.

This approach essentially eliminated manifesting and shipping of spent materials as hazardous waste and significantly reduced new acid solution purchases. From 2003 to the present, Allbright has reduced its outlays for virgin acid by more than 95%, even though cost per gallon for the proprietary acid blend has increased each year and throughput has also increased. The reduction is documented in Table I.

Substantial cost savings also resulted from elimination of shipping of hazardous waste off-site. In previous years, Allbright generated more than 38, 55-gallon drums of hazardous waste annually—more than 27,700 lb per year. Cost for waste hauling was more than $7,000 annually. The company has shipped no electropolishing solution off-site since September 2005, and has generated (from the electropolishing tanks) a total of 832 lb of hazardous waste. Waste disposal cost since September 2005 totals $798. Waste consists of 16, 20-inch long poly-spun cartridge filter elements per month.

Table I. Allbright's Purchases of Virgin Acid

Year	Cost of Virgin A
2003	$23, 040
2004	$11, 600
2005	$ 6, 755
2006	0 (virgin material was left over from 2005)
2007	$1,500

ACHIEVING ZERO DISCHARGE

As a result of Allbright's success with the acid purification chemistry, Dustin Colina decided to move toward zero-discharge operation. The company submitted a Pollution Prevention Plan to the Florida Department of Environmental Protection (DEP). The plan was approved in March 2006, and implementation was completed in September.

To accomplish zero discharge, Allbright is using sodium hydroxide to maintain pH in its normally acidic rinses between 6.5 and 8.5. The same reagent chemistry used in the acids is also maintained at 1% in the rinse waters and filtered through standard 20-inch long, 20-µm polyspun cartridge filters.

The chemistry and filtration remove organics such as greases, oils and chelating agents, and keep metal concentrations low in the rinses. In addition, salts are picked up in the filter paste at a rate that keeps their concentration low enough for effective rinsing. Filter cartridges are scraped when they become caked with about 1/2 inch of sludge. Cartridges are reused four to six times before disposal.

Implementing closed-loop processing of rinse waters has allowed Allbright to turn off its atmospheric evaporator. Shutting off the equipment saves over $500 per month on electricity alone.

Allbright is one of hundreds of shops that have used PRO-pHx proprietary catalytic reagent technology to reduce operating costs and waste generation. Very few, however, have gone the distance to eliminate rinse water disposal and use their old waste acids as product. By following the benefits of the technology to their logical conclusion, the company cut operating costs, reduced waste and eliminated wastewater discharge. As a result, the Florida DEP will reclassify Allbright this year from a Large-Quantity Generator to a Small-Quantity Generator.

The company is also looking at testing the filter sludge with an eye toward having the waste declared non-hazardous. "Sodium hydroxide controls the pH, and the amounts of metals and other substances in there are so minute, we think there's a good chance it could be classified as non-toxic," Dustin Colina says. "At that point, we'll only be disposing of the filter elements, when we throw them out, and rags used for cleaning and minor spills in the shop. Right now we're disposing of two drums a month; we'd like to cut that to one." PF

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