# P2: Pollution Prevention

## Metal Finishing Shops Shine with P2

November 2021

Metal finishers conduct a variety of operations, such as chemical conversion coating, anodizing, electroplating, electro-less plating, chemical milling and printed circuit board manufacturing. They also routinely perform several related subprocesses, including surface preparation, machining and equipment cleaning. The metal-ion-bearing solutions used in the metal finishing sector often contain chromium, zinc, nickel and other metals. Solvents and cleaners applied to metal parts and solutions used in plating tanks generate significant amounts of waste and contain hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) that can be emitted into the air, released in wastewater or disposed of in solid form. Other process wastes include metal-bearing filter press sludge.

Although releases of these pollutants can be costly and trigger regulatory requirements, they can be addressed successfully through sound pollution prevention (P2) and manufacturing best practices, such as those provided by EPA's grant-funded P2 practitioners.

## P2 Strategies to Reduce Costs and Environmental Footprint

Below are just a few of the many strategies that metal finishers can consider to reduce costs and their environmental footprint.

### *Optimize Rinse Tanks*

Rinse tanks usually provide P2 opportunities for increased efficiency. Rinsing improves the quality of the surface finishing process and prevents contamination of subsequent process baths, but it can be water-inefficient, especially in a system that uses single overflow rinse tanks following each process tank.

Rinse tank design and rinsing configuration greatly influence water usage. Optimal rinse tank design aims to quickly remove dragout solution (the chemical remaining on a part as it is removed from a process tank) and disperse it throughout the rinse tank. The following techniques can optimize your rinse tanks:

- Counter-current cascade rinsing consists of a series of rinse tanks that are plumbed such that water flows from one tank to another in the direction opposite of the workflow. Water is introduced into the last tank of the series, making it the cleanest, and is discharged from the first tank, which has the highest concentration of process chemicals.
- Dragout rinsing is done in a static rinse tank, initially filled with fresh water, positioned immediately after the process tank. Work pieces are rinsed in dragout tanks after exiting the process bath. The dragout tank reclaims process chemicals and minimizes contamination of subsequent process and rinse tanks. Electrolytic recovery is commonly used to remove dissolved metals from dragout tanks.
- Adding air agitation helps mix rinse water, reduce short circuiting, and mechanically remove dragout to improve rinsing efficiency. Air agitation is added into the tank by one or more aerator pipes on the bottom of the tank. The air is supplied by a blower, as air compressors can contaminate the solution with oil. A recent P2 grant-funded project measured the benefits of air agitation, showing an increase in rinsing efficiency of more than 25 percent.

The EPA P2 Program chose the metal manufacturing and fabrication industry—which includes the metal finishing and electroplating sectors—as a National Emphasis Area (NEA) because of its potential to benefit the economy and achieve measurable environmental results. EPA is providing P2 grants to provide technical assistance to businesses within the NEAs to help them develop and adopt source reduction practices.

**For more information on EPA's P2 Grants Program, visit www.epa.gov/p2**

### *Reduce Water Use*

Facilities can reduce water use by closely monitoring rinse water requirements and using the minimum amount of water necessary to keep quality consistent. Monitor your water use to help identify the necessary steps to minimize usage and reduce associated costs. Techniques to reduce rinse water use include the following:

- Flow restrictors prevent the flow in a water-supply pipe from exceeding a predetermined flow rate. These restrictors are commonly installed on a rinse tank's water inlet. As a standalone device, a flow restrictor provides a constant water flow and is therefore best suited for continuous rinsing.
- A rinse timer is an electronic device that controls a solenoid valve, activated either manually by the operator or automatically by the action of racks or hoists. Automatic rinse timers are better for intermittent rinses because they eliminate operator error.
- Spray rinsing uses considerably less water than immersion rinsing. During spray rinsing, the part is held over a catch tank and sprayed with water. Water drips from the part into the catch tank and is then either recycled to the next stage or discharged to treatment. Spray rinsing can enhance draining over a process bath by diluting and lowering the viscosity of the process fluid film clinging to the product.
- Fog nozzles are effective for rack operations, especially heated process tanks. Benefits include reduced rinsing load, dragout, and staining. A fine-density water fog is applied as the rack slowly exits above the process tank. The solution washes directly back into the same process tank.

The National Center for Manufacturing Sciences (NCMS), a P2 grantee, researched and tested a set of exponential decay curves that show the relationship between dragout rates and time curves for a typical plating solution. The grant project produced a formula that matches the shapes of the expected curves and provides the basis for estimating dragout time and drip volumes. NCMS also developed a data-driven drip calculator tool that uses the curves and formulas to estimate potential reductions in dragout volume from increased drip time. NCMS's Drip Calculator and Rinsing Manual are publicly available on the Surface Technology Environmental Resource Center website.

### *Reduce Dragout*

Process lines can be modified to reduce dragout of bath chemicals. For example, air knives and drip tanks reduce the pollutant loading and volume of rinse water requiring treatment, meaning you use less process bath chemical, generate less wastewater, and therefore pay lower costs. The following equipment and techniques can reduce dragout:

- Air knives are high-pressure air blowers installed over a process tank or drip shield that remove dragout by blowing liquid off the surfaces of work pieces and racks into a catch tank. Liquid from the catch tank is pumped back to the process tank. Air knives are most effective with flat parts and cannot be used to dry surfaces that stain due to oxidation.
- Drainboards or drip shields installed between process and rinse tanks can catch the drips from parts as they are transferred between tanks.
- Long dragout (or drip) times can be automatically programmed for optimal periods. Long dwell times over the process tank reduce the volume of dragout reaching the rinsing system. Increases in drip time might be unsuitable for surfaces that can be oxidized or stained by exposure to air.
- Optimizing process bath temperatures can reduce dragout by maximizing process bath viscosity in relation to energy consumption.
- Determining the proper concentration of chemicals in process baths reduces the mass of chemicals in dragout. Also, viscosity and concentration are directly related: a lower process bath concentration will result in lower process bath viscosity and less dragout volume.
- Wetting agents or surfactant additions to process baths can reduce viscosity and surface tension, thereby significantly reducing dragout.

### *Extend Useful Life of Process Baths*

Process baths become contaminated with impurities that affect their performance. Listed below are techniques to keep baths in good operating condition, extend the useful life of the process solutions, reduce contamination and chemical loss, and reduce the cost of the inputs and cleaning and disposal costs.

- In metal finishing shops, conductivity helps indicate the cleanliness of water. Measuring conductivity can quickly generate very useful data; the instruments involved are relatively inexpensive and easy to use. Regularly collecting and reviewing rinse tank conductivity measurements will help determine if rinse water is being efficiently used. The data will also be useful in evaluating options for improving rinsing practices.
- Activated carbon adsorption removes organic contaminants from electroplating baths by directing process solution flows through a filter where the carbon adsorbs organic impurities. Carbon treatment is commonly applied to nickel, copper, zinc, and cadmium electroplating baths but also can be used to remove organic contaminants from paint curtains.
- Carbonate "freezing" removes excessive carbonate buildup by forming carbonate salt crystals at a low temperature that are then removed. Electroplating baths formulated with sodium cyanide most commonly use this operation.

## P2 Resources for the Metal Finishing Sector

- NCMS' "Rinsing Manual" (and drip calculator): A guidance manual to help metal finishing facilities improve their rinsing processes to ensure high-quality production, save water, and minimize sludge generation, leading to reduced pollution and lower operating costs.
- Surface Technology Resource Center: Provides useful environmental compliance information to the surface finishing and surface treatment industry.
- EPA's "P2 Webinar—Pollution Prevention Opportunities in the Metal Finishing Sector"
- New York State Pollution Prevention Institute (NYSP2I) case study: Rinse Water Assessment for Reduction and Reuse
- NYSP2I case study: Acid Control and Recovery Assessment for Control Electropolishing
- NYSP2I case study: Water and Chemical Use Assessment of Plating Operations
- Institute of Advanced Manufacturing Sciences' "Pollution Prevention Resource Manual for Metal Finishers"
- New Jersey Small Business Assistance Program's "Metal Finishers Pollution Prevention Checklist": Provides an overview of P2 and safety techniques that can be applied to metal finishing operations.
- Metal Manufacturing and Fabrication: P2 National Emphasis Area (FY 22-23), P2 TRI Fact Sheet Provides environmental and P2 information for the metal manufacturing and fabrication sector ((NAICS 331 and 332).