Colorado Department of Public Health & Environment

POLLUTION PREVENTION IDEAS FOR ELECTROPLATING

NOVEMBER 2001

The environmental aspects of decorative and functional electroplating are regulated by numerous federal and state regulations that address air emissions, hazardous waste management, and wastewater discharges. The Colorado Department of Public Health and Environment (CDPHE) prepared this bulletin to convey information about source reduction practices for businesses that perform electroplating. Source reduction, or pollution prevention (P2), practices complement emission control measures and waste management procedures required by regulations. CDPHE defines P2 as the reduction or elimination of pollutants or wastes at the source, by using less hazardous raw materials or using more efficient practices or processes. It includes reducing the use of energy, water, and other resources through increased efficiency or through conservation. For more information about regulations that apply to electroplating, contact Ed Smith at (303) 692-3386 or visit www.cdphe.state.co.us/hm/hmhom.asp.

HOTLINE!
Through June 2002, CDPHE is offering focused P2 research and implementation support through a P2 Hotline (303-312-8880). Take advantage of this free and confidential opportunity to obtain assistance investigating process improvements that are on your "wish list" or address waste streams that are expensive to manage or cause compliance problems. Call now!

The objective of this bulletin is to stimulate small quantity generators of hazardous waste to consider implementing various P2 strategies. This document describes commonly applicable P2 opportunities and provides references for further information and, where appropriate, vendor information. However, the P2 opportunities for electroplating are as numerous and diverse as the purpose and configuration of electroplating processes. Therefore, limited topics are discussed here. For more detailed information about these and other P2 opportunities than is provided in this bulletin, please consult the information sources included at the end of the document.

After June 2002, contact the CDPHE P2 Program: Kirk Mills at (303) 692-2977 or Margo Griffin at (303) 692-2979. The CDPHE P2 Program (www.coloradoP2.org) provides confidential, non-enforcement, P2 assessments for Colorado businesses and follows up with a report that summarizes P2 opportunities.

Remember, P2 pays – on the "front end" through improved raw material utilization and on the "back end" by decreasing waste management and compliance costs.

P2 + WASTE MANAGEMENT HIERARCHY FOR ELECTROPLATING

- Investigate and adopt alternative, less-toxic chemicals
- Extend bath life (minimize dumps and decants)
- Reduce dragout
- Recover dragout
- Reduce rinse water
- Reuse spent baths
- Reuse rinse water
- Recycle process baths and rinse water
- Segregate waste streams
- Improve wastewater treatment efficiency

Higher Priority

These strategies are listed in order of decreasing priority with respect to P2.

Lower Priority

TAKE ADVANTAGE OF OVER 10 YEARS OF ELECTROPLATING SOURCE REDUCTION (P2) AND WASTE MINIMIZATION RESEARCH!

Since the late 1980s, EPA, state environmental agencies, and local sanitation districts have sponsored an array of P2 technical assistance initiatives for the metal finishing industry. In fact, few other industry sectors have received such sustained and intensive P2 outreach. These initiatives have produced numerous P2 guidance documents, technology evaluations, training workshops, videos, checklists, case studies, and so on. In addition, some recent projects have developed ISO 14001-like environmental management system (EMS) templates for metal finishers. Most of these resources are available on the Internet. Two excellent web sites with many of these resources and links to others are: www.nmfrc.org and www.strategicgoals.org.

MINIMIZE CONTAMINANT DRAGIN AND PLATING BATH DRAGOUT

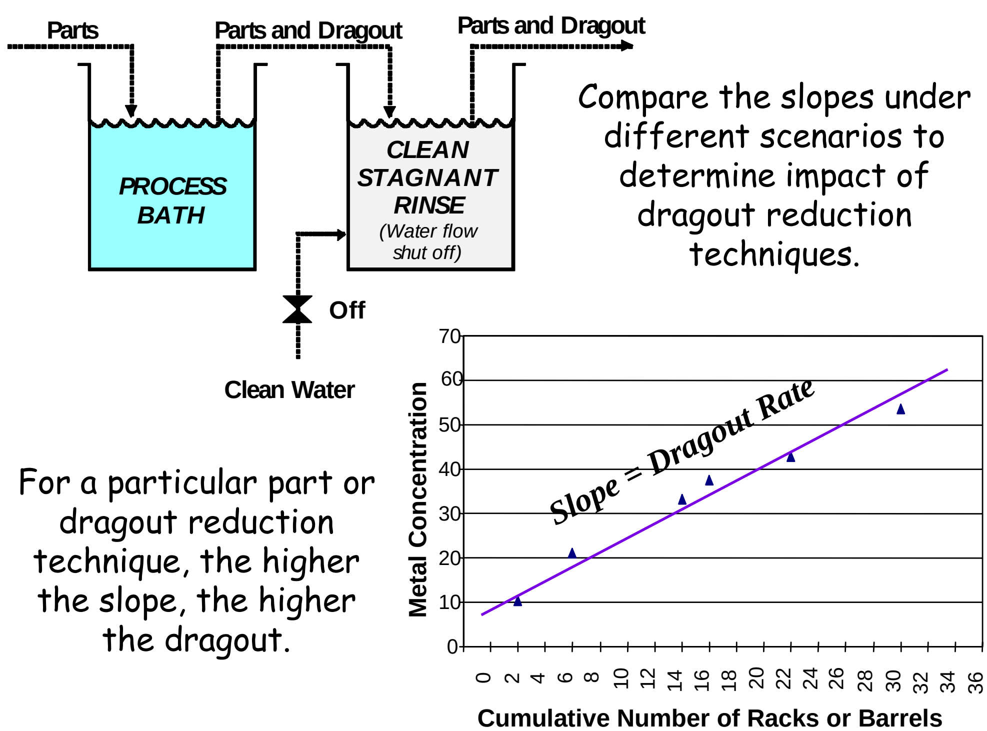
Dragin from preceding process baths introduces inorganic and organic contaminants to plating baths that can accumulate and cause quality problems if not controlled or treated. Contaminant buildup is typically resolved through solution decants or bath treatment by selective technologies, which are costly and often generate hazardous waste streams. Furthermore, rejected parts must be stripped and re-plated, which more than doubles the amount of chemicals used and waste generated compared to a part satisfactorily plated the first time.

Similarly, dragout from process baths represents lost chemicals that are often regulated in wastewater or, after treatment, in hazardous waste sludge or saturated ion exchange resins. Thus, excessive dragout increases operating costs through material purchase and waste management.

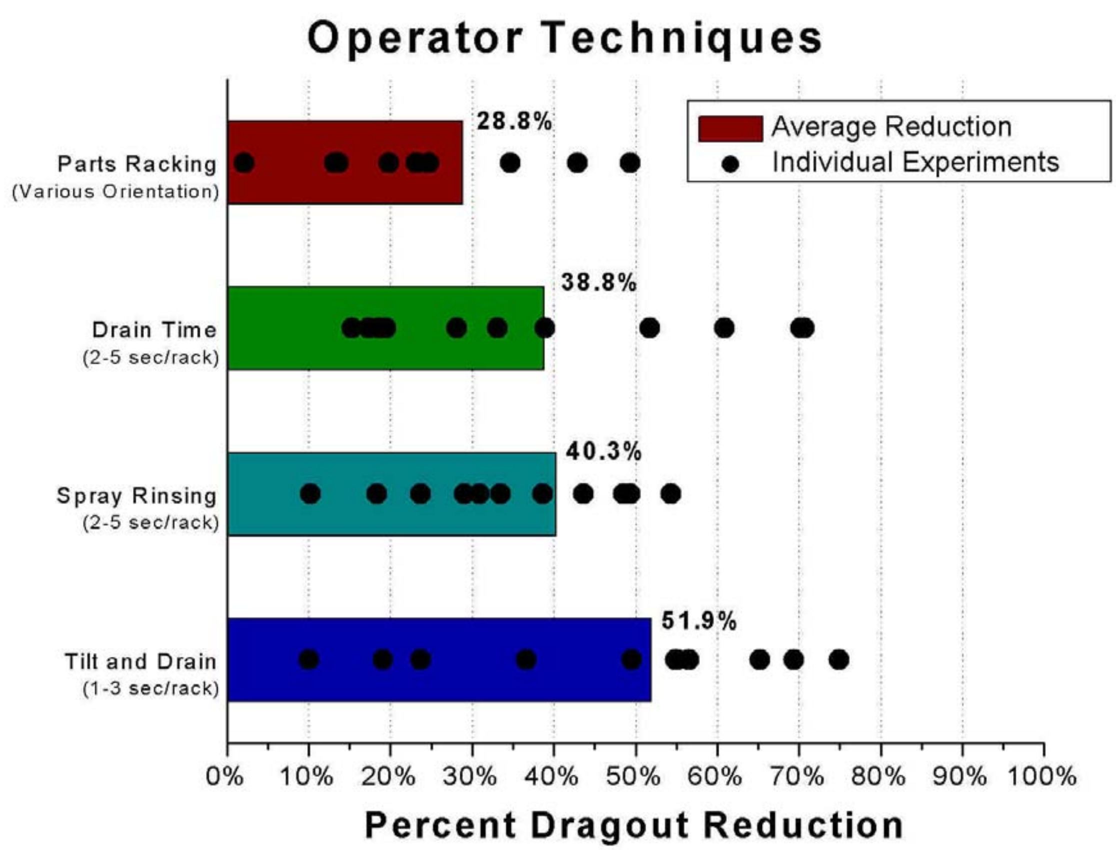
Although all platers realize excessive dragout is conceptually undesirable, few facilities (1) aggressively implement and "enforce" well-known dragout reduction techniques and (2) measure dragout to quantify and optimize dragout reduction techniques. A procedure for measuring dragout and dragout reductions possible from conventional best practices are presented below.

Measuring and Reducing Dragout – It's Easier Than You Think!

Dragout is the amount of process chemicals carried out of the bath with each rack or barrel. Dragout is easy to measure with a conductivity meter and a clean, stagnant (non-flowing) rinse tank. At low metal concentrations, such as those found in relatively clean rinse water, the relationship between metal concentration and conductivity is linear. Therefore, conductivity can be used to measure the rate at which metal concentration increases in a clean stagnant rinse, which is proportional to the dragout rate. In other words, the higher the rate at which conductivity increases (the slope in the graph below), the higher the dragout.



Conductivity can be measured in "real time" with a simple handheld meter[1]. Using this dragout measurement method, the impact of dragout reduction techniques can be compared to current operating practices in about 30 minutes. For example, the dragout rate for a particular part can be measured with 1 second of hang time and 3 seconds of hang time to evaluate and justify the additional 2 seconds of hang time. This dragout measurement method has been used in numerous training events sponsored by the EPA Metal Finishing Strategic Goals Program[2] and the results, shown below, speak for themselves – traditional dragout reduction practices such as fine-tuning part orientation, an extra second or two of hang time, spray rinsing, and tilting parts **make a difference** in dragout and subsequent waste generation.[3]



[1] Handheld conductivity meters range in price from $200 to $600. Vendors include Great Lakes Instruments (www.gliint.com) and Foxboro Instruments (www.foxboro.com/index.htm).

[2] The EPA Metal Finishing Strategic Goals Program is a national collaboration between EPA, states, publicly owned treatment works (POTWs), and metal finishers to improve metal finishing environmental performance. For more information about the Strategic Goals Program, visit www.strategicgoals.org

[3] Dragout reduction data shown in chart are from similar tests performed with a wide variety of parts and plating processes. Percent dragout reduction is from a "baseline" of typical parts handling.

USE AND OPTIMIZE SPRAY RINSING

Most platers are somewhat familiar with spray rinsing. Hard chrome plating operations, in particular, commonly feature spray rinsing over the plating tank to rinse dragout off parts directly back into the plating tank. Nevertheless, many spray rinses are "rigged" using inefficient garden spray devices and the potential for sprays to reduce dragout and conserve water is not fully realized.

Spray rinsing systems should be designed with a net water flow equal to the evaporation from the plating tank. For this reason, nozzles are a key component of spray rinses and are available with a wide range of flow rates and several spray patterns. Using nozzles with specified flow rates is particularly important in decorative plating processes, which have greater throughput and, consequently, less rinse water available for each rack of parts compared to hard chrome plating. **A well-designed spray system can reduce dragout by 40 to 60 percent** (see figure on previous page) and be installed for less than $2,000 in most cases. Spray system design and installation tips are provided below:

- Quantify daily evaporative losses, in gallons, from each plating tank and divide by the typical number of plating cycles per day to determine the volume of water available for spraying per plating cycle.

Hoist Mounted Spray System

- For automated tank-mounted spray systems, select spray patterns that provide good coverage but do not waste water by spraying outside the tank or the air space around or between racks. Nozzles are available with cone, flat fan, and mist/fog spray patterns at flow rates between 0.04 and 10 gallons per minute.
- Automated tank-mounted systems are usually on for only a few seconds per cycle; therefore, ensure the spray patterns develop immediately and nozzles do not drain into the plating tank by installing pressure-sensitive valves behind the nozzle to keep the spray manifold pressurized.
- Quick-connect nozzles should be used to facilitate troubleshooting and nozzle replacement. For instance, if the evaporation rate was overestimated and the net spray flow is too high, quick-connect nozzles can be replaced in minutes to lower the net flow.

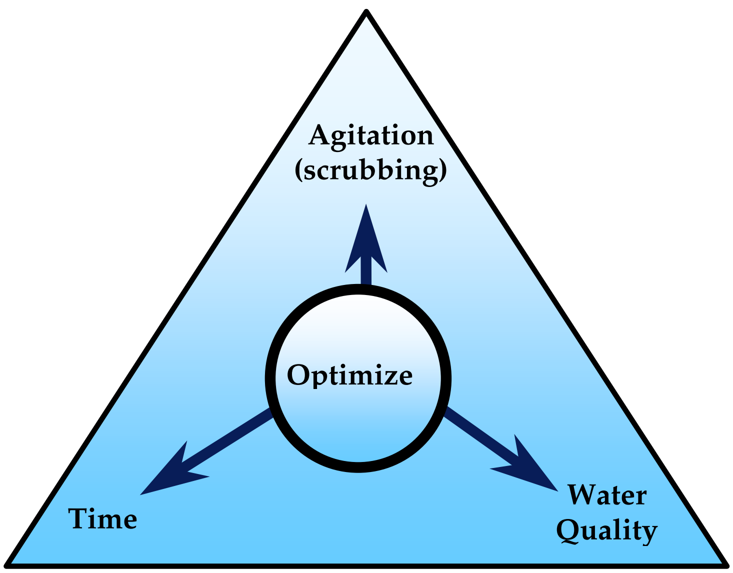
- For handheld spray rinsing, use a spray gun with a quick-connect nozzle and flow pattern that provides the best coverage for the types of parts plated. A spray gun and several quick-connect nozzles cost about $75.

Handheld Spray Rinse

Spray rinsing hardware (nozzles, guns, and valves) can be obtained from many vendors and distributors. One national source is Spraying System [(800) 95-SPRAY or www.spray.com].

OPTIMIZE IMMERSION RINSING

Most plating processes involve immersion rinses after plating. Effective immersion rinsing is important for overall plating quality; however, high (>2 gpm) rinse water flow rates through the bath are seldom needed to ensure good rinsing. Immersion rinsing with low flow rates can be optimized by understanding the "rinsing triangle" shown and discussed below.

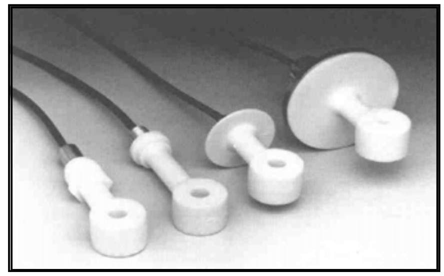


Rinsing is achieved through two physical mechanisms: scrubbing and diffusion. Scrubbing action is required to actively remove dragout film from parts immersed in the rinse water. Scrubbing represents mechanical energy applied to the rinsing process through air agitation, water flow, or simple "elbow grease" in the case of manual "double dipping". In any case, the more scrubbing action, the better.

The second and subtler rinsing mechanism is diffusion. Maximizing diffusion, which requires time and clean water, is particularly important for parts with complex geometries and "nooks and crannies" that are not exposed to turbulent flow associated with scrubbing. The distinction between the two rinsing mechanisms is important – for complex parts, immersion time is often as important as flow rate to achieve good rinsing! **Bottom line: lower flow rates and increase agitation and immersion time to optimize immersion rinsing efficiency.**

Several relatively low-cost (less than $500) devices can be applied to electroplating rinse systems to reduce and optimize water use. Three particularly effective examples include:

- Electrodeless conductivity control systems
- In-line flow restrictors
- Manual- and hoist-activated timers that link rinse water flow to rinse system use



Electrodeless Conductivity Meters

QUANTIFY AND TRACK PROCESS AND ENVIRONMENTAL BENCHMARKS

A benchmark is a metric or indicator that reflects a high level or "best in class" performance. Benchmarks and process metrics are important elements of quality and environmental management systems and are used extensively by facilities striving for continual improvement. Metal finishing benchmarks for water use, sludge generation, and energy use are available and should be used to gauge a facility's overall environmental performance relative to other electroplating facilities. Average values for the benchmarks for most common electroplating processes are provided in the *Benchmarking Metal Finishing* report[4]. This report also summarizes overall environmental operating costs for three groups or tiers of facilities; these data are shown below. Facilities in the top performance tier generally had more formal and aggressive management characteristics related to P2 and environmental management systems.

How Does Your Facility Compare?		
Performance Tier	**Average Environmental Costs**	
	$/$1,000 sales	**% of total sales**
Top Tier	$83.51	7.0%
Middle Tier	$96.32	10.1%
Bottom Tier	$133.63	12.7%

The importance of routine data collection and charting for process metrics that reflect the facility's overall efficiency and environmental performance cannot be overstated. Facilities that adopt tracking systems to chart trends in performance metrics are more competitive and generally have lower operating costs.

[4] Source: Benchmarking Metal Finishing, National Center for Manufacturing Sciences, June 2000. Copies are available through the National Metal Finishing Resource Center website at www.nmfrc.org. Data are based on 132 facilities.

P2 SCORECARD FOR ELECTROPLATING FACILITIES

This checklist addresses common P2 opportunities at metal finishing facilities, but is not exhaustive. The main purpose of the checklist is to assess the extent to which these opportunities have been implemented at a facility (the more "yes" answers, the more P2). The completed checklist can be used to stimulate discussion and inquiry by facility personnel and, if desired, as a starting point for a more detailed, non-enforcement, and confidential P2 assessment by the CDPHE P2 Program, a group that specializes in P2 technical assistance. For more information, contact Kirk Mills at (303) 692-2977 or Margo Griffin at (303) 692-2979.

QUESTION	YES	NO	NA	UNKNOWN
Management				
Does the company have an environmental policy?	☐	☐	☐	☐
Does the facility routinely track and chart: • Reject/rework • Water use • Process chemical use • Wastewater treatment chemical use • Electricity and gas use Are any of the data normalized by production metrics?	 ☐ ☐ ☐ ☐ ☐ ☐	 ☐ ☐ ☐ ☐ ☐ ☐	 ☐ ☐ ☐ ☐ ☐ ☐	 ☐ ☐ ☐ ☐ ☐ ☐
What less hazardous/toxic chemical alternatives have been adopted in the last 5 years? • Water-based degreasing • Trivalent chrome plating • Others (list):	 ☐ ☐ ☐	 ☐ ☐ ☐	 ☐ ☐ ☐	 ☐ ☐ ☐
Bath Maintenance				
Is there a rack maintenance program to prevent metal buildup on racks?	☐	☐	☐	☐
Are tools for removing parts dropped into process baths readily available and are they used regularly, as needed?	☐	☐	☐	☐
Is deionized (DI) or reverse osmosis (RO) water used for process bath makeup?	☐	☐	☐	☐
Are process baths analyzed in an on-site laboratory?	☐	☐	☐	☐
Are chemical additions made by dedicated, trained staff?	☐	☐	☐	☐
Are chemical additions recorded and charted using statistical process control (SPC) methods?	☐	☐	☐	☐
Dragout				
Are dragout rates ever measured from a plating bath?	☐	☐	☐	☐
Do supervisors/upper management review how parts are positioned on racks to minimize dragout?	☐	☐	☐	☐
Are drip boards in place to cover gaps between process tanks?	☐	☐	☐	☐
Are workers periodically reminded through formal training about best practices for dragout reduction?	☐	☐	☐	☐
After parts are withdrawn from a process tank, do workers use reasonable (2 to 5 seconds) hang time?	☐	☐	☐	☐
Rinsing	☐	☐	☐	☐
Are automated spray systems used to rinse parts over heated process baths? How many:	☐	☐	☐	☐
Are hand-held spray guns used to rinse parts over heated process baths? How many:	☐	☐	☐	☐
Are spray systems used after process baths for rinsing in a manner that facilitated rinse water reuse? How many:	☐	☐	☐	☐
Are rinses systems operated properly (good mixing, flow control, no short circuiting, reasonable freeboard)?	☐	☐	☐	☐
Are flow restrictors used on rinse tanks? How many:	☐	☐	☐	☐
Are conductivity control systems used to regulate rinse water flow? How many:	☐	☐	☐	☐
Are timers used to turn rinse water flow off?	☐	☐	☐	☐
What percentage of plating tanks is followed by a static dragout tank?				
What percentage of rinse tanks is counterflow?				
Recycling/Recovery				
Are ion exchange systems used to and/or — Yes ☐ recover dragout and/or water for reuse Yes ☐ remove contaminants from plating baths? Describe:				
Are any technologies used to "close loop" rinse water use?	☐	☐	☐	☐
Column Totals				

Score Your Facility	>30 Yes → Top Performers, Ahead of the Pack 20 to 30 Yes → Rising Stars with Room to Improve 10 to 20 Yes → Hanging in There, Time to Get Serious about P2! <10 Yes → Inefficient, Ultimately Noncompetitive Shop