HBI-94-006-02, Pub. 10/31/94

Pollution Prevention Assessment for an Electroplating Facility
CASE STUDY

What is EP3?

The amount of pollutants and waste generated by industrial facilities has become an increasingly costly problem for manufacturers and a significant stress on the environment. Companies, therefore, are looking for ways to reduce pollution at the source as a way of avoiding costly treatment and reducing environmental liability and compliance costs.

The United States Agency for International Development (USAID) is sponsoring the Environmental Pollution Prevention Project (EP3) to establish sustainable programs in developing countries, transfer urban and industrial pollution prevention expertise and information, and support efforts to improve environmental quality. These objectives are achieved through technical assistance to industry and urban institutions, development and delivery of training and outreach programs, and operation of an information clearinghouse.

EP3's Assessment Process

EP3 pollution prevention diagnostic assessments consist of three phases: *pre-assessment*, *assessment*, and *post-assessment*. During *pre-assessment*, EP3 in-country representatives determine a facility's suitability for a pollution prevention assessment, sign memoranda of agreement with each facility selected, and collect preliminary data. During *assessment*, a team comprised of U.S. and in-country experts in both pollution prevention and the facility's industrial processes gathers more detailed information on the sources of pollution, and identifies and analyzes opportunities for reducing this pollution. Finally, the team prepares a report for the facility's management detailing its findings and recommendations (including cost savings, implementation costs, and payback times). During *post-assessment*, the EP3 in-country representative works with the facility to implement the actions recommended in the report.

Summary

This assessment evaluated an electroplating facility. The objective of the assessment was to propose a program of pollution prevention that would: (1) reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, thereby reducing pollution and worker exposure, (2) demonstrate the environmental and economic value of pollution prevention methods to the electroplating industry, and improve operating efficiency and product quality.

The assessment was performed by an EP3 team comprised of an expert in electroplating and a pollution prevention specialist.

Overall, the assessment identified 18 pollution prevention opportunities at this facility. Recommendations for pollution prevention include replacing the solvent degreaser with an alkaline cleaner, improving process solution monitoring, and capturing and returning 100 percent of chromium dragout to the process solution.

Facility Background

This facility is an electroplater that performs zinc, nickel, brass, and chrome plating. Seventy percent of production is comprised of brass articles. The facility operates with 23 workers who work in a single 8-hour shift, 300 days a year. Approximately 15 m^2 of metal surface is finished per day.

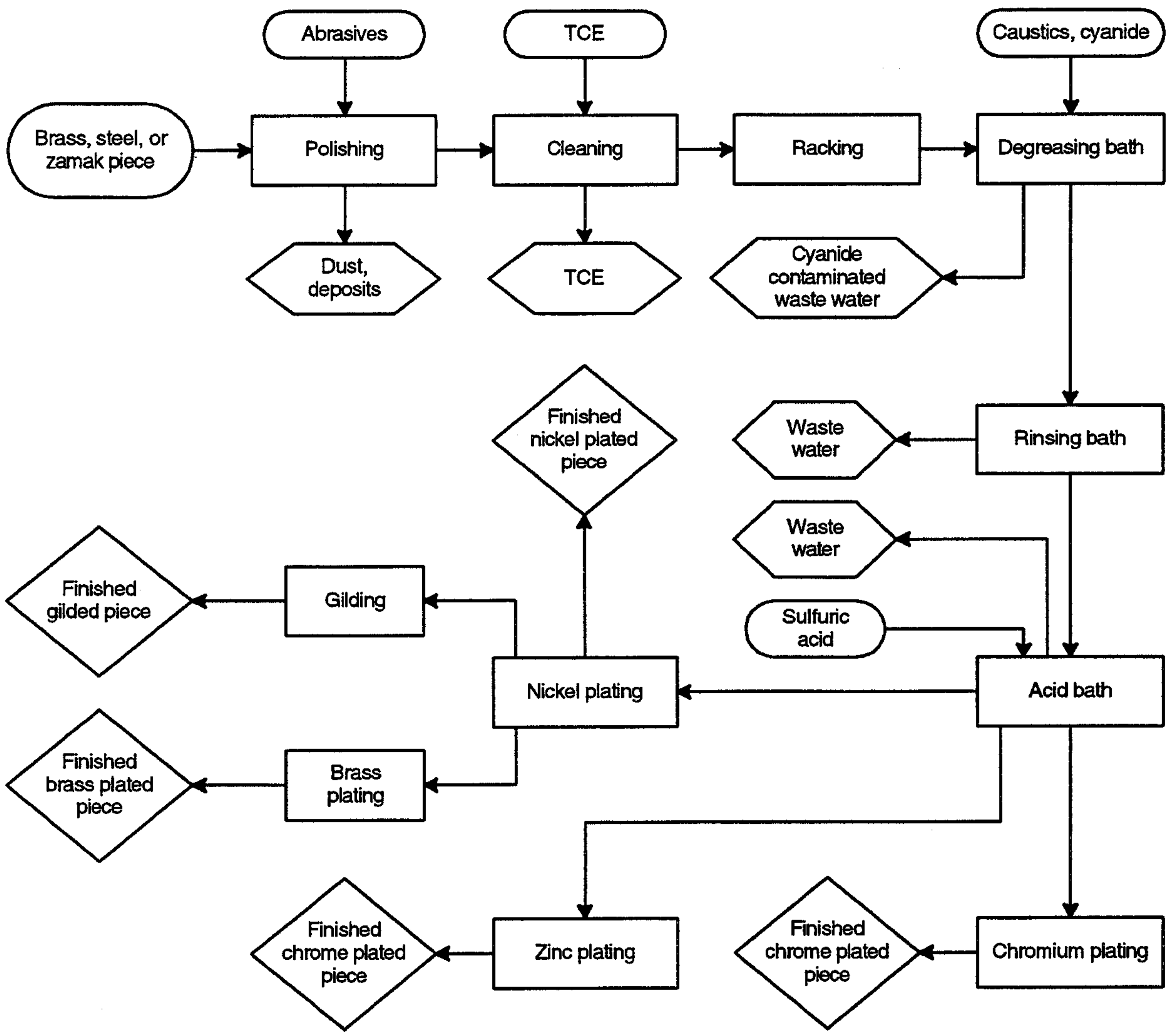
Manufacturing Process

Facility operations can be divided into five main steps: (1) polishing, (2) cleaning, (3) racking, (4) electroplating, and (5) gilding as shown in **Figure 1**.

Parts are first polished. Polishing paste is applied to stationary belt sanders to provide the necessary abrasion. The parts are then polished with the sanders. Dust generated by the polishing process is collected by vacuums connected to each machine.

EP3 is sponsored by the U.S. Agency for International Development.

Figure 1: Overview of Facility's Electroplating Process



Prior to electroplating, many parts are cleaned in a vapor degreaser that uses trichloroethylene (TCE) to remove grease and other impurities. Parts removed from the degreaser are dried with paper towels.

The facility electroplates many different kinds of parts. Several parts are hung on special racks that are constructed specifically to handle the part. Other pieces are plated in baskets that are placed directly in the solutions.

The electroplating line consists of washing tanks, rinsing tanks, and nickel and chrome plating and recuperation baths. A copper cyanide bath is located across from the line and is used to plate zamak before it is plated to nickel and chrome. All plating is manual. Times are not exact, and there is considerable variation in soaking times among different parts and different workers.

Before gilding, parts are rinsed in special rinse baths. They are then immersed in gilding solution for less than a minute.

Existing Pollution Problems

At the time of the assessment, there were a number of pollution problems including (1) polishing debris, (2) the use of organic solvents for degreasing, (3) acid dip contamination, (4) inefficient cyanide electroplating, (5) unnecessary chrome and nickel waste, and (6) excessive water use.

Table 1: Summary of Recommended Pollution Prevention Opportunities

Unit Operation	Pollution Prevention Action and Environmental/ Product Quality Benefit	Cost	Financial Benefit	Payback Period
Polishing -- Option #1	Reduce time between buffing and cleaning	$0	Savings in costs of degreasing	N/A
Polishing -- Option #2	Replace polishing compound with one compatible with aqueous alkaline cleaners	$0	Savings in costs of degreasing	N/A
Polishing -- Option #3	Improve operator performance by purchasing fixtures and jigs; provide training	Undetermined	Savings in costs of degreasing	N/A
Polishing -- Option #4	Reduce compound and wheel use through proper operator practice	$0	$150 - $300 per year	Immediate
Solvent degreasing	Replace this process step with aqueous alkaline cleaner	$5,000	$11,134 per year	< 6 months
Alkaline cleaning -- Option #1	Eliminate cyanide use in cleaning	$0	$895 per year	Immediate
Alkaline cleaning -- Option #2	Improved process control and solution monitoring	< $100	$930	Immediate
Acid Dip -- 10% sulfuric	Isolate acids for steel and brass	$0	Quality improvement	N/A
Acid Dip -- 10% sulfuric	Improved process control and solution monitoring	$0	$144	Immediate
Acid Dip -- Depassivation of nickel	Eliminate this process step; cleaner is adequate	$0	$672	Immediate
Acid Dip -- Mixed acid stripper	Replace with solutions in smaller tanks; practice segregation and recovery	Undetermined	Reduced treatment	N/A
Copper cyanide	Improved process control and solution monitoring	< $100	Quality improvement	N/A
Cyanide brass electroplating	Improved process control and solution monitoring	< $100	Quality improvement	N/A
Nickel electroplating -- Option #1	Improved process control and solution monitoring	< $100	Quality improvement; reduced solution loss	N/A
Nickel electroplating -- Option #2	Less frequent purification	Already incurred in other options	$4,130 to $5,875 per year	Immediate
Chrome electroplating -- Option #1	Capture and return 100% of dragout to the process solution	$0	Reduced need for treatment	N/A
Chrome electroplating -- Option #2	Improved process control and solution monitoring: porous pot	$500 to $1,000	Could eliminate need to invest in treatment	1 - 2 years
Rinsing -- Effectiveness	Add agitation and sprays; control water use; reduce water use	< $100	$1,728 per year	< 3 months
TOTALS		$5,500 to $6,500	At least $19,783 per year	

Pollution Prevention Opportunities

The assessment identified 18 pollution prevention opportunities that could address the problems identified above, with significant environmental and economic benefits to the facility. **Table 1** lists the recommended opportunities for the facility, and presents the environmental benefits and implementation costs for each.

Polishing Debris. As currently performed, the polishing process leaves considerable debris (consisting of a mixture of polishing compound and solids from the polishing wheel) inside the pieces. These deposits cannot be removed by scraping or wiping.

To alleviate this problem, the facility can take several steps. Reducing the amount of polishing compounds used will reduce the amount of debris. Removing visible residue will allow less debris to harden on the pieces. Reducing the time between buffing and cleaning will also allow less debris to harden on the pieces. Lastly, employing a polishing compound that is compatible with alkaline cleansers will improve the efficiency of the cleaning process (along with recommendations outlined in the next section).

Degreasing. The facility currently employs the chlorinated solvent TCE to degrease parts. TCE is highly toxic and chemically reactive, and has been linked to liver cancer and ozone depletion. Parts can be cleaned equally well, or better, through the use of aqueous alkaline cleaners. Thus, the facility can greatly reduce its environmental impact *and* improve product quality by implementing an alkaline cleaning system. Further, the alkaline system is more cost effective than the TCE system. A $5,000 investment will yield savings (from eliminated solvent purchases) of $12,000 per year.

Acid Dips. In this facility's plating process, an acid dip (usually 10 percent sulfuric acid) is used to remove any oxides that may have developed on the brass or steel surface. With time, copper and organic contamination accumulates in the acid bath. If more than 300 mg/l of copper is present in the acid dip, the bath can cause adhesion problems for the steel substrate. Further, copper contamination also impacts the nickel electroplating solution. While the facility utilizes nickel depassivation to remove the copper contamination, it is not efficient, wasting nickel, brightener, and energy.

Separate acid dips for steel and brass substrates will improve the quality of both the steel substrate cleaning, and the nickel electroplating solution, and hence reduce the number of rejects the facility produces. Additionally, by employing tighter process control over the acid dips, the facility will save $816 a year in reduced solution cost.

Inefficient Cyanide Electroplating. Cyanide electroplating cannot be eliminated at this facility because the known non-cyanide alkaline alternatives do not function well in this application. However, improved process control and solution monitoring could enhance product quality, and hence reduce the number of rejects the facility produces.

Unnecessary Nickel and Chrome Waste. Currently, the facility purifies the nickel bath six times per year. By improving process control and purifying the nickel bath only once per year, the facility should save between $4,100 and $5,900 a year from recovered nickel solution.

The lost chrome solution is only valued at $180 per year. However, if 100 percent of this chrome could be captured, the facility would not have to install expensive chrome waste treatment required by the facility's government. A porous pot purification system (priced between $500 and $1,000) is capable of removing the chromium from the waste water. While the expected costs of meeting chromium discharge limits have not been determined, they are sure to be greater than the cost of the purification system.

Excessive Water Use. Waste water is generated in significant volumes from the facility's rinse steps. Some fairly simple changes can be made that will reduce water use by 25 percent. The use of air or solution agitation would increase the efficiency of the rinses, and reduce the frequency of changes. Spray rinses would also be more efficient than the current practice. Lastly, water inputs should be installed with switches that turn off the inputs after a set period of inactivity. For an investment of less than $100, the facility should save $1,728 a year from reduced water usage.

For Further Information

For further information on this assessment or other activities sponsored by EP3, call the EP3 Clearinghouse at (703) 351-4004, send a fax to (703) 351-6166, or on Internet apenderg@habaco.com.