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EPP Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Furniture Manufacturer

Executive Summary

This assessment evaluated an office furniture manufacturing facility. The objectives of the assessment were to: 1) identify pollution prevention actions that would reduce the quantity of toxics, raw materials, and energy used in the manufacturing process; 2) demonstrate the environmental and economic value of a comprehensive pollution prevention assessment; 3) improve manufacturing competitiveness and product quality; and 4) improve health and safety concerns at the plant. The assessment team was comprised of a US pollution prevention expert and four local professionals.

Eight pollution prevention opportunities were identified for this facility. The one-time cost to implement these measures is approximately US$107,500 with an additional annual cost of $10,100. These measures would result in a financial benefit of around $326,540 per year. This saving results primarily from the reduction in the use of raw materials.

The environmental benefits of these pollution prevention opportunities are substantial. The facility would be able to totally eliminate the use of two highly toxic substances; reduce the consumption of and discharge to the sewer system of sulfuric acid, nickel, and chrome; reduce water use by 30%; and reduce worker exposure to solvents. Furthermore, implementing these measures will improve product quality and enable the facility to reduce the cost of installing and operating an expensive wastewater treatment plant that is currently mandated by government environmental regulation.

Facility Background

The facility covers an area of approximately 33,500 square meters. The plant produces two basic types of office furniture: furniture with chrome-plated tubular legs (60%) and steel shell furniture (40%), including file cabinets and metal desks. It has a production line of over 200 items, most of which are made of steel and either painted or electroplated. These products are marketed to public service establishments and to the local market. In 1993, over 650,000 units were sold. The plant is a public facility with 1,500 employees, 1,000 of whom work in manufacturing.

Manufacturing Process

The manufacturing operations consist of four process areas: fabrication, painting, electroplating, and assembly. The raw materials used in production are metal sheets and tubes, paint, electroplating chemicals, and upholstery material. In the fabrication process, steel sheets are cut to predetermined sizes depending on the piece being made and bent or pressed into the desired shape. The parts proceed on to either a painting step or an electroplating step. Some of these pieces are then welded together. The finished parts are assembled to produce the final products (see Figure 1).

The plant has two painting lines (shown in Figure 2). The first is automated, using electrostatic equipment, liquid paint, with manual touch up. The second line uses standard manual air guns. Prior to painting, parts are cleaned/degreased, phosphated, passivated, and dried. The plant has two different phosphating lines, which produce a large portion of the wastewater from

Figures 1 and 2: Overview of Facility's Fabrication and Painting Processes

Figure 1: Fabrication process

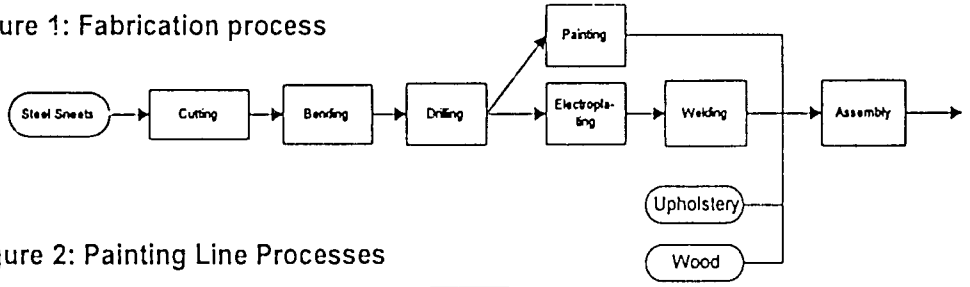

Figure 2: Painting Line Processes

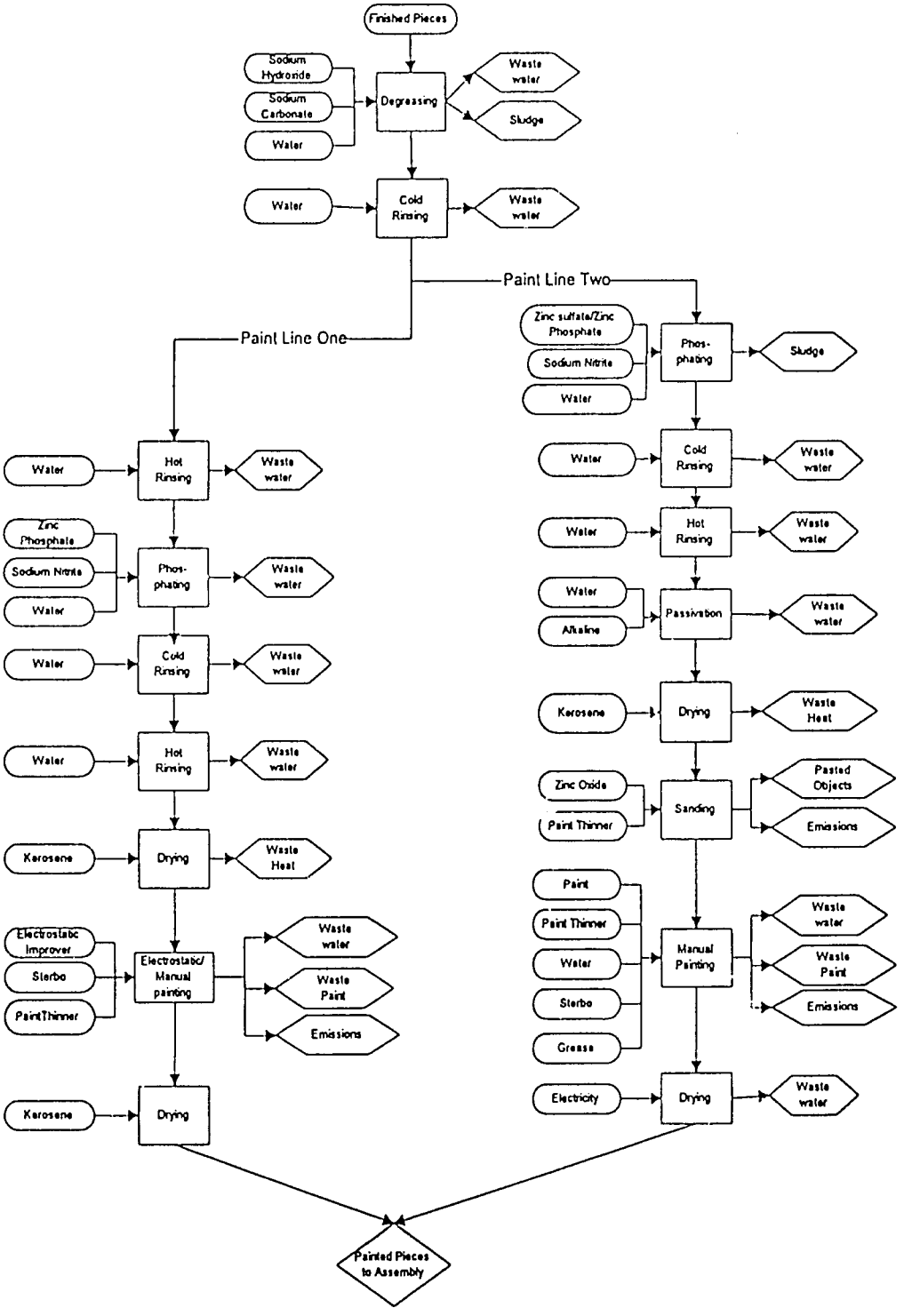

Table I: Summary of Recommended Pollution Prevention Opportuntities

Operation	Pollution Prevention Option	Environmental and Health Benefit	Implementation Cost (US$)	Financial Benefits (US$)	Payback Period
Cleaning	Replace sulfuric acid and benzene with alkaline solution	Reduction in sulfuric acid and benzene released to environment	$6,388/yr	none	none
Cleaning	Clean parts properly	Elimination of copper cyanide	none	$1,108/yr	immediate
Etching	Standardize sulfuric acid use; eliminate use of inhibitor	Reduction in sulfuric acid and inhibitor released to environment	none	$326/yr	immediate
Electroplating	Improve process parameter	Reduction of pollutants in wastewater	$154 and $3,692/yr	$3,946/yr	1 year
Electroplating	Reduce process solution loss	Reduction of pollutants in wastewater	$3,892	$4,392/yr	10.5 months
Electroplating	Replace zinc cyanide with zinc chloride	Elimination of zinc cyanide	$6,154	not determined	n/a
Electroplating	Improve water use practices	Reduction in wastewater generation	$462	$2,307/yr	2.5 months
Printing	Improve paint application	Reduction in paint loss	$96,923	$314,461/yr	4 months
TOTAL:	* one-time costs are capital costs; per year costs are operational costs		$107,539 (one-time); $10,080/year	$326,540/year	

this facility. Once painted, the pieces are hung to dry.

The plant electroplates with either copper/nickel/ chrome or zinc. All electroplating operations are manual.The electroplating process used in this plant is relatively standard and follows a series of steps including polishing and grinding, degreasing, rinsing, etching and plating.

Environmental Problems

The key environmental problems associated with this facility are: 1) discharge of highly contaminated untreated water (caustics, phosphates, sodium nitrate, sulfuric acid, and sodium carbonate) directly to sewer; 2) discharge of plating solution (copper cyanide, zinc cyanide, nickel, sodium cyanide, sulfuric acid, chromic acids); and 3) solvent loss from paint thinner and drag-out spills at electroplating area which affect worker health.

Pollution Prevention Opportunities

This assessment identified 8 pollution prevention opportunities that, if implemented, would result in significant economic and environmental benefits for the facility. Table 1 lists the recommendations and presents the benefits and costs. The implementation costs include none-time capital expenditures as well as annual operating costs.

Replace sulfuric acid and benzene with alkaline solution for cleaning: The current cleaning and degreasing process uses a sulfuric acid bath followed by manually wiping the part with benzene. An alkaline based cleaner can be used as a substitute for both. While switching to an alkaline solution will cost an additional $6,400 per year, the benefits are improved product quality, a reduction in the amount of harmful chemicals discharged to the environment, and better safety measures.

Eliminate the use of copper cyanide: The use of copper cyanide as an undercoat for electroplating is unnecessary if proper cleaning is part of the preparation process. Eliminating this process solution protects worker health and the environment by eliminating a toxic substance from the manufacturing process. There is no cost associated with implementing this option; annual savings are $1,100.

Standardize sulfuric acid and eliminate the use of inhibitors: Parts are kept in etching tank filled with sulfuric acid solution for long periods of time (up to 48 hours). In order to prevent corrosion, an inhibitor is added. Standardization of sulfuric acid use will eliminate the need to purchase the inhibitor and improve product quality. Annual savings are about $300. In addition, instead of storing parts in the etching tank as currently done, another location should be found to store the parts.

Improve process parameters: The current quality of the electroplating process is poor. In order to improve the process, it is suggested that laboratory analysis of process solutions be performed every thirty days, and a Hull cell be purchased to control process parameters. Implementing measures will reduce overal chemical use and the pollutant concentration in the wastewater. Implementing these measures will cost $154 in capital costs and $3,700 per year for laboratory fees; annual savings are $3,950.

Reduce loss of process solution during electroplating: The current nickel/chrome electroplating process is not optimal; large amounts of process solution are lost in the drag out process. This contaminates wastewater and results in poor quality product. A bar or chain hoist can be installed for extended drainage time over solution tanks, and the tanks can be moved closer together to catch more drag out. Extending drainage time from 3 seconds to 10 seconds can save as much as 80% of the wasted process solution. The cost to implement these measures is $3,850, with a yearly savings of $4,400.

Replace zinc cyanide with zinc chloride: The use of zinc cyanide in electroplating is declining because of the environmental concerns. Alternatives should be explored which, while more expensive, have higher plating rates and more brightness. Replacing the current system with one based on zinc chloride will cost $6,150.

Improve water-use practices: Water use at the plant is not monitored and no work has been done to determine the amount and quality of water needed for adequate rinsing. To reduce the amount of wastewater generated, the required water quality needed for electroplating should be determined, flow restrictors installed, and spray rinses used. The cost of implementation is about $500 with a resulting yearly savings of $2,300.

Improve paint application techniques: Painting at this facility is performed both manually and using an automated system. In both painting lines, there are opportunities to reduce paint losses from overspray. For the automated system, the recommendations to optimize the painting process include adjusting the target to gun distance and angle, pressure of the air to paint ratio of the gun, paint consistency, and activating the sensors that control the range of motion of the systems' robot arms. For the manual painting system, high-volume, low-pressure paint spray units should be used for higher paint-use efficiency.

The assessment also examined several options that would help recover the overspray produced in the painting process. It was suggested that the plant investigate paint reclaim/recycle systems, stagger parts on the painting lines to catch some of the overspray, and to monitor the coating thickness to avoid over application that results in waste. These recommendations would result in a reduction in the amount of paint used or wasted. The total cost of implementation is $96,900 with a corresponding yearly savings of $314,500.

Conclusion

Adopting the pollution prevention opportunities identified by this report will have a number of benefits for this facility: 1) increase product quality; 2) improve worker health (especially in the electroplating area); 3) save the facility approximately $316,500/year; and 4) reduce investment in pollution control. Under the new environmental law, the plant will be required to install a wastewater treatment system. While pretreatment of the wastewater will still be necessary due to its highly toxic nature, installation and operation costs can be reduced significantly if the recommended pollution prevention measures are implemented.

For Further Information

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