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Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for an Electroplating Facility

Executive Summary

This assessment details the evaluation of the nickel and zinc plating lines at a motorcycle component supplier. The objectives of this assessment were to: 1) identify pollution prevention options that would reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, and thereby reduce industrial pollution and worker exposure to toxic chemicals; 2) demonstrate the environmental and economic value of a comprehensive pollution prevention assessment; and 3) improve manufacturing competitiveness and product quality for this facility.

The assessment identified 20 pollution prevention opportunities; 10 were classified as a #1 (high) priority, 8 as a #2 (medium) priority, and 2 as a #3 (low) priority. These options will generate financial benefits estimated at US$93,500 annually (plus an additional one-time savings of $1,000) if all the requirements and assumptions are met. The total investment for the proposed changes amounts to a one-time cost of $10,060 and an annual cost of $640 (the figures for both costs and benefits do not include several opportunities which were difficult to quantify due to lack of information, but are assumed to provide cost savings). Quantified payback periods are all relatively short, ranging from one week to three months.

By implementing the recommendations, the company can expect significant benefits in many areas. These include reduced volume of wastewater, reduced chemical requirements, reduced reject rates, and a lower exposure of workers and the surrounding environment to hazardous chemicals.

Facility Background

This facility is involved in the manufacture of motorcycle components such as baskets and carrier racks, household metal wares, and other metal products. The company has two plating plants, located 500 meters apart; one for nickel and chrome deposition and one for zinc plating. Both plants have been open since 1976. They employ a total of 224 workers and operate one shift per day, 5 days a week.

Manufacturing Process

The manufacturing process utilizes about 600-800 tons of metal annually. Metal material inputs consist of metal sheet, rods, and tubes. Rods, tubes, and some sheet metal go to the cutting machines while the rest of the sheet metal goes directly to the pressing/stamping machines (approximately 30% of the input ends up as scrap). Subsequently, there is metal welding followed by grinding of unfinished parts. Waste from the grinding process includes metal dust and fines.

After grinding, parts are sent to either the zinc or the nickel/chrome plate lines. Each line has its own pretreatment equipment, but both are basically the same. The first pretreatment step consists of removing grease and particulates from the surface of unfinished parts using diesel oil as a solvent. Other common pretreatment operations (such as degreasing, pickling, and rinsing) follow.

The zinc plating operation is divided into two systems, barrel and rack plating. A semi-automatic machine is used in the barrel system and manual equipment is used in the rack system. Parts are plated with zinc and

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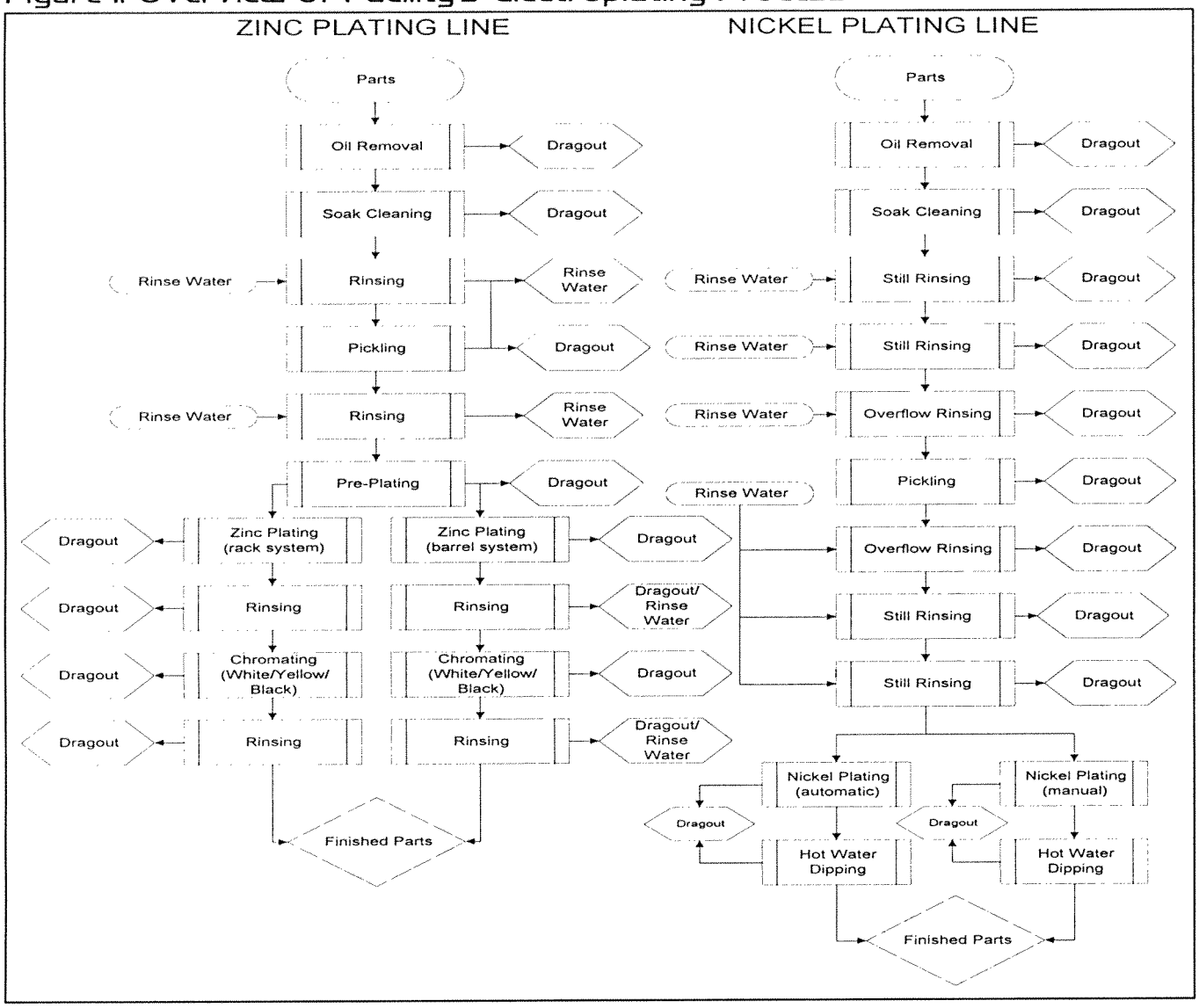
Figure 1: Overview of Facility's Electroplating Process



are colored through the use of chromate passivation solutions. Three different solutions are used: white, yellow, and black.

In the nickel/chrome line both automatic and manual rack plating are used. Parts are plated first with nickel, and then with hexavalent chrome for increased water resistance and hardness.

Environmental Problems

This facility has several water and air pollution problems, and uses both materials and energy inefficiently. The wastewater treatment system does not neutralize all of the harmful contaminants before they are discharged into a nearby stream. Contaminated fluids enter the wastewater stream via dragout dropping onto the floor and bus panel chromating, which is done directly on the floor. Fumes and steam are emitted from a number of baths, especially the heated soak cleaning, degreasing, electrocleaning, and plating baths. There is a tremendous amount of wasted chemicals along both lines, as well as a high number of rejects and scrap material. Energy is used inefficiently because of low production rates.

Pollution Prevention Opportunities

Of the 20 pollution prevention opportunities identified, 11 involve the zinc plating line, 5 involve the nickel plating line, and 4 involve the waste management system for nickel plating. Ten opportunities have been classified as high priority. Because of space considerations, only these top-priority opportunities are outlined here and in Table 1, which details the environmental benefits associated with these opportunities, and the projected implementation costs and savings.

Zinc Plating Line:

Dragout Minimization: Currently, parts housed on racks and in barrels are not properly drained before being moved from one tank to another. Chemicals

Table I: Summary of Recommended Pollution Prevention Opportunities

Operation	Pollution Prevention Option	Environmental and Health Benefits	Implementation Cost (US$)	Financial Benefits (US$)	Payback Period
Zinc Plating Line	Dragout Minimization	Savings on chemical requirements, reduced wastewater load	$530 for horizontal bars and labor	$310/year	20 months
Zinc Plating Line	Spray Rinsing	Savings on chemical requirements	$780 for spray nozzles, hose reels, hoses, piping, and labor	$5,300/year	2 months
Zinc Plating Line	Bath Analysis	Savings on chemical make-up and reducing rejects	$320/year for increased operations and management costs	$14,000/year	N/A
Zinc Plating Line	Demineralizing	Savings on chemical make-up and reducing rejetcs	$1,320 for an ion exchanger	$4570/year	3.5 months
Zinc Plating Line	Recover solution from bus panel chromating	Savings on white chromating usage, reduced wastewater load	$110 for a modified oil tank	$90/year	15 months
Zinc Plating Line	Area Modernization	Increased productivity, savings on chemical usage, reducing wastewater load and rejection rate	Dependent upon basic design solution	Dependent upon basic design solution	N/A
Nickel Plating Line	Dragout Minimization	Savings on chemical requirements, reduced wastewater load	$260 for horizontal bars and labor	$12,200/year	1 week
Nickel Plating Line	Bath Analysis	Savings on chemical requirements	$320/year for incresed operations and management costs	$12,100/year	N/A
Nickel Plating Line	Retainment of Still Rinses	Savings on chemical make-up, reduced wastewater load	0	$27,000/year	N/A
Waste Management System	Recover Material from Sludge	Recovering expensive metals, reduced wastewater load, and reduced landfilling	--	$1,000	N/A
Total from High Priority Opportunities	--	--	**$3,320 in one-time costs and $640 annual cost**	**$1,000 in one-time costs and $48,570 annually**	--
Total from Low Priority Opportunities (not in Table)	--	--	**$6,740 in one time costs**	**$44,930 annually and increased productinn**	--
Total	--	--	**$10,060 in one time costs and $640 annual costs**	**$1,000 in one-time costs and $93,500 annually**	--

such as plating solutions, soak, and electrocleaners drain onto the shop floor, or into rinse baths, and are lost. By increasing drainage time from 5 to 10 seconds, dragout can be reduced by 40 to 50%, while production rates remain unaffected. This can be achieved by installing horizontal bars above the baths, on which the racks can be hung to drain. At a cost of $45 for each of the 12 baths, the total one-time cost is $540. Chemical savings from this practice can amount to $310 annually, for a payback time of 20 months.

Spray Rinsing Installation: In addition to increasing drainage time, rinsing the parts with water will rinse contaminants off the parts before they proceed to the next bath. This can be directly above the process bath, or, if this causes too much dilution, above an empty tank. The total one-time cost of installing spray rinses (nozzles, reels, and hoses) for the 10 baths is $770. If this process were to cut chemical requirements by 2%, annual benefits would amount to $5,200.

Chemical Bath Analysis Frequency: Currently, complete process bath analysis is done only once per month. As analysis and control of the composition of each bath is very important in order to maximize product quality and bath lifetimes, it is recommended that these analyses be conducted at least every week. This will ensure that the need for specific chemicals is identified before there is a serious problem with plating. The total cost of these analyses is $310 annually. By enhancing bath lifetimes and reducing reject rates, this step can save the plant up to $13,900 per year.

Demineralizer Installation: The lifetimes of many process baths are shorter than they need to be. One reason is that the plant's tap water has a high content of iron and other minerals, as well as suspended solids, which results in the buildup of impurities. The use of demineralized water will reduce impurities found in the process sludge and lengthen process bath lifetimes. The one-time cost of installing demineralizing equipment is estimated to be $1,300. Savings derived from improved chemical compoition and reduced rejection rates can amount to $4,550 annually.

Recover Solution from Bus Panel Chromating: Because there are no tanks large enough, bus panels are currently chromated on the floor. Solution runs off the surface of the bus panel onto the floor, and eventually into the wastewater conveyance system. To address this problem, a tank needs to be specially modified for bus panel chromating. Such a tank would have a drain that will keep runoff from entering the wastewater conveyance system, but which will also collect the runoff for reuse. The one-time cost of tank modification is approximately $110. Annual savings can be up to $90, creating a payback period of 15 months.

Modernize Zinc Plating Area: Currently, facility management is planning to replace the existing manual barrel zinc plating equipment with an automated system. This presents an excellent opportunity to simultaneously undertake auxiliary operations modernization in order to emphasize dragout volume minimization, dragout recovery, water use minimization, bath quality/integrity maintenance, and process control automation. Such actions would create improvements to the cleaning, chromating, surface preparation, stripping, and rinsing activities. While the one-time implementation costs will not be trivial, they are largely dependent on the scenario chosen. Annual savings will correspond to the program implemented, and will include reduced rejection rates, chemical purchase reductions through increased in-process recovery and reuse of valuable chemicals, and reduced wastewater and sludge management costs.

Nickel Plating Line:

Dragout Minimization: The problems associated with this process are the same as in the zinc plating line. By increasing drainage time by 7 seconds, dragout can be dramatically reduced, without affecting production rates. This can be achieved by installing horizontal bars above the baths, on which the racks can be hung to drain. At a cost of $45 over 6 baths, the total one-time cost is $270. Chemical savings from this practice amount to $12,200 annually, for a payback time of one week.

Chemical Bath Analysis Frequency: The problems associated with this process, and the recommended pollution prevention procedures, are the same as in the zinc plating line. Total cost of increased chemical analyses is $320 per year. By enhancing bath lifetimes and reducing reject rates, this procedure can save the plant up to $11,200 annually.

Avoid Dumping of Still Rinses: Still rinses are often discarded even though they contain valuable chemicals. It is recommended that, whenever possible, still rinses are used as part of the process bath. No significant costs are associated with this option, and there is an annual chemical savings worth approximately $27,000.

Waste Management System:

Although waste treatment is not the focus of the assessment process, some critical concerns are presented that will help reduce waste generation from the treatment area. Since the company is now planning to construct such a facility, there is an immediate need to thoroughly quantify the volume and constituents of the facility's wastewater.

Recover Metals from Waste Treatment System Sludges at the Nickel Plant: It is necessary to remove sludge that has accumulated in the wastewater treatment tanks. It is recommended that, prior to landfill, the facility attempts to extract metals from the sludge. With a 10% recovery rate, earnings of up to $960 can be achieved. Landfilling rates are approximately $260 and, with recovery, it is possible to realize a profit on this process.

Lower Priority Recommendations:

For the zinc plating line, recommendations include cleaning electrical contacts daily, filtering the soak cleaner, replacing plastic buckets, installing separate pickling tanks for separate operations, and using float balls on process baths to reduce evaporative losses. For the nickel plating line, these include cleaning electrical contacts daily, and converting hexavalent chrome plating to a trivalent process. For the waste management system of the nickel/chrome facility, recommendations include recovering metal from spent cyanide stripping solution, improving wastewater neutralization efficiency, and improving the efficiency of hexavalent chromium reduction in wastewaters. Total one-time costs from these options is $6,470. Cumulative annual financial benefit is estimated at $46,000.

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: ep3clear@habaco.com