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EPA ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Finished Metal and Plastic Parts

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Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. In an effort to assist these manufacturers, Waste Minimization Assessment Centers (WMACs) were established at selected universities, and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at Colorado State University performed an assessment at a plant that applies coatings to metal and plastic components supplied by its customers. Several different coating operations are performed, but the ones that generate consistent and significant quantities of waste are anodizing of aluminum parts, chromating of aluminum parts, and painting of plastic and metal parts. The team's report, detailing findings and recommendations, indicated that large quantities of spent rinse water and process solutions, and spent solvent and still bottoms are generated by the plant and that the life of the black dye bath could be extended to yield significant cost savings.

This Research Brief was developed by the principal investigators and EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center, Philadelphia, PA.

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Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste generation is to reduce or eliminate the waste at its source.

University City Science Center has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the in-house expertise to do so. Under agreement with EPA's Risk Reduction Engineering Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at Colorado State University's (Fort Collins) WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The waste minimization assessments are done for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $75 million, employ no more than 500 persons, and lack in-house expertise in waste minimization.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experience for graduate and undergraduate students who participate in the program and a cleaner environment without more regulations and higher costs for manufacturers.

Methodology of Assessments

The waste minimization assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended, and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

This plant is a job shop that applies coatings to metal and plastic components supplied by its customers. It operates 4,940 hr/yr to produce approximately 234,000 ft^2 of product annually.

Manufacturing Process

Prefabricated aluminum, steel, and plastic parts are supplied to the plant by its customers who specify the coating or paint that is to be applied. The plant performs several different coating operations, but the ones that generate consistent and appreciable amounts of waste are anodizing of aluminum parts, chromating of aluminum parts, and painting of plastic and metal parts.

Anodizing

Aluminum parts to be anodized are first immersed in a caustic solution and then an etching solution to remove surface contaminants. Smut that remains on the parts after etching is removed using an acidic deoxidizing solution. A surface oxide layer is then formed on the parts in an aqueous electrolytic bath that contains sulfuric acid. The anodized parts are then dyed one of five colors or left undyed. Next, an aqueous nickel fluoride solution is used to seal the oxide layer. The last step is rinsing of the finished parts. The anodized parts are then assembled if necessary, packaged, and shipped back to the customer.

Chromating

Chromate conversion coatings are applied to aluminum parts by first immersing the parts in a series of aqueous solutions for cleaning, etching, and acidic deoxidizing. The parts are then immersed in the chromate conversion solution and rinsed. The finished parts are then painted if required, inspected, assembled if necessary, packaged, and shipped back to the customer.

Painting

Parts that require painting are painted in one of three spray paint booths. Water-based, solvent-based, and powder coatings are used by the plant according to the customer's specifications. Special tooling supplied by the customer is used to mount the parts to be painted. After the coating has been applied, the parts are placed in an oven for curing and drying. The completed parts are inspected, packaged, and shipped back to the customer.

An abbreviated process flow diagram for this plant is shown in Figure 1.

Existing Waste Management Practices

This plant already has implemented the following techniques to manage and minimize its wastes:

- Flow reducers have been installed on all flowing rinses in the anodizing and chromating lines.
- A solvent distillation unit is used to recover paint-related solvents which are then reused by the plant.
- The use of water-based instead of solvent-based paints is significant and is increasing. Plant personnel encourage customers to specify water-based and powder-based paints.
- Operators use care in raising part racks slowly from the process solutions and allowing sufficient drainage time to reduce drag-out in the anodizing and chromating lines.
- Water used to cool Freon™ in the chillers associated with the anodizing tanks is reused as rinse water.

Waste Minimization Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the annual waste management cost are given in Table 1.

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. The minimization opportunity, the type of waste, the possible waste reduction and associated savings, and the implementation cost along with the payback time are given in the table. The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

It should be noted that the economic savings of the minimization opportunity, in most cases, results from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, one additional measure was considered. This measure was not completely analyzed because it was beyond the scope of this analysis. Since this approach to waste reduction may, however, yield significant savings, it was brought to the plant's attention for future consideration.

- Modify the on-site solvent distillation unit in order to raise the temperature and the recovery factor.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-814903 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. The EPA Project Officer was **Emma Lou George**.

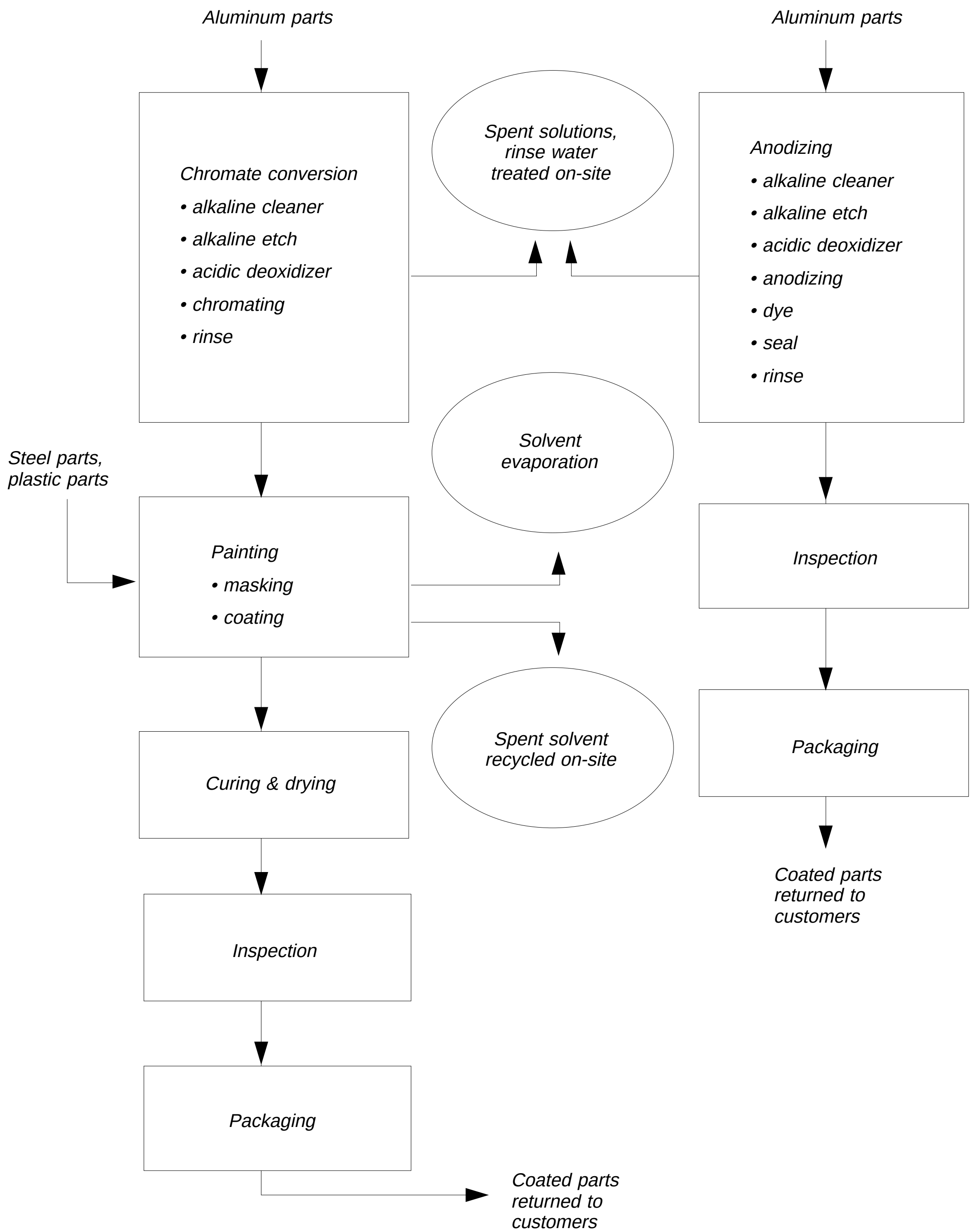

Figure 1. *Abbreviated process flow diagram.*

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb)	Annual Waste Management Cost*
Spent process solutions	Anodizing and chromating	pH adjusted; sewered	3,140,810	$37,920
Spent black dye solution	Anodizing	pH adjusted; sewered	21,660	13,640
Spent rinse water	Anodizing and chromating	pH adjusted; sewered	17,840,700	5,600
Caustic sludge	Wastewater treatment	Stored on-site pending disposal (Plant personnel are evaluating possible reuse of this material for neutralizing rinse water and spent acidic solutions.)	7,330	2,100
Spent solvent and still bottoms	Painting and on-site solvent recovery unit	Shipped to a treatment, storage, disposal facility	13,580	11,970
Paint sludge	Washer in painting line	Stored on-site pending disposal (Sludge will be shipped off-site when a larger quantity has accumulated.)	1,440	1,640
Evaporated solvent	Painting	Evaporates to plant air	2,940	870
Aluminum oxide sludge	Stripping of anodizing racks and reject parts	Stored on-site pending disposal (Sludge will be shipped off-site when a larger quantity has accumulated.)	N/A	N/A

* Includes waste treatment, disposal, and handling costs and applicable raw material costs.

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Minimization Opportunity	Waste Stream Reduced	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Simple Payback (yr)
		Quantity (lb)	Per cent			
Extend the life of the black dye bath by installing a cation exchange column to remove dissolved aluminum, and a filtration unit to remove particulate contaminants suspended in solution and sulfate in the form of insoluble barium sulfate precipitate. A small amount of barium sulfate sludge will be generated.	Black dye solution	17,330	80	$10,240	$4,930	0.5
Operate the on-site solvent recovery unit more frequently to reduce the amount of spent solvent that is shipped off-site without being reprocessed.	Spent solvent and still bottoms	3,920	29	2,770	0	Immediate

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