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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Motor Vehicle Exterior Mirrors

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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. 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). The WMAC team at the University of Tennessee performed an assessment at a plant manufacturing exterior motor vehicle mirrors — approximately 3 million mirrors per yr. Galvanized steel and stainless steel stock undergo stamping, pressing, and cutting operations followed by degreasing. Stainless steel mirror housings are buffed, assembled, packaged, and shipped. Galvanized steel, zinc die-cast, and plastic mirror parts are washed then electrostatically primed and painted. Parts are assembled, packaged, and shipped. The team's report, detailing findings and recommendations, indicated that the majority of the waste was generated in the cleaning and washing areas but that the greatest savings could be obtained by installing an electrostatic powder coating system to reduce primer/paint overspray (100%), solvent evaporation (55%), cleaning solvent evaporation (80%), and still bottoms (80%).

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 the authors.

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 is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small- and medium-size manufacturers who want to minimize their formation of waste but who lack the inhouse 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 the University of Tennessee's (Knoxville) WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize 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 $50 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, reduced waste treatment and disposal costs for participating plants, 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 Opportu-*

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nity Assessment Manual (EPA/625/7-88/003, July 1988). The WMAC staff locates the sources of hazardous waste in the plant and identifies 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 manufactures exterior mirrors for motor vehicles. The plant operates 6,120 hr/yr to produce approximately 3 million mirrors.

Manufacturing Process

This plant takes galvanized and stainless steel stock and forms it into mirror housings for use on both automobiles and trucks. Raw materials in use include sheets and rolls of galvanized steel, stainless steel, zinc die-cast parts, plastic stock, hardware, and mirror glass.

The following steps are involved in making the mirrors:

- Raw materials undergo stamping, pressing, and cutting operations to form mirror housings and arm braces.
- Galvanized steel mirror housings and parts and stainless steel mirror housings are rinsed in water to remove any residual dirt or grease. Buffing stones are added to the tank for parts degreasing to aid in the removal of dirt and grease. Contaminated water from the degreasing operation is sent to the plant's on-site water treatment facility.
- The degreased stainless steel mirror housings are mechanically buffed. Spent buffing compound, metallic waste, and soiled cleaning rags are discarded in municipal waste.
- Degreased galvanized steel parts, zinc die-cast parts, and high temperature plastic parts are cleaned and their surfaces are prepared for priming and painting in a nine-stage washer. The nine-stage washer consists of an alkaline-wash tank followed by two water rinse tanks, a titanium conditioner tank, a zinc phosphate-accelerator additive tank for further surface preparation followed by a water rinse tank, and a chromic acid rinse tank followed by two water rinse tanks. Contaminated wash and rinse water is sent to the on-site water treatment facility. Spent ion-exchange columns used to produce deionized water are taken off-site by an outside contractor.
- After the nine-stage washer process, galvanized steel, zinc die-cast, and high temperature plastic parts are electrostatically primed, dried, electrostatically painted, and dried again before assembly. Primer and paint overspray is collected on plastic sheets which are disposed of in municipal waste.
- Other plastic parts are cleaned and prepared for painting in a five-stage washer. The five-stage washer consists of a heated water-rinse tank, three currently unused stages, and a conductive surface treatment tank. Contaminated water is sent to the on-site treatment facility.
- Following the five-stage washer process, plastic parts are electrostatically painted and dried before assembly. Paint overspray is deposited on paint booth filters which are disposed of in municipal waste.
- Contaminated water received from various areas of the plant is treated in the on-site facility. First, hydrochloric acid is added to the water to reduce its pH. Contaminants precipitate from the water and collect as sediment which is piped to a filter press to remove water. The water which is removed is directed back to the treatment tank, then pumped to a second tank where additional sediment is collected. That sediment is also processed in the filter press. The water is then passed through an ion-exchange column to remove residual heavy metals before being released to the municipal sewer.

Existing Waste Management Practices

- Only non-hazardous primer and paint products are used.
- Contaminated water generated on-site is treated within the plant before being released to the municipal sewer.
- Hexavalent chrome which is used in one stage of the nine-stage washer is converted to the less hazardous form of trivalent chrome prior to water treatment.
- A portable distillation unit recycles spent solvent generated by the spray gun and paint-line cleaning.
- Electrostatic primer and paint application systems maximize paint application efficiency.

Waste Minimization Opportunities

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

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. The type of waste, the minimization opportunity, 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, in most cases, the economic savings of the minimization opportunities result 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 should also 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 would result when the opportunities are implemented in a package.

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.

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Annual Quantity Generated	Annual Waste Management Cost
Contaminated wash water	Degreasing of galvanized steel and stainless steel components.	142,800 gal	$7,688
Spent buffing compound and metallic waste	Buffing of stainless steel components	1,123 bbl	5,100
Contaminated wash and rinse water	Nine-stage washer.	797,150 gal	9,188
Spent ion exchange columns	Nine-stage washer.	24 units	9,057
Evaporated solvents	Primer and paint application	5,620 gal	0[1]
Primer and paint overspray collected on plastic sheets	Primer and paint application.	12 bbl	8,925
Contaminated water	Five-stage washer.	10,200 gal	4,687
Paint overspray collected on filters	Paint application.	6,375 filters	8,925
Sediment	Water treatment facility.	162 bbl	26,688
Evaporated solvent	Spray gun and paint-line cleaning.	957 gal	0[1]
Still bottoms	Distillation unit for recovering spray gun and paint line cleaning solvent.	770 gal	15,097
Primer and paint ash	Burn-off oven for cleaning parts racks.	3,825 lb	7,687

[1] The plant reports no waste management cost associated with solvent evaporation.

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Waste Stream Reduced	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years
Evaporated solvent and primer and paint overspray collected on plastic sheets.	Install an electrostatic powder coating system to replace painting of galvanized steel and zinc die-cast parts.	12 bbl[1] 3,076 gal[2] 766 gal[3] 616 gal[4]	100 55 80 80	$113,418	$236,880	2.1
Contaminated wash and rinse water from the nine-stage washer.	Install a metal recovery system (an ion-exchange or electrodialysis system) to recover and reuse zinc phosphate from the nine-stage washer.	8 bbl[5]	5	17,349	74,600	4.3
Evaporated solvent.	Recover solvent from the paint curing oven stacks using a freon-refrigeration system.	3.794 gal	68	11,337	104,000	9.2
Contaminated wash and rinse water from the degreasing, five-stage, and nine-stage washing processes.	Construct a water recirculating system in conjunction with the on-site treatment facility.	855,135 gal	90	11,027	42,760	3.9
Contaminated wash and rinse water from the nine-stage washer.	Install air curtains in the nine-stage washer to reduce solution contamination and loss.	79,715 gal 13 bbl[5]	10 8	7,197	6,500	0.9
Sediment from the water treatment facility.	Use a gas-fired dryer to dry the solid waste from the filter press before shipping the waste off-site.	138 bbl	85	8,199	40,000	4.9

[1] Primer/paint overspray [2] Solvent [3] Cleaning solvent [4] Still bottoms [5] Sediment

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