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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Sheet Metal Components

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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). The WMAC team at Colorado State University performed an assessment at a plant that manufactures precision sheet-metal components, primarily for electronics and medical equipment. Sheet metal is machined into desired components that are anodized or chromated if aluminum; degreased and painted if required; and assembled, inspected, packaged, and shipped. The team's report, detailing findings and recommendations, indicated that the plant could achieve significant cost savings and waste reduction by replacing its standard paint spray guns with high-volume low-pressure paint guns, thereby reducing paint overspray.

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.

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 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 inhouse 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

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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

The plant manufactures precision sheet-metal components, primarily for electronics and medical equipment. It operates approximately 2,100 hr/yr to process about 300,000 square feet of sheet metal annually.

Manufacturing Process

The major raw materials used by the plant are aluminum and steel, but iron phosphate-coated sheet steel, tin-plated sheet steel, and vinyl-coated sheet steel are also used.

The sheet metal is cut to size with hydraulic shears, and patterns are cut with computer numerically-controlled (CNC) turret punch presses. Some counterboring and tapping follows. Burrs are removed using wet and dry deburrers, sanders, grinders, and buffers. The deburred parts are formed and bent to the desired shape.

All aluminum parts are then anodized (1%) or chromated (99%). The anodizing/chromating line consists of a series of tanks containing cleaning solutions, rinses, anodizing solutions, dye, nickel acetate sealing solution, hot deionized water, and chromating solutions. Instructions specified by the customer are silk-screened onto the parts after anodizing or chromating.

About 25% of the fabricated steel parts are painted, usually with solvent-based paints after degreasing with 1,1,1-trichloroethane (TCA).

The components are then assembled as needed, inspected, packed, and shipped.

An abbreviated process flow diagram is shown in Figure 1.

Existing Waste Management Practices

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

- Reactive rinsing for cleaning prior to anodizing is used in order to reduce the amount of fresh make-up water required and to help neutralize the rinse following the alkaline cleaning solution.
- Air agitation of some of the tanks in the anodizing/chromating line improves the effectiveness of the solutions and extends their life.
- Water consumption is controlled through a flow meter on the anodizing/chromating line. In addition, water consumption is monitored daily in an effort to encourage conservation.
- Chromating solutions are very effectively maintained so that the frequency of dumping and replenishment is minimized.
- Clean-up solvent is reused before offsite disposal.
- Scrap metal is segregated by type and sold to a scrap dealer for recycling.
- A replacement aqueous cleaner is being phased-in to replace TCA degreasing.

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 type of waste, the minimization opportunity, the possible waste reduction and associated savings, and the implementation cost along with the payback times 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.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, additional measures were considered. These measures were not completely analyzed because of insufficient data or minimal savings and a projected lengthy payback. Since these approaches to waste reduction may, however, increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Install a solvent recovery unit to distill the waste cleaning solvent for reuse.
- Encourage customers to consider specifying water-borne instead of solvent-based paints for their products.

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.

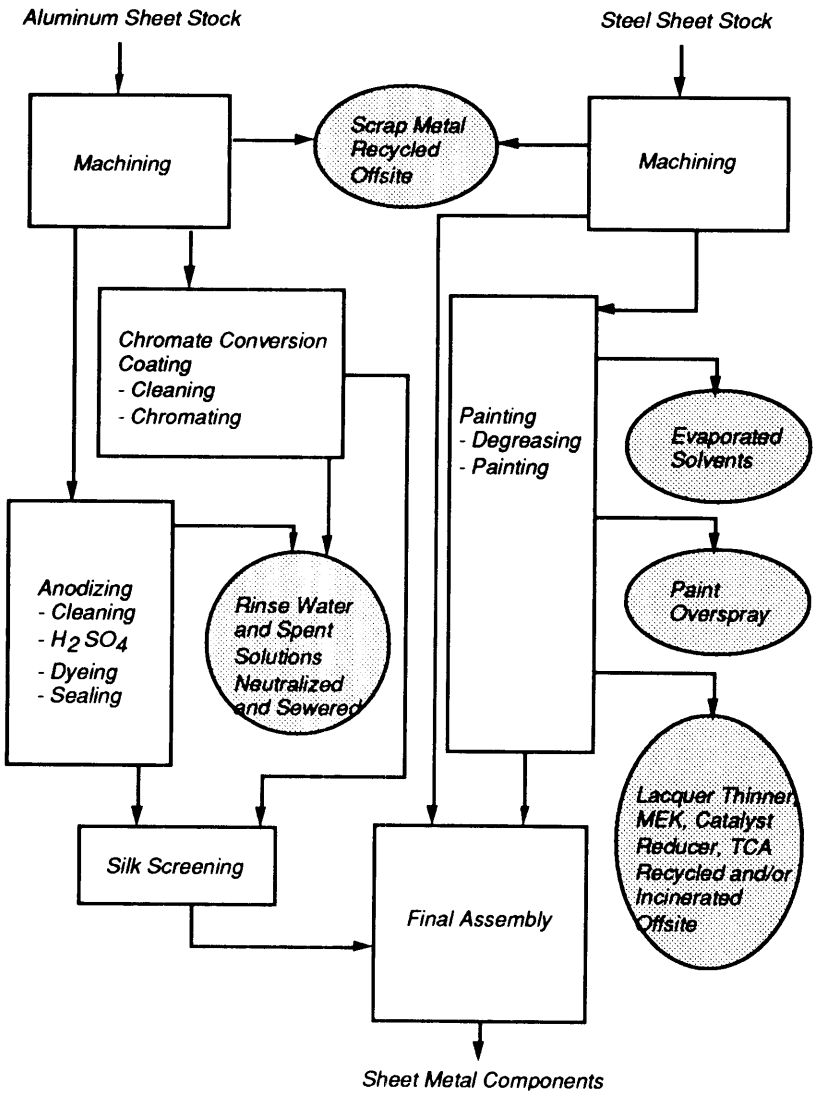

Figure 1. Abbreviated process flow diagram.

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Table 1. Summary of Current Waste Generation

Waste Stream Generated	Source of Waste	Waste Management Method	Annual Quantity Generated	Annual Waste Management Cost
Spent anodizing reagents	Anodizing line	Neutralized and sewered	2,460 gal	$260
Spent anodizing rinse water	Anodizing line	Neutralized and sewered	339,840 gal	1,810
Spent chromate conversion reagents	Chromate conversion line	Neutralized and sewered	25,870 gal	530
Spent chromate conversion rinse water	Chromate conversion line	Neutralized and sewered	997,380 gal	4,260
Spent 1,1,1-trichloroethane	Cleaning of parts in paint line	Shipped offsite for recycling and/or incineration	190 gal	2,310
1,1,1-trichloroethane evaporation	Cleaning of parts in paint line	Evaporates to plant air	470 gal	2,260
Clean-up solvent and other paint wastes	Paint line	Shipped offsite for incineration	200 gal	2,270
Clean-up solvent evaporation	Paint line	Evaporates to plant air	130 gal	280
Paint overspray	Paint line	Conventional disposal offsite	5,570 lb	19,525
Scrap metal	Machining	Sold to a recycler	N/A	N/A

[1]Includes raw material costs.

Table 2. Summary of Recommended Waste Minimization Opportunities

Waste Generated	Minimization Opportunity	Annual Waste Reduction		Net Annual Savings	Implementation Costs	Payback Years
		Quantity	Percent			
Paint overspray	Replace the conventional paint spray guns with High Volume Low Pressure (HVLP) spray guns. The use of the proposed guns will lead to improved paint application efficiency.	1,750 lb	31	$6,060	$800	0.1
Chromate conversion rinse water	Install an additional counter-flowing rinse at the end of the chromating line to reduce the total amount of rinse water consumed.	312,400 gal	31	1,080	2,160	2.0

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