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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Aluminum Extrusions

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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 hazardous 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 Louisville performed an assessment at a plant manufacturing aluminum extrusions — over 10 million lb/yr. Aluminum parts are extruded and tempered followed by electrostatic painting, anodizing, or shipping. The team's report, detailing findings and recommendations, indicated that the most waste was generated by the painting process and that the greatest savings could be obtained by replacing the currently used paints with electrostatic powder coatings.

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 hazardous 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 hazardous 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 hazardous 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 the University of Louisville's WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize hazardous 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 $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 painted, anodized, and mill-finished aluminum extrusions. Over 10 million lb of aluminum extrusions are produced each year by the plant's 100 employees who operate the plant approximately 4000 hr/yr.

Manufacturing Process

The manufacturing processes of this plant and the wastes generated are described below.

Extrusion

Three extrusion presses are used to produce aluminum parts. Aluminum billets are processed in two of the presses. First, the billets are coated with an extrusion compound to reduce friction and heated to 900°F in a furnace. Then the billets are extruded through the appropriate die and the ends of the billets are cut off. The resulting parts are then moved to a cooling station prior to age-hardening.

Aluminum logs are processed in the third press, which is computer-controlled. These logs are also coated and heated to 900°F prior to extrusion. The logs are extruded and cut to size as determined by the control system. The resulting parts are cooled before age-hardening.

The cooled, extruded parts are tempered in ovens at 365°F for 4 hr (age-hardening). The parts are then sent to painting, anodizing, or directly to shipping.

Several wastes are generated by the extrusion process. Aluminum shavings and billet ends are recycled by a sister plant. The caustic solution that is used to clean the extrusion dies is sent to the on-site wastewater treatment plant. Waste hydraulic fluid from the presses is recycled on-site; sludge from the recycler is landfilled. Wastewater from the cooling of the extrusion presses is disposed of through a storm sewer drain.

Painting

Parts that require painting are hung on an overhead conveyor. Prior to painting, the parts are run through a conversion coating system in which a coat of chromium phosphate is bonded to part surfaces for corrosion protection. Parts are dried in a 250°F oven.

After drying, the parts are electrostatically painted in one of two paint booths. Paint is cured in a 350°F oven. Selected parts are then tested. Most of the failed parts are scrapped, but some failed parts are reworked.

Waste generated by the painting process includes wastewater from the conversion coating process that is sent to the onsite wastewater treatment plant. Chromate chips that result from the cleaning of the solution mixing tank are disposed of in a hazardous waste landfill. A significant amount of overspray paint waste is disposed of in a nonhazardous landfill. Sludge containing xylene and paint results from the cleaning of the paint atomizer parts and is disposed of as a hazardous waste. Hydraulic oil that leaks from the atomizers mixes with paint and xylene in the paint booths and is disposed of in a nonhazardous waste landfill. Used filters from the booths are disposed of in the dumpster with other miscellaneous trash.

Anodizing

Parts to be anodized are degreased, rinsed, etched, rinsed again, and then dipped into the anodizing tank. After anodizing, the parts are rinsed and dipped in a seal tank. Waste solutions from the anodizing line are sent to the onsite WWTP.

Thermalfilling

Painted and anodized parts which will be used in household windows and doors are sent to the thermalfill line. In this process, the cavity of the part is filled with epoxy. Once the parts have dried, a portion of the metal and epoxy is removed to create a discontinuity, thereby providing greater insulation potential.

Waste epoxy resin, aluminum and epoxy cuttings, and waste methylene chloride, which is used to clean the epoxy discharge nozzles, are disposed of in the dumpster.

Existing Waste Management Practices

This plant has already taken the following steps to manage and minimize its wastes:

- The computer-controlled extrusion press operates more efficiently and generates less waste aluminum than standard extrusion presses. Eventually all of this plant's extrusions will be produced by the computer-controlled press.
- Hydraulic oil is cleaned onsite and reused.
- Scrap aluminum is reused by a sister plant.
- Waste from the conversion coating process is treated to reduce chromium (VI) to chromium (III) before disposal.
- High-solids electrostatic paint is used in the paint line to reduce volatile organic compound (VOC) emissions and overspray.
- An on-site wastewater treatment plant pretreats all process wastewater prior to discharge to the public owned treatment works (POTW).

Waste Minimization Opportunities

The waste streams currently generated by the plant, the waste management methods applied, the quantities of waste, and the annual treatment and disposal costs are given in Table 1.

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. Current plant practice, the proposed action, and waste reduction, savings, and implementation cost data are given for each opportunity. 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 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 analyzed and recommended by the WMAC, several other possibilities for waste minimization were evaluated by the assessment team. These measures were not completely analyzed because of insufficient data or minimal savings. They were brought to the manufacturer's attention for future reference, however, since these approaches to waste minimization may increase in attractiveness with changing plant conditions.

- Recover chromium from the waste rinse waters using ion exchange. This measure probably would not be cost-effective because of the small amount of chromium involved.
- Recover the aluminum from the caustic dip tank of the anodizing line or arrange to sell the waste aluminum hydroxide through a waste exchange. The recovery of the aluminum would result in an unacceptably long payback. It is possible that a buyer may be interested in the waste.
- Use an alternate solvent or a non-solvent method for cleaning the nozzles in the thermalfill line.
- Use more efficient heat exchangers for cooling the extrusion presses.

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 Stream Generated	*Waste Management Method*	*Annual Quantity Generated*	*Annual Waste Management Cost*
Extrusion			
Hydraulic oil sludge	*Off-site landfill*	*5,400 lb*	*$ 4,210*
Caustic cleaning solution	*Treated onsite and sewered*	*57,600 gal*	*180*
Cooling water from well	*Storm drain*	*68,160,000 gal*	*0*
Aluminum shavings and cuttings	*Recycled by sister plant*	*	*
Painting			
Paint overspray	*Off-site landfill*	*3,300 gal*	*13,680*
Paint and xylene sludge	*Off-site hazardous waste disposal facility*	*55 gal*	*360*
Hydraulic oil and paint sludge	*Off-site landfill*	*495 gal*	*1,170*
Chromate conversion solutions	*Treated onsite and sewered*	*3,720,000 gal*	*11,840*
Chromium chips	*Off-site hazardous waste disposal facility*	*1,200 lb*	*920*
Anodizing			
Anodizing solutions	*Treated onsite and sewered*	*3,732,000 gal*	*15,040*
Thermalfill			
Aluminum and epoxy cuttings	*Dumpster*	*42,000 lb*	*1,370*
Epoxy resin and methylene chloride	*Dumpster*	*15,000 lb*	*460*
Wastewater Treatment			
Chromate sludge	*Off-site landfill*	*33,830 gal*	*13,700*
Miscellaneous			
Metal packing bands	*Sold to recycler*	*18,000 lb*	*(340)[1]*
Empty drums	*Sold to recycler*	*220 units*	*(220)[1]*
Paper, cardboard, rags, etc.	*Dumpster*	*1,040 yd^3*	*450*

* *Quantity and cost not available*
[1] *Revenue received*

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Table 2. Summary of Recommended Waste Minimization Opportunities

Present Practice	Proposed Action	Waste Reduction and Associated Savings
Waste hydraulic oil unreclaimed after the plant's on-site recycling process is sent to an off-site landfill.	Ship the remaining hydraulic oil to a secondary fuels program at a lower disposal cost. Discontinue the addition of lime kiln dust to the waste for solidification.	Waste reduction = 2,700 lb/yr Waste management cost savings = $3,540/yr Implementation cost = 0 Payback is immediate.
The paint spray booths operate continuously. Paint is sprayed during long gaps when no parts are fed through the line.	Install optical sensors and controls to turn off the flow of paint when no parts are being fed through the line.	Waste reduction =1,650 gal/yr Waste management cost savings = $6,840/yr Raw material cost savings = $1,800/yr Total cost savings = $8,640/yr Implementation cost = $7,500 Simple payback = 0.9 yr
High-solids, electrostatic paint is used in the paint spray booths.	Replace the currently used paints with electrostatic powder coatings.	Waste reduction = 2,915 gal/yr Waste management cost savings = $11,330/yr Raw material cost savings = $12,600/yr Total cost savings = $23,930/yr Implementation cost = $118,000 Simple payback = 5.1 yr
Wastewater is released to the sewer after on-site treatment.	Recycle the effluent from the on-site WWTP.	Waste reduction = 5,520,000 gal/yr Waste management cost savings = $6,790/yr Water cost savings = $4,750/yr Operating cost = $580/yr Net cost savings = $10,960/yr Implementation cost = $1,520 Simple payback = 0.2 yr
Overflow from the anodizing tank is sent to the on-site WWTP.	Install an anion exchange-based acid purification unit to recover the sulfuric acid from the solution and return it to the bath. Water usage will also be reduced because it will no longer be fed continuously to the tank.	Waste reduction = 248,000 gal/yr Waste management cost savings = $500/yr Raw material cost savings = $5,250/yr Total cost savings = $5,750/yr Implementation cost = $35,000 Simple payback = 6.1 yr
Aluminum and epoxy cuttings from the thermalfill line are disposed of in the dumpster.	Separate the aluminum from the epoxy in a zig-zag classifier and sell the aluminum to the company's sister plant.	Waste reduction = 21,000 lb/yr Waste management cost savings = $685/yr Revenue received = $2,940/yr Total cost savings = $3,625/yr Implementation cost = $6,180 Simple payback = 1.7 yr

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