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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Cutting and Welding Equipment

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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 produces custom-built cutting and welding equipment. Components are fabricated from steel and other raw materials that are cleaned, machined, welded, and painted. Machines are then assembled, tested, and calibrated. The hazardous wastes generated by the plant include tramp oil, spent cutting fluid, spent lacquer thinner, and chromium-contaminated paint dust and filters. The team's report, detailing findings and recommendations, indicated that the plant could achieve the greatest dollar savings by replacing chromium-containing solvent-based paints with chromium-free water-based paints.

This Research Brief was developed by the principal investigator 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 that is 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. The primary solution to the problem of waste is to reduce or eliminate it 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

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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

The plant manufactures custom-built welding equipment and cutting machines. It operates approximately 4,500 hr/yr to produce more than 80 machines annually.

Manufacturing Process

This plant produces welding equipment and cutting machines that are custom-built to meet clients' requirements. The major raw material is steel; however, iron, aluminum, brass, zinc-plated steel, and phenolic materials are also used.

Prior to fabrication, the metals are cleaned using a spray wand to remove residual rust-preventing oil. A flame cutter is then used to cut the metal to workable dimensions. The material undergoes machining with drills, lathes, and cutting and milling machines. The parts are then mechanically cleaned using grinders and sanders. Welding is performed as necessary.

Components to be painted are first treated with alkaline cleaner and phosphate solution in a series of dip tanks. Solvent-based acrylic lacquers and enamels are applied using spray guns in the paint booth. Logos are applied using silk-screening.

The various components are then assembled, tested, and calibrated. An abbreviated process flow diagram that also describes waste generation is shown in Figure 1.

Existing Waste Management Practices

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

- A portable oil skimmer is used to remove tramp oil from the cutting fluid in the sumps of the computer numerically-controlled (CNC) machines. The decreased amount of tramp oil in the sumps has increased the life of the cutting fluid.
- A belt skimmer and filter are used to remove tramp oil and particulate matter from the cutting fluid drained from the CNC machines so that the fluid can be reused in the manual machining equipment.
- The phosphating dip line used prior to painting was installed to reduce the use of lacquer thinner for cleaning and degreasing.
- Electronic assemblies are cleaned with a terpene hydrocarbon cleaner instead of perchloroethylene.
- High-volume low-pressure paint guns are used in order to reduce overspray and conserve paint.
- Water-based paints are being evaluated on a trial basis as a replacement for the solvent-based paints currently used.

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 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. 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 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 may 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, minimal savings, implementation difficulty, or a projected lengthy payback. Since one or more of 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.

- Test the waste cutting fluid from the CNC machines to determine if the lead and benzene concentrations are low enough that the waste could be shipped to a disposal facility for nonhazardous waste.
- Evaluate the need for the application of rust-preventive oil to the raw material. It is possible that the rust-preventive oil is unnecessary thereby reducing the need for cleaning.
- Segregate the scrap metal by type to increase the amount of revenue received.

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.

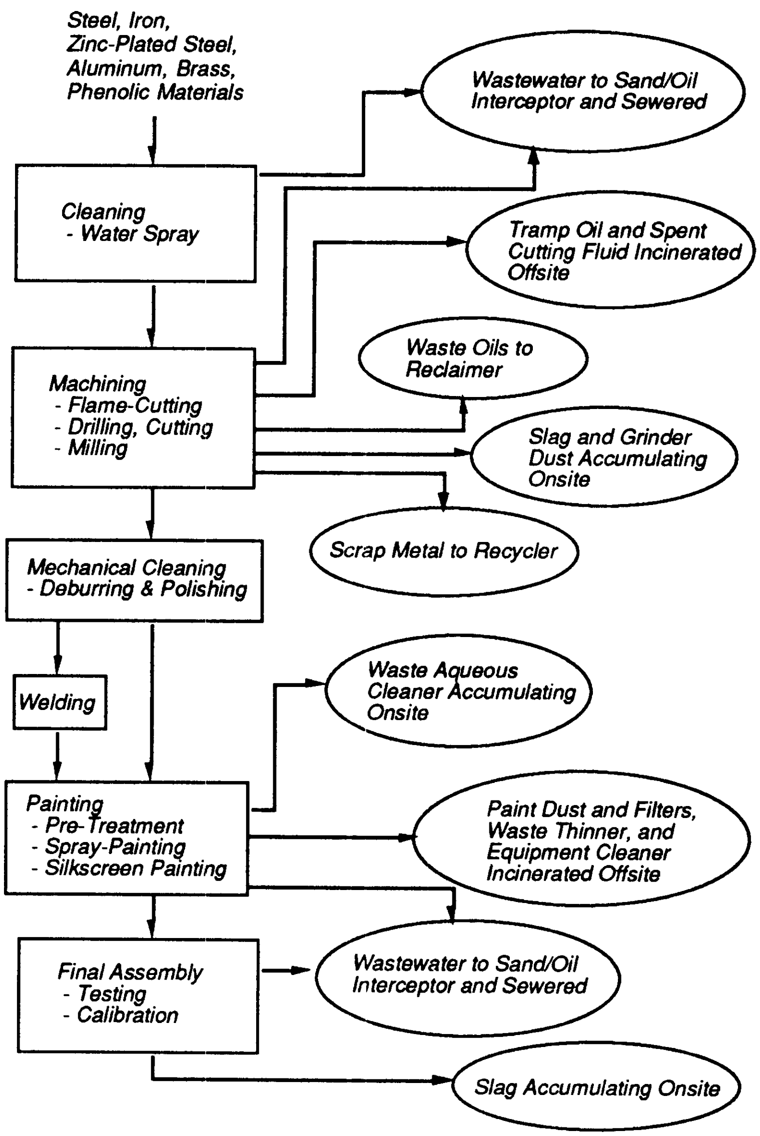

Figure 1. Abbreviated process flow diagram.

Table 1. Summary of Current Waste Generation

Waste Generated	Source of Waste	Annual Quantity Generated	Annual Waste Management Cost
Wastewater	Spray wand phosphating/cleaning. Wastewater from the removal of rust-preventing oil from metal prior to fabrication is drained to a sand and oil interceptor and then sewered as industrial wastewater.	210,000 gal	$500 [1]
Wastewater	Flame cutting. Cooling water that is used to prevent metal warping during flame cutting is drained to a sand and oil interceptor and then sewered as industrial wastewater.	437,500 gal	1,040 [1]
Tramp oil	Machining. Tramp oil from cutting fluid is shipped offsite for incineration at a hazardous waste disposal facility.	495 gal	2,310
Spent cutting fluid	Machining. Cutting fluid that cannot be reused is shipped offsite for incineration at a hazardous waste disposal facility.	420 gal	1960
Miscellaneous waste oil	Various plant equipment. Waste motor oil and lubricating oil from forklifts and other plant equipment is shipped offsite for reclamation as industrial boiler fuel.	400 gal	80
Slag and grinder dust	Machining. Slag resulting from flame cutting and grinding dust are accumulating onsite.	Not available	0 [2]
Scrap metal	Machining Scrap metal generated by sawing and machining operations is sold to a recycler.	Not available	Not available.
Wastewater	Paint line pretreating. Water used for pretreating prior to painting is drained to a sand and oil interceptor and then sewered as industrial wastewater.	23,000 gal	60 [1]
Waste aqueous degreasers	Paint line pretreating. Waste aqueous cleaners used in small volumes are stored onsite pending analysis and determination of a proper disposal method.	Not available	0 [2]
Spent lacquer thinner	Painting. Lacquer thinner used to degrease parts prior to painting is shipped offsite for incineration at a hazardous waste disposal facility.	810 gal	4,430 [1]
Equipment cleaning solvent	Painting. Solvent used to clean paint guns and other painting equipment is shipped offsite for incineration at a hazardous waste disposal facility. (This solvent is no longer used; it has been replaced by the lacquer thinner.)	95 gal	510 [1]
Chromium-contaminated paint dust and filters	Painting. Paint filters that trap overspray and paint dust are shipped offsite for incineration at a hazardous waste disposal facility.	1,390 lb	5,610
Wastewater	Assembly and testing. Cooling water used in flame cutting testing is drained to a sand and oil interceptor and then sewered as industrial wastewater.	3,180 gal	10 [1]
Slag	Assembly and testing. Slag resulting from flame cutting testing is accumulating onsite.	Not available	0 [2]

[1] Includes cost of raw material.
[2] Accumulating onsite; no waste management costs incurred.

Table 2. Summary of Recommended Waste Minimization Opportunities

Waste Generated	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Costs	Payback Years
Chromium-contaminated paint dust and filters	Replace chromium-containing solvent-based paints with chromium-free water-based paints.	1,390 lb	100	$4,180 [1]	$1,000	0.2
Spent lacquer thinner	Paint dust and filters can then be disposed of in the municipal landfill without an increase in trash hauling fees. The purchase of lacquer thinner and the subsequent disposal of spent thinner will be reduced.	40 gal	5			
Spent lacquer thinner	Install a distillation unit to recover lacquer thinner for reuse. The amount of spent thinner shipped offsite for disposal and the amount of lacquer thinner purchased will be reduced.	610 gal	75	2,300 [2,3]	7,060	3.1
Spent cutting fluid	Acid treat the cutting fluid waste from the CNC machines to effect a separation of organic and aqueous phases. Discharge the aqueous phase to the industrial sewer and dispose of the organic phase at a hazardous waste disposal facility.	240 gal	57	1,100 [2]	1,000	0.9
Spent cutting fluid	Heat the cutting fluid waste from the CNC machines to evaporate the aqueous phase and reduce the volume of waste sent to the offsite hazardous waste disposal facility.	240 gal	57	1,070 [2]	2,800	2.6
Spent cutting fluid	Replace the cutting fluid used in the track mill with a vegetable oil-based spray coolant that is biodegradable and completely consumed during cutting.	150 gal	36	770 [3]	1,210	1.6

[1] Total waste management cost savings have been reduced by increased raw material costs.
[2] Total waste management cost savings have been reduced by the operating cost of the proposed system.
[3] Includes savings on raw materials.

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