United States Environmental Protection Agency
Research and Development

Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

EPA/600/S-95/005 April 1995

EPA ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of New and Reworked Rotogravure Printing Cylinders

Marvin Fleischman*, Clay Hansen*, and
Gwen P. Looby**

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). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at the University of Louisville performed an assessment at a plant manufacturing cylinders for rotogravure printing. Rotogravure printing cylinders are produced from new stock and used cylinders that require reworking. Cylinders undergo cleaning, plating, lathing, polishing, and grinding. Then the surfaces of the cylinders are engraved, cleaned, polished, and chrome-plated. The assessment team's report, detailing findings and recommendations, indicated that significant cost savings could be achieved by melting and reusing copper scrap as anodes in the plating bath.

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 generation 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 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 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 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*

* University of Louisville, Department of Chemical Engineering.
** University City Science Center, Philadelphia, PA.

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

The plant produces chrome-plated engraved copper-plated steel and aluminum cylinders for rotogravure printing from new stock and customer returns. It operates 6,240 hr/yr to produce over 7,000 cylinders annually.

Manufacturing Process

Rotogravure printing cylinders are produced from new stock (primarily steel or aluminum) and used cylinders requiring reworking.

New cylinders are cleaned and degreased before processing. Then the aluminum cylinders are passivated in a wash tank containing an acid mixture, and zincated in a zinc oxide solution. Next, all aluminum and steel cylinders are nickel-plated and then copper-plated. Used cylinders undergo cleaning, acid stripping, and lathing and are then copper-plated. The plated cylinders then undergo lathing, polishing, and grinding.

Customer-provided artwork is used to create plating images which are then mechanically engraved on the surfaces of the cylinders. The engraved cylinders are cleaned, polished, and chrome-plated.

Cylinders are then tested in the proofing department. Those cylinders that pass inspection are packaged and shipped. The cylinders that fail inspection are stripped of chrome (using acid) and are either replated with chrome or lathed and returned to the copper-plating baths for reprocessing.

An abbreviated process flow diagram is shown in Figure 1.

Existing Waste Management Practices

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

- Metal shavings (primarily copper) from turning, polishing, and electronic engraving are recovered and sold for reclamation.
- Cylinders are rinsed with deionized water directly above the tanks after nickel and copper plating in order to eliminate drag-out of plating solution.
- Film with a very low silver content is used in image processing in order to reduce the amount of waste silver generated.
- Silver is recovered onsite by electrolytic deposition.
- Recovered silver and waste film are sold to a recycler.
- Electronic engraving is used for etching cylinders in order to eliminate the wastes that would be generated using chemical etching.
- Cylinders are rinsed over the plating tanks and fume scrubber water is reused as plating bath make-up in order to eliminate the need for chromium removal from wastewater.
- Chromic acid fume and evaporative losses are reduced through the use of tank covers and floating plastic balls.

Plant personnel are currently evaluating the following options for managing and minimizing plant wastes:

- The plant plans to switch to computer-generated image-making as a replacement for photographic image processing.
- Ceramic coating of the cylinders to replace nickel-, copper, and chrome-plating is being investigated.
- An alternative to the ink solvent that contains methylene chloride is being sought.

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 for each waste stream identified 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 would result when the opportunities are implemented in a package.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, several 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.

- Reduce or eliminate spillover from the nickel- and copper-plating tanks by installing plastic guards around the tank edges.
- Evaluate the necessity for and standardize the use of solvents in cleaning cylinders.
- Recover chromium or hydrochloric acid from the spent acid stripper solution.
- Replace disposable filters used for filtering nickel- and copper-plating solutions with reusable stainless steel filters.

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**.

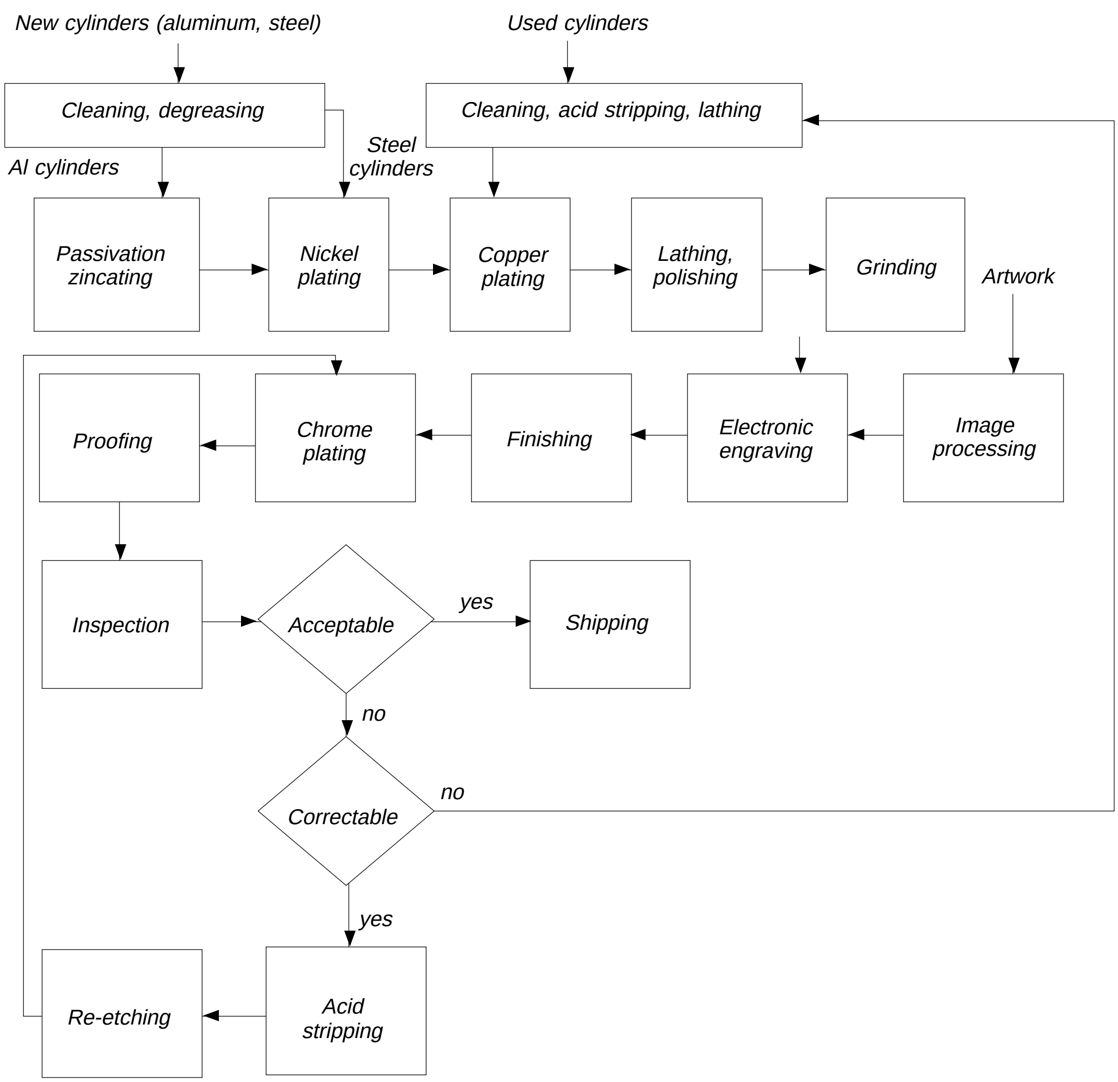

Figure 1. *Abbreviated process flow diagram for rotogravure printing cylinders.*

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb/yr)	Annual Waste Management Cost [1]
Butyl acetate, acid stripping solution, and rinse water	Preparation of used cylinders	Drained to storage tank; shipped offsite for disposal as hazardous waste	144,600	10,530
Wastewater	Preparation of used cylinders	Drained to holding tank; neutralized; sewered	607,900	—[2]
Passivating and zincating solutions	Preparation of new cylinders	Drained to storage tank; shipped offsite for disposal as hazardous waste	21,520	1,460
Wastewater	Preparation of new cylinders	Drained to holding tank; neutralized; sewered	349,780	—[2]
Cleaning water	Cleaning of copper-plating tanks	Drained to storage tank; shipped offsite for disposal as hazardous waste	160,130	11,520
Copper- and nickel-plating sludge	Copper- and nickel-plating tanks	Shipped offsite for disposal as hazardous waste	1,320 gal	7,320
Copper anode nuggets	Copper plating	Sold to recycler/reclaimer	1,440	-1,330
Chromium sludge	Chrome-plating tank	Shipped offsite for disposal as hazardous waste	550 gal	2,540
Wastewater	Chrome plating	Drained to holding tank; neutralized; sewered	3,002,400	—[2]
Copper sludge	Grinding	Shipped offsite for disposal as hazardous waste	26,000 gal	15,600
Scrap metal	Cutting, lathing, and polishing	Sold to recycler/reclaimer	93,700	-79,580
Wastewater	Cleaning of film processors	Drained to storage tank; shipped offsite for disposal as hazardous waste	15,000	1,080
Water overflow	Film processors	Drained to holding tank; neutralized; sewered	676,540	—[2]
Silver	Onsite electrolytic silver recovery	Shipped offsite for further recovery	100	-3,780
Waste film	Image processing	Sold to reclaimer	750	-7,560
Copper dust	Engraving	Sold to recycler/reclaimer	120	-110
Solvent-based ink	Proofing of cylinders	Shipped offsite for fuels blending	8,700	1,540
Water-based ink	Proofing of cylinders	Shipped offsite for ink reblending	900	160
Spent etch bath and rinse water	Re-etching of cylinders	Drained to storage tank; shipped offsite for disposal as hazardous waste	3,000	640
Ethanol	Re-etching of cylinders	Drained to holding tank; neutralized; sewered	4,300	—[2]
Wastewater	Re-etching of cylinders	Drained to holding tank; neutralized; sewered	16,010	—[2]
Rags	Various plant operations	Laundered offsite; returned for reuse	15,000 units	not available
Paper towels	Various plant operations	Shipped to landfill	300,000 units	—[3]

[1] Includes waste treatment, disposal, and handling costs.
[2] Included in total POTW and onsite treatment costs of $32,750/yr.
[3] Included in total landfill disposal costs of $34,200/yr.

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Minimization Opportunity	Waste Reduced	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Simple Payback (yr)
		Quantity (lb/yr)	Per cent			
Melt copper scrap resulting from turning and cutting cylinders, polishing, engraving, and plating in a furnace and reuse as anodes in the plating bath. A degreasing system may be required for cleaning of the copper scrap prior to melting.	Copper shavings, particles, and spent anode nuggets	43,200	45	$35,890	57,100	1.6
Install a drip board on the chrome plating bath so that dragout can be captured and returned to the plating bath. Currently trapped dragout in the core tape used on the cylinders is lost on the floor and in the rinse tank and eventually is sewered.	Chromic acid	1,530	n/a	1,760	40	0.1
Install a filter press in order to recover copper from the grinding sludge. Sell the recovered copper to a reclaimer and sewer the removed water.	Copper sludge	26,000 gal[1]	100	47,460	16,820	0.4
Reuse spent butyl acetate once for subsequent cleaning.	Butyl acetate	5,150	50	2,960	640	0.2
Use a small distillation unit to reclaim spent butyl acetate for reuse.	Butyl acetate	7,210	70	3,740	3,700	1.0
Remove metal from the spent cleaning water from copper-plating tank clean-out using electrolytic metal recovery. Sell recovered copper to a reclaimer and sewer the water.	Cleaning water	160,130[1]	100	17,450	35,520	2.0
Install high pressure spray rinses and automatic shut-offs in certain process areas in order to reduce water consumption.	Nonhazardous rinse water Hazardous rinse water	1,200,960 6,765	50 50	4,120	1,150	0.3
Replace the ethanol rinse with a hot deionized water rinse followed by hot air blowing. This measure will also reduce BOD (Biological Oxygen Demand) and BOD surcharges.	Ethanol	4,300[2]	100	2,740	290	0.1
Install a distillation unit to recover ethanol for reuse. This measure will also reduce BOD and BOD surcharges.	Ethanol	3,000	70	1,670	3,700	2.2
Install an in-line evaporator to remove water from the waste going to the waste disposal tank for later disposal as hazardous waste.	Hazardous liquid waste	384,360	62	24,040	37,700	1.6
Base sewer charges on actual wastewater effluent rather than on water consumption.	Not applicable	—-	—-	7,600	4,140	0.5

[1] Waste has been changed in form to one that is less costly for plant to manage.
[2] A wastewater stream of the same quantity will be generated if this opportunity is implemented.

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35

Official Business
Penalty for Private Use
$300

EPA/600/S-95/005