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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Penny Blanks and Zinc Products

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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 penny blanks, dry cell battery cans, and other zinc products—approximately 120 million lb/yr. Zinc ingots and scrap zinc are melted in an electric furnace. The molten zinc is formed into coils of strip for further processing or sale to industrial customers. The circular penny blanks are formed in a press, upset to form a rim on the edge, copper plated, and visually inspected. Battery can blanks are pressed from the strip, drawn into can shape, cleaned, and dried. The team's report, detailing findings and recommendations, indicated that the most waste was generated as dross in melting the zinc and that the greatest savings could be obtained by reducing drag-out from the plating tanks to reduce downstream sludge formation and installing driers to dewater the sludge before shipment for disposal.

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 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 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, 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 Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identifies the current disposal or treatment methods and their

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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 penny blanks, dry cell battery cans, zinc roll stock, and other zinc products. The raw materials include zinc ingots, caustic soda, chlorine, potassium cyanide, copper anodes, sodium metal sulfide, sulfuric acid, iron sulfide, phosphate cleaner, electro-cleaning solution, active carbon, and solvents.

Manufacturing Process

The following steps are involved in making the penny blanks:

- The circular blanks are formed from zinc strip in a press. Scrap zinc is recycled to the electric melting furnace.
- The blanks are upset to form a rim on the edge.
- The blanks are cleaned in a non-alkaline cleaner solution and a heated electro-cleaning solution, rinsed in water, and treated in a copper strike tank (containing copper cyanide and copper anodes), where a thin copper film is formed on the zinc surface.
- The blanks are copper plated in a solution containing potassium cyanide, copper cyanide, tartar, and brighteners. Spent solution is filtered, treated with active carbon and hydrogen peroxide, and returned to the plating tank. Carbon slurry and decanted liquids are sent to a wastewater treatment system.
- The blanks are rinsed in water, washed in a water spray washer with an anti-tarnishing agent added, and dried in a steam-heated drier. Rinse water is sent to the wastewater treatment system.

The following steps are involved in making the dry cell battery cans:

- Blanks are formed from zinc strip in a press. Scrap zinc is washed and returned to the melting furnace.
- The can shape is formed from the blanks in a draw-redraw machine.
- The cans are cleaned in a drum washer and dried.

An abbreviated process flow diagram is shown in Figure 1.

Existing Waste Management Practices

A batch system is used for lime treatment of spent cleaning solutions and filter media, with alkaline chlorination to destroy residual cyanide. Spent plating solutions and rinse waters are handled in a continuous flow water treatment system with electrolytic metal recovery for solutions with high copper content and an alkaline chlorination system to break down residual cyanide. Effluents from these treatment systems are treated with a flocculant to precipitate insoluble copper compounds as a sludge. Remaining soluble copper is reacted with iron sulfide and precipitated as copper sulfide sludge. The sludges are dewatered for disposal, and the effluent water is filtered and discharged to a creek.

Spent cleaner solutions (nonhazardous) from battery can production are treated with a flocculant to trap insolubles, which settle as a

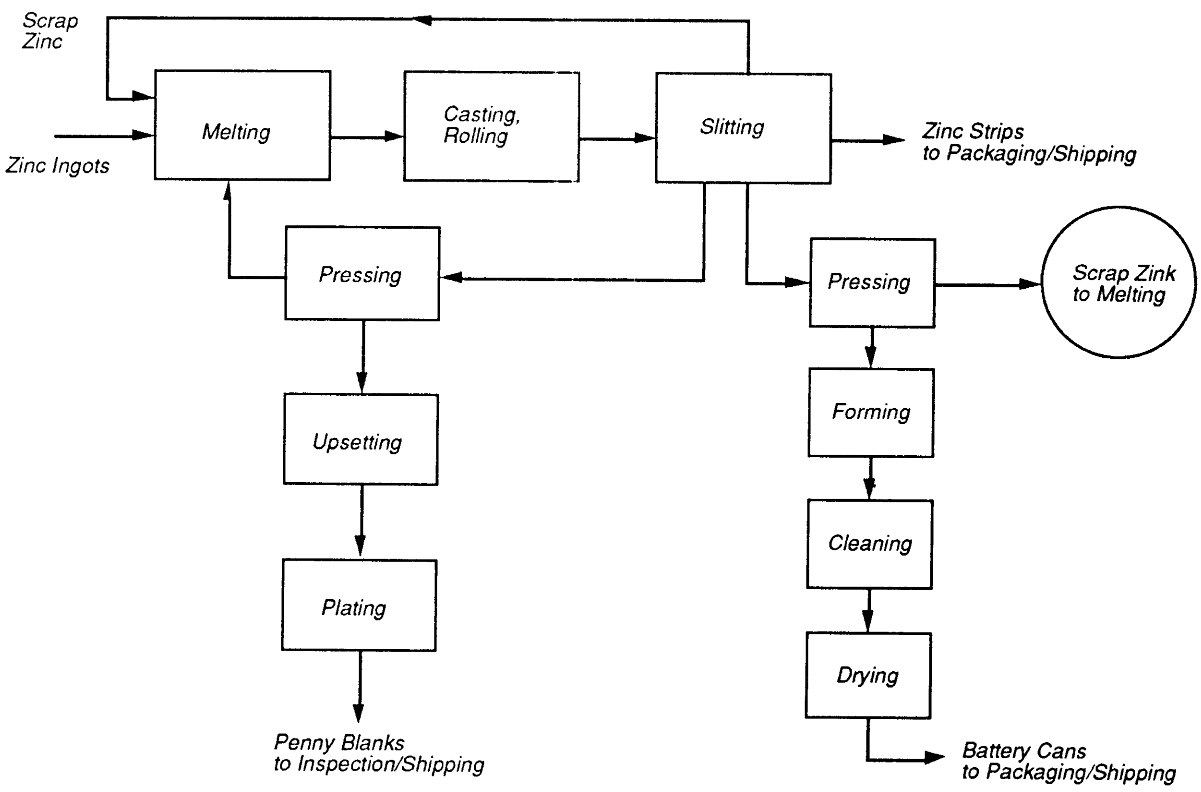

Figure 1. Abbreviated process flow diagram.

sludge. Effluent water is filtered and discharged to a creek. Sludge is dried in a vacuum filter and disposed of as landfill.

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 times are given in the table. The quantities of hazardous 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 hazardous 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*
Zinc dross	*Zinc ingots are melted in an electric furnace. Dross, periodically raked from the surface of the molten zinc and sold to a reclaimer, contains about 45% zinc metal.*	*2,000,000 lb*	*$221,200*
Spent cleaner (a solvent mixture)	*Zinc strip, after slitting, is cleaned in a cold cleaner tank. The spent cleaner is shipped offsite for disposal as hazardous waste.*	*3,500 lb*	*24,225*
Cleaner solvent vapor loss	*Solvent vapor loss occurs when slit zinc strip is cleaned with a cold cleaner solvent mixture.*	*12,400 lb*	*5,178*
Spent phosphate cleaner and spent electrocleaner solutions	*A non-alkaline phosphate cleaner solution and a low-foaming electro-cleaning solution used to clean penny blanks before plating, when spent, are treated with hydrated lime and combined with other aqueous effluents in the plant's wastewater treatment system.*	*98,400 gal**	*0*
Spent copper strike solution	*Copper dissolved in spent copper strike solution is recovered by plating it onto zinc anodes for recycle to the zinc melting furnace. The effluent solution is diluted with rinse waters and treated by alkaline chlorination (to break down residual cyanide) in the wastewater treatment system.*	*2,200 gal**	*0*
Spent copper plating solution	*Copper plating solution is continuously treated with hydrogen peroxide and active carbon, filtered, and recirculated to the plating tanks. Spent solution is decanted and treated by electrolytic metal recovery and alkaline chlorination in the wastewater treatment system.*	*14,400 gal**	*0*
Spent filter paper	*Filter paper from filtration of copper plating solution is pulverized and, with the spent plating solution, is treated by hydrated lime and alkaline chlorination in the water treatment system.*	*900 lb**	*0*
Spent active carbon slurry	*Spent active carbon used in treating recirculated plating solution is transferred to the wastewater treatment system for alkaline chlorination.*	*200 gal**	*0*
Plating solution drag-out	*Drag-out from the plating tanks is collected in a drip tank and pumped to the wastewater treatment system for recovery of dissolved copper and alkaline chlorination.*	*60,000 gal**	*0*
Processed wastewater	*Spent aqueous solutions and rinse waters, after treatment in the wastewater treatment system, are discarded to a local creek.*	*80,000,000 gal**	*0*
Copper-rich sludge	*Sludge filtered from recirculated copper plating solution is sold to a reclaimer.*	*816,000 lb*	*319,140*
Iron sulfide/cleaner sludge	*Wastewater treatment clarifier effluent is treated with iron sulfide to remove copper. Effluent from treatment of the aqueous cleaner solutions is added, and the sludge is removed by filtration and disposed of as hazardous waste.*	*183,600 lb*	*111,340*
Battery can wastewater sludge	*Drum washer wastewater is treated with a flocculant. The resulting sludge, with a filter aid, is removed by vacuum filtration and disposed of in a landfill.*	*384,000 lb*	*97,775*

**Water is obtained by the plant without charge and after treatment, is discarded without charge in a local creek. Charges for waste materials accumulated in the plant's wastewater treatment system are listed here.*

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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
Zinc dross	Install a small furnace to bleed zinc metal contained in the dross, and recharge it to the zinc melting furnace.	630,000 lb	32	$75,310	$86,160	1.1
Copper-rich sludge and iron sulfide sludge	Install rinse spray nozzles above stations where penny blanks are transferred from plating baths to rinse tanks. The spray mist will reduce solution drag-out, which causes sludge formation downstream. Circulate air over the bath to increase the water evaporation rate and compensate for the added water.	30,000 lb	3	53,652	5,800	10.8
Copper-rich sludge, iron sulfide/cleaner sludge	Install gas-fired driers to dewater the sludge. It is estimated that 50% of the contained water can be removed, reducing the weight of hazardous sludge by 25% and that of nonhazardous sludge by 40%.	403,500 lb	29	41,093	81,880	2.0
Spent cold cleaner (a solvent mixture)	Use an aqueous cleaner (nonhazardous) instead of a solvent-based cleaner for cleaning slit zinc coils. (There is no net reduction in waste generated, but raw material and disposal costs are reduced.)	0	0	29,725	20,000	0.7
Copper-rich sludge, iron sulfide/cleaner sludge, and battery can wastewater sludge	Avoid excess copper plating thickness by injecting plating solution into the barrels of penny blanks and increasing barrel rotating speed to improve solution circulation. Plating to a more uniform and lower thickness will consume a lesser amount of plating reagents and generate lesser amounts of sludge downstream.	30,000 lb	3	9,539	32,740	3.4
Solvent vapor loss (cold cleaner) in cleaning the slit zinc strip	Tight enclosure of the zinc coil cleaning station will reduce cleaner solvent vapor loss.	9,900 lb	80	4,118	1,250	0.3

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