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ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Manufacturer of Electroplated Wire

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Abstract

The U.S. Environmental Protection Agency (EPA) funded a project with the New Jersey Department of Environmental Protection and Energy (NJDEPE) to assist in conducting waste minimization assessments at 30 small- to medium-sized businesses in the state of New Jersey. One of the sites selected was a facility that manufactures electroplated wire for use in the automotive, computer, aerospace, and related industries. The wire is plated with copper, silver, nickel, tin, or tin-lead according to customer specifications. The process involves cleaning of the base wire followed by electroplating using a reel-to-reel technique. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options identified included reduction of discharge volume, improved rinsing operations, changes in the wire drawing operation, and consideration of a zero-discharge system. Implementation of the identified waste minimization opportunities was not part of the program. Percent waste reduction, net annual savings, implementation costs and payback periods were estimated.

This Research Brief was developed by the Principal Investigators and EPA's Risk Reduction Engineering Laboratory in Cincinnati, OH, to announce key findings of this completed assessment.

Introduction

The environmental issues facing industry today have expanded considerably beyond traditional concerns. Wastewater, air emissions, potential soil and groundwater contamination, solid waste disposal, and employee health and safety have become increasingly important concerns. The management and disposal of hazardous substances, including both process-related wastes and residues from waste treatment, receive significant attention because of regulation and economics.

As environmental issues have become more complex, the strategies for waste management and control have become more systematic and integrated. The positive role of waste minimization and pollution prevention within industrial operations at each stage of product life is recognized throughout the world. An ideal goal is to manufacture products while generating the least amount of waste possible.

The Hazardous Waste Advisement Program (HWAP) of the Division of Hazardous Waste Management, NJDEPE, is pursuing the goals of waste minimization awareness and program implementation in the state. HWAP, with the help of an EPA grant from the Risk Reduction Engineering Laboratory, conducted an Assessment of Reduction and Recycling Opportunities for Hazardous Waste (ARROW) project. ARROW was designed to assess waste minimization potential across a broad range of New Jersey industries. The project targeted 30 sites to perform waste minimization assessments following the approach outlined in EPA's *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003). Under contract to NJDEPE, the Hazardous Substance Management Research Center at the New Jersey Institute of Technology (NJIT) assisted in conducting the assessments. This research brief presents an assessment of the manufacturing of electroplated wire (1 of the 30 assessments performed) and provides recommendations for waste minimization options resulting from the assessment.

Methodology of Assessments

The assessment process was coordinated by a team of technical staff from NJIT with experience in process operations,

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basic chemistry, and environmental concerns and needs. Because the EPA waste minimization manual is designed to be primarily applied by the in-house staff of the facility, the degree of involvement of the NJIT team varied according to the ease with which the facility staff could apply the manual. In some cases, NJIT's role was to provide advice. In others, NJIT conducted essentially the entire evaluation.

The goal of the project was to encourage participation in the assessment process by management and staff at the facility. To do this, the participants were encouraged to proceed through the organizational steps outlined in the manual. These steps can be summarized as follows:

- Obtaining corporate commitment to a waste minimization initiative
- Organizing a task force or similar group to carry out the assessment
- Developing a policy statement regarding waste minimization for issuance by corporate management
- Establishing tentative waste reduction goals to be achieved by the program
- Identifying waste-generating sites and processes
- Conducting a detailed site inspection
- Developing a list of options which may lead to the waste reduction goal
- Formally analyzing the feasibility of the various options
- Measuring the effectiveness of the options and continuing the assessment.

Not every facility was able to follow these steps as presented. In each case, however, the identification of waste-generating sites and processes, detailed site inspections, and development of options was carried out. Frequently, it was necessary for a high degree of involvement by NJIT to accomplish these steps. Two common reasons for needing outside participation were a shortage of technical staff within the company and a need to develop an agenda for technical action before corporate commitment and policy statements could be obtained.

It was not a goal of the ARROW project to participate in the feasibility analysis or implementation steps. However, NJIT offered to provide advice for feasibility analysis if requested.

In each case, the NJIT team made several site visits to the facility. Initially, visits were made to explain the EPA manual and to encourage the facility through the organizational stages. If delays and complications developed, the team offered assistance in the technical review, inspections, and option development.

No sampling or laboratory analysis was undertaken as part of these assessments.

Facility Background

The facility is a manufacturer of electroplated wire, used typically for electrical wiring applications in the automotive, computer, aerospace, and related industries. The process involves cleaning of the base wire and plating with copper, silver, nickel, tin, or tin-lead as required by the customer specification. The plated wire is drawn to assure the correct diameter.

The facility is located in an urban area and employs about 25 people. This particular facility has been in operation for many years and the manufacturing practices are well ingrained in the staff. A metal recovery system has been installed to limit the level of metals in the discharge to the sewerage system.

Manufacturing Processes

The production of the plated wire is fundamentally a 3-step operation—cleaning the base wire, plating the desired top coat, and drawing to assure the required size in the final product. Each of these steps has a number of individual operations, however. The base wire which is usually copper of beryllium/copper is electro-cleaned in a caustic solution, rinsed in water, acid dipped, and water rinsed. The cleaned wire is then plated in a reel-to-reel operation with copper, silver, nickel, tin, or tin-lead as required by the customer. There is a final rinse after the plating bath. The plated wire is size-reduced by drawing through a diamond die using a lubricant of water and detergent.

Existing Waste Management Activities

The company has already instituted a program of pollution prevention. This is perhaps best illustrated by the ion exchange/electrowinning procedures which have been installed to recover metals from the combined dragout and rinse waters before they are sent to the POTW for treatment.

In schematic terms all of the rinses and acid/base cleaning effluents are combined and prepared for the ion exchange/electrowinning process. The exception to this is an intermediate processing step required for the effluent from the copper and silver plating baths and rinses. These effluents contain cyanide and require a cyanide destruction step. This is accomplished by oxidation with hydrogen peroxide.

The combined effluents are adjusted to near neutral pH and filtered to remove any solids or dirt. The filtered solutions are piped to a multi-bed ion exchange system to remove copper and other residual metals. The exchanged aqueous stream is sent to the POTW for treatment. It is reported that this stream is approximately 500 gal/day.

When the resin is spent, or has reached its exchange capacity, it is regenerated with sulfuric acid and backwashed. The backwash averages about 300 gal and is rich in copper and other metals. The regeneration is required about once a month. The backwash is pumped to a 500-gal electro-winning tank where the metal is plated onto cathodes until the concentration of metal in solution drops below 50 ppm. The residual solution is looped back to the ion exchange system for further treatment and the plated out material is sold for scrap.

The lubricating process for the wire drawing step is basically a closed loop system. When the water-detergent bath appears to be too dirty, it is decanted off and disposed of as hazardous waste. The volume of this material appears to be about 25 gal and is disposed of about every 2 weeks.

Waste Minimization Opportunities

The type of waste currently generated by the facility, the source of the waste, the quantity of the waste and the annual treatment and disposal costs are given in Table 1. This particular facility presents a dilemma in describing waste streams. The presence of an in-place material recovery system means that the actual waste streams sent offsite are relatively insignificant in terms of the total effluent from the process before the material recovery step. Therefore, some options will also be presented which may relate to improvement of the recovery procedure.

Table 2 shows the opportunities for waste minimization recommended for the facility. The type of waste, the minimization opportunity, 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 at the facility and possible waste reduction depend on the level of activity of the facility. 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. 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.

The cost savings are calculated both in terms of avoided costs of waste disposal and recovery of the value of raw material used again. Also, no equipment depreciation is factored into the calculations.

*. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Regulatory Implications

There do not seem to be significant regulatory implications of pollution prevention initiatives at this facility. It is likely that the metal recovery system was installed at the facility in light of regulatory pressures to control the level of metals in the effluent sent to the POTW. It is also likely, according to the POTW, that additional restrictions will be applied to such effluents in the future. In such a case, the facility will have to enhance its testing of effluent in order to assure that all emissions meet the more severe requirements. The concept of zero discharge to the POTW may also be a viable strategy for the facility, although retaining the metal recovery capability would be desirable.

This Research Brief summarizes a part of the work done under cooperative Agreement No. CR-815165 by the New Jersey Institute of Technology under the sponsorship of the New Jersey Department of Environmental Protection and Energy and the U.S. Environmental Protection Agency. The EPA Project Officer was Mary Ann Curran. She can be reached at:

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Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
Aqueous Discharge to Sewer	*Effluent from the ion exchange system*	*182,000 gal*	*$48*
Detergent/Water Mixture	*Lubricant from the wire drawing operation*	*650 gal*	*1200*
Metal-Containing Aqueous Waste Stream	*Combined rinses and cleaning effluents*	*182,000 gal*	*The facility could not provide the costs of this part of their operation. This is the feed stock for the metal recovery operation and the key cost factors include periodic replacement of resin,acid costs for regeneration of the resin, power consumption for electrowinning, and loss of metals from the plating baths. There is some cost recovery from sale of recovered metal scrap. Estimate: $6,000*

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Table 2. *Summary of Recommended Waste Minimization Opportunities*

Waste Stream Reduced	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years *
Wire Drawing Lubricant	Filtration or centrifugation to remove dirt and solids and extend life of fluid. Additions of biocide may extend fluid life even further.	325 gal	50	$ 600	$1,000	1.6
	Because this is a mechanical operation, filtration to remove any metal particles should produce a liquid which is not hazardous. This should be confirmed by appropriate testing. Disposal as non-hazardous water solution would significantly lower disposal costs.	650 gal	100	1200	1,200	1.0
Metal-Containing Aqueous Waste Stream	Install solenoid valves to shut off rinse water flow when plating current is off. This reduces flow through the system and saves on water consumption.	9,100 gal	5	100 primarily from water savings but but also reduces cation load on resin, extending time between resin regenerations	300	3.0
	Install scrapers and wipers to remove adhering dragout from the wire and return to the plating baths. Because of the uniformity of the wire shape as contrasted to plating of irregularly shaped articles, this is a technically feasible step. This returns plating chemicals to use and reduces load on the metal recovery system.	1,820 gal (The volume of the stream would be relatively unchanged, however the metal content would be substantially reduced.)	1	3000	1000	0.3
	Use rinse water as make-up water for plating baths.	9,100 gal (The volume which can easily be added back depends on the rate of removal or evaporation from the plating baths. The savings could be greater than estimated here.)	5	300	100	0.3

* Savings result from reduced raw material and treatment and disposal costs when implementing each minimization opportunity independently.

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