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ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Manufacturer of Electroplating Chemical Products

Alan Ulbrecht and Daniel J. Watts*

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 produces chemicals for use in electroplating baths. The process formulates and blends concentrates of metal salts and additives which are used in electroplating and other metal finishing operations. The resulting solutions are clarified and tested for quality and consistency. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options identified include a spill prevention plan, expanded use of ion exchange, and electrowinning to recover metal from concentrated waste streams. 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 production of chemicals for use in electroplating baths (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,

* New Jersey Institute of Technology, Newark, NJ 07102

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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 inhouse 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 pure chemical concentrates for use in the electroplating and metal finishing industries. The process uses several large tanks for precise formulation of the components of the marketed concentrates. Quality control checks for purity and product consistency are carried out. Filtration of the batches to clarify the liquids prior to shipment to customers is also carried out.

This urban facility employs about 50 people. It has been in business at its present location for about 50 years.

Manufacturing Processes

The production of the plating bath chemicals is fundamentally a blending and dissolving process where mixtures of the chemicals required for use in electroplating baths or other metal finishing processes are prepared in large tanks (1000 to 3000 gal). The product concentrates are useful to metal finishers because they facilitate bath preparation and makeup at their facilities and the consistent quality reduces the likelihood of metal finishing problems and resulting waste from their activities. Regular chemical analysis is carried out during the course of the preparation to assure quality and consistency of the product. Off-specification material is sent for treatment or for recycling.

The formulated solutions are filtered to assure purity and clarity when they reach the customer and then packaged for shipment. Besides the off-specification materials, waste streams are generated by spills and leaks, laboratory wastes, filter cleanup, and cleaning of other equipment. The facility produces products containing nickel, copper, tin, and lead.

Existing Waste Management Activities

The company has already instituted pollution prevention activities. For example, certain metal-containing concentrates have been sent to smelters or other secondary recovery operations in order to reduce the volume of the waste stream which is sent for disposal. Spills are treated with adsorbent rather than being washed into discharge to the POTW. This reduces the burden of metals to the POTW, but does create a solid waste stream.

The concern for quality and consistency in the products leads to a certain amount of the production being considered off-specification. Often this results at the end of production runs when levels of some additives such as sulfate or ammonia may be too high. These materials are sent offsite for recovery. About 3200 gal of this type of waste is generated annually. These streams typically have about 30% solids.

The batches of metal-containing concentrates are filtered through spiral wound polypropylene filters to specified clarity. The filters are washed with hydrochloric and sulfuric acids to remove residual metal solution, and the acid solutions are combined with other acid streams from throughout the operation. The washed filters are disposed of as nonhazardous solid waste.

The laboratory tests both in-process and finished batches from the manufacturing process. In addition, samples of customer's electroplating baths made from the company's products are analyzed upon customer request. Analysis of on-going research and development products is also carried out in the laboratory. All unused samples, concentrates, and similar materials are collected and separated by metal type for either recovery or combination, where feasible, with spent concentrate batches. Solutions generated from the laboratory procedures are combined with other acid streams from throughout the facility.

Spills and leaks of processing chemicals and formulated batches are cleaned up by application of commercial adsorbent cleanup materials. These products are collected and sent offsite for disposal as hazardous waste. Approximately 1200 lb of this waste stream are generated annually.

The combined acid streams are adjusted to pH 10 to induce precipitation of hydroxide sludges. The solids are recovered by use of a filter press. The supernatant liquids are polished by passage through ion exchange resins and the effluent is discharged to the POTW. The resins are regenerated by use of sulfuric acid and this acid stream is recycled back to the mixed acid stream for precipitation.

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.

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.

It should be noted that the economic savings of the minimization opportunity, in most cases, result 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. Also, no equipment depreciation is factored into the calculations.

Some of the opportunities for waste reduction in manufacturing operations related to this one include possibilities for reblending of off-specification batches into future batches of the product. The demands of the customers for quality and consistency in the product concentrates preclude such an approach in the opinion of the management of the facility. Another potentially useful option at this facility would be to segregate metal-rich waste streams and subject them to electrowinning giving a marketable metal product. Such waste streams may be created from the ion exchange resin backwashings or the washings of the clarifying filters.

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

Regulatory Implications

The greatest regulatory imperative which drives pollution prevention in the metal finishing industry and affiliated industries are regulations, or the possibility of regulations, which govern levels of heavy metals in water discharges and in streams to be sent for landfilling. Aside from that type of acceleration, there seems to be no significant regulatory impediment at a facility of this type. The option of electrowinning to recover metal from concentrated process streams might be interpreted by some regulators as a treatment process requiring a RCRA permit. Any such permitting requirements would make implementation of an option such as this very difficult.

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Pollution Prevention Research Branch
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
High Metal Content Liquids	*Off-specification products*	*3,200 gal*	*$11,600*
Metal Contaminated Adsorbent	*Clean-up of spills and leaks*	*1,200 lb*	*2,400*
Metal Hydroxide Sludge	*Filter press cake from acid stream precipitate*	*8,300 lb* (The facility did not supply this information, the values are estimated based on analogy with similar facilities.)	*6,000*
Aqueous Discharge	*Supernatant from metal precipitation*	*280,000 gal*	*60*

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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 *
Cleanup Adsorbent	Develop spill control and leak mitigation plan	600 lb	50	$1,200	$4,000 (This will be a continuing activity with continuing expenses.)	3.3
Metal Hydroxide Sludge	Install electrowinning capability, segregate concentrated metal streams by metal type, recover metal for scrap	4000 lb	50	3,000 (Electrowinning from the process off-specification material may improve may change the economics but may also require different size units and more operating expense.)	20,000	6.6
Acid Waste Stream	Rather than precipitation of metals consider expanded use of ion exchange capability. Process all acid wastes with segregation according to metal content through resins. Recover washings and electrowin metal.	8,300 lb	100	6,000	20,000	3.3

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

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