United States Environmental Protection Agency
Research and Development

Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

EPA/600/S-92/046 October 1992

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Manufacturer of Wire Stock Used for Production of Metal Items

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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 wire stock used for production of metal items. The facility processes carbon steel and stainless steel coiled rods by cold drawing them into smaller diameter wire which is sold as stock for production of metal items such as ball bearings and springs. The process involves several surface cleaning and preparation steps in addition to simple cold drawing. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options identified included improvement of quality of acid wastes leading to beneficial secondary use, and modification of rinsing procedures to reduce flow of wastewater. 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 manufacturing of wire stock used for production of metal items (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, basic chemistry, and environmental concerns and needs. Be-

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cause 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 wire stock used for production of metal items. The facility processes carbon steel and stainless steel coiled rods by cold drawing into smaller diameter wire which is sold as stock for production of metal items such as fasteners, ball bearings, hand tools, springs, welding rods, and wire mesh. The entire process includes straightening and cutting, descaling, shot blasting, degreasing, cleaning, phosphating, and soap coating prior to the drawing and annealing steps.

The facility is located in a suburban area and employs about 50 people. This facility uses well water as a source for the water used in its processing and rinsing. The facility has on a few occasions surpassed the limits for some metals set by the POTW which receives its aqueous effluent. This concern contributed to the decision to participate in a waste reduction opportunity assessment.

Manufacturing Processes

The production of the drawn wire is fundamentally a three step operation—cleaning the original steel rod, preparing the surface for the cold drawing step, and carrying out the cold drawing. The details are different for the two types of raw materials—carbon steel and stainless steel. The first step—descaling— is the same for both types of steel. The steel is placed in a tank of 20% sulfuric acid heated to 160-185 °F and held there for 10-12 min.

For carbon steel rods, the next step is rinsing in a 1000-gal tank where well water flows at a rate of about 50 gpm. The rinsing is followed by a dip into a permanganate bath for cleaning of organic contaminants, followed by submersion in a hot water tank for preheating prior to precoating. The carbon steel rods are precoated either by dipping in a 180°F zinc phosphate bath or a sodium borate bath, depending upon the ultimate use of the cold drawn product. After the pre-coating, the rod coils are heated in a 212° F gas-fired oven for about 5 min. The coils are then dipped into a reactive soap bath to neutralize the metal surface and treat it sufficiently to allow it to hold stearate soap which is the lubricant for the cold drawing process.

After the descaling step the stainless steel is dipped in a nitric acid bath to passivate the metal surface. The pretreatment step uses a borax-based soap solution rather than zinc phosphate or sodium borate used in the carbon steel process.

The facility also has an alkaline bath which is used to degrease rejected wire prior to reprocessing.

It should be understood that these treatments are carried out by dipping large, heavy coils of steel from one bath or container to another. This is accomplished by a mechanical hoist system which allows movement between the 15 tanks at the facility.

Existing Waste Management Activities

In spite of the number of different chemicals used in the surface processing of the steel at this facility, there are only two regularly produced waste streams: the spent sulfuric acid from the descaling operations and the rinse-water which is sent to the POTW. The other chemical baths are changed or cleaned irregularly and cannot be quantified on an annual basis. Typically they are used as dips and it is expected that the chemicals contained will be incorporated onto the surface of the product.

The spent sulfuric acid from the descaling operation is presently sent offsite for disposal. The annual volume of this stream is about 12,000 gal and disposal costs are $8300/yr. The spent descaler has an acid concentration of 8% to 10% and an 8% to 10% iron concentration. There is also some zinc contained in the solution. In the past this spent acid solution had been accepted by a nearby chemical company for use in their manufacturing operations. The company stopped accepting it because of the presence of zinc.

The outflow of the rinse-water is adjusted to pH 6-9 with anhydrous ammonia prior to sending to the POTW.

As indicated above, rejected wire is reprocessed to the maximum extent which reduces the amount of waste generated by the facility.

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 an interesting challenge in determining waste minimization opportunities since at one time the major waste stream, the spent sulfuric acid from the descaling operations, was provided to another company for beneficial secondary use. It is no longer acceptable to the second company due to the presence of zinc in the solution. The waste minimization challenge then was to determine the source of the zinc and to suggest corrective action to keep it from the sulfuric acid bath.

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 opportunities, 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 included waste disposal costs which are avoided and the value of raw materials recovered. Equipment depreciation is not factored into the calculations.

In attempting to determine the source of the zinc which had begun to appear in the spent descaling baths, two likely sources were postulated. Zinc could be contained in the steel rod which was acquired as raw material for the wire-making process. For example the steel might have been galvanized. This was considered to be unlikely because there had been no change in suppliers between the time the zinc was found in the acid and the previous times when there was no zinc in the solution. The other possible source seemed to be the zinc phosphate bath which was used for pre-coating some of the carbon steel metal. With the information available, it was not obvious how zinc from this bath would be transferred into the acid tank because the zinc treatment step occurred after the descaling process.

However, careful observation of the entire process suggested that insufficient time was being allowed by the operators for draining of solution from the coils before transferring them to the next step in the process. This allowed the draining to continue as the coils passed over other tanks including the sulfuric acid descaling tanks. It is suggested, therefore, that guidance be given to the operators to allow the appropriate amount of drain time before moving the coil over top of any other process tank. This should decrease any zinc content of the sulfuric acid but also prevent the loss of materials from the tanks unnecessarily.

Regulatory Implications

There do not seem to be significant regulatory implications of pollution prevention initiatives at this facility. It is likely that additional restrictions will be applied to the metal-containing effluents going to the POTW 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 additional requirements. Testing may be utilized to maintain the quality of their spent acid stream. This waste stream may be considered as a product with QA/QC standards. Such standards and assurances to the buyers of this material will encourage beneficial secondary uses.

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

Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
Sulfuric Acid Stream	*Spent acid from descaling step*	*12,000 gal*	*$8300*
Aqueous Effluent to POTW	*Rinse water after pH adjustment with anhydrous ammonia*	*6,000,000 gal*	*2500*

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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 *
Spent Acid Stream	Identify source of zinc in the spent acid. If as expected it results from too short drain time, then operator training may be effective. Zinc level reduction should permit this stream to be used again by another company as part of one of their processes. A regular analysis and quality control program for this stream should build confidence on the part of the buyer.	12,000 gal	100	$ 8300	0	immed.
Aqueous Effluent	Determine whether the present flow rate for the rinse is necessary or can be reduced and still maintain product quality. An alternative may be to feed in a portion of the pH adjusted effluent into the rinse tanks. Any option such as this will require some evaluation as to its effect on the product.	600,000 gal	10 (estimate)	250	0	immed.

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

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