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EPA ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer Producing Galvanized Steel Parts

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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 hazardous 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 Colorado State University performed an assessment at a plant producing galvanized steel parts–approximately 10,000 tons/yr. The major process operations are degreasing and rinsing, acid pickling and rinsing, prefluxing, and galvanizing. All these operations, except galvanizing, result in the formation of waste streams requiring off-site disposal. Bottom dross from the galvanizing kettle and zinc oxide skimmed from the surface of the molten zinc are sold as usable products. The team's report, detailing findings and recommendations, indicated that most waste was generated in acid pickling and rinsing and that the greatest savings could be obtained by continuous air agitation to extend the life of the pickling acid and rinse by enabling more complete removal of dissolved iron when those solutions are treated.

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 the authors.

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Introduction

The amount of hazardous 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 hazardous 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 hazardous 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 Colorado State University's (Fort Collins) WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize hazardous 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 $50 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, 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.

This assessment was done by engineering faculty and students at Colorado State University's (Fort Collins) WMAC.

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 locates the sources of hazardous waste in the plant and identifies 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

This plant produces galvanized steel (reinforcing strips, pipes, ducts, angle iron, and prefabricated parts). The plant operates 4,420 hr/yr to galvanize about 10,000 tons of steel products.

Manufacturing Process

The plant produces galvanized steel products. The raw materials in addition to the steel include zinc ingots, alkaline phosphate cleaner, 10% hydrochloric acid for pickling, and zinc ammonium chloride for prefluxing the steel.

The following steps are involved in galvanizing the steel:

- The steel parts are carried through an alkaline phosphate degreasing cleaner solution followed by a water rinse.
- Acid pickling is done in 10% to 4% hydrochloric acid followed by a water rinse.
- The steel is prefluxed by immersion in a 30% zinc ammonium chloride solution.
- Galvanizing is done by immersion in molten zinc.

Existing Waste Minimization Practices

The plant uses degreasing rinse water as make-up for water lost by evaporation from the degreasing tank. This practice eliminates the need to dispose of contaminated degreasing rinse water and reduces the consumption of caustic in the degreasing tank.

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 time 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.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, four additional measures were considered. These measures were not completely analyzed because of insufficient data or a long payback time as indicated below. They were brought to the plants's attention for future reference, however, since these approaches to waste reduction may increase in attractiveness with changing plant conditions.

- Use dry descaling by an airless grit blast cleaner instead of acid pickling to descale reinforcing strips for galvanizing. A solid waste of scale and spent grit would be generated instead of spent pickling acid and rinse. Because the scale would contain a small amount of hazardous chromium, disposal would be costly. Pilot tests were suggested to determine the life of the grit, necessary for economic evaluation.
- Install an electrodialysis system, a wastewater treatment system and an ion exchange unit to reduce the amount of acid pickling wastes generated. Operating costs, including disposal of large amounts of chromium-containing sludge, would be high with a long payback period.
- Rinsing efficiency could be improved by dipping the steel into the rinse tanks twice. However, the improvement from dipping twice could not be quantified.

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	Sources of Waste	Annual Quantity Generated	Annual Waste Management Cost
Degreaser and rinse tank sludge	Sludge from caustic degreasing and rinsing of steel to be galvanized is dried in drums and disposed of as landfill.	20,200 gal	$500
Spent pickling acid (4% HCL) and rinse water	Spent acid solution (from pickling the steel for galvanizing) and spent rinse water each contain about 10% dissolved iron. They are combined with spent preflux solution and disposed of as hazardous waste.	105,400 gal	66,435
Spent preflux solution (zinc ammonium chloride)	Prefluxing of the steel prior to galvanizing results in spent preflux solution containing about 20% zinc ammodium chloride. It is combined with spent pickling acid and rinse water for disposal as hazardous waste.	19,300 gal	12,165
Preflux tank sludge	Iron dissolved in spent preflux solution is removed by precipitation as ferric hydroxide. The resulting non-hazrardous sludge is separated by decanting, dried and disposed of as landfill.	2,400 gal	60

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Waste Generated	Minimization Opportunity	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Payback Years
		Quantity	Percent			
Spent preflux solution and preflux tank sludge	Provide continuous air agitation and filtration of the preflux solution for complete removal of contained iron as ferric hydroxide on addition of hydrogen peroxide. Removal of iron will extend the life of the preflux solution and the pickling rinse water which is discarded when the preflux solution is discarded.	25,325 gal	62	$24,550	$16,000	0.7
Spent preflux solution	Provide air agitation of the acid pickling rinse tank preceding the preflux tank. This agitation will reduce dissolved iron drag-out into the preflux solution, extending its life.	5,510 gal	29	4,370	3,820	0.9
Spent pickling acid	Provide continuous filtration of the pickling acid solution to remove solid contaminants and extend its life.	19,300 gal	22	10,700	25,040	2.3
Spent pickling acid and spentpreflux solution	Increase drainage time above the pickling and preflux tanks from 1 to 15 seconds to reduce drag-out and extend reagent life. (A reduction in the rate of generating spent solutions is expected but could not be quantified.)	–	–	990	0	0

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Table 2. Summary of Recommended Waste Minimization Opportunities (concluded)

Waste Generated	Minimization Opportunity	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Payback Years
		Quantity	Percent			
Degreasing rinse sludge	Parts for re-cleaning after pickling are rinsed in the degreasing rinse before pickling again. Drag-out from the pickling tank reacts with alkaline compounds in the degreasing rinse to form sludge. Use the pickling rinse, which is not alkaline, instead of the degreasing rinse to avoid forming sludge.	7,580 gal	75	190	0	0

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