United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/M-91/015 Jul. 1991

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Metal Parts Coating Plant

F. William Kirsch and Gwen P. Looby*

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 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 where automotive parts are coated with epoxy, vinyl, or polyester powders; with liquid plastisol; or with paint. After the WMAC team analyzed five process lines (for applying coatings) and the reworking operation (where unacceptably finished parts are stripped), a report was prepared detailing their findings and recommendations. They found three ways to reduce the evaporation of methylethyl ketone (MEK), the largest source of waste on the process lines: reduce the open surface area of the MEK container, cool the MEK, or meter the MEK. They also found ways to reduce wastes from the rework process by installing controls, repairing defective drive components, or using alternative methods to remove defective coatings.

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.

*University City Science Center, Philadelphia, PA 19104.

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 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 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 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.

Printed on Recycled Paper

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

The plant coats metal automotive parts with epoxy, vinyl, or polyester powders; liquid plastisol (a vinyl plastic in a liquid carrier); or paint. Each year, the plant produces approximately 52 million parts ranging in size from 1/4 to 1 lb.

Coating Operations

The following basic steps are employed to coat the metal parts:

- surface cleaning and/or priming the metal parts,
- heating metal parts for improved coating in a natural gas or electric oven at 350° F to 900° F,
- applying the desired coating,
- curing the coated part in a natural gas, electric, or infrared oven, and
- water- or air-cooling the finished parts.

The following distinct process lines were analyzed by the WMAC team, with each line using a different method for applying the coating:

- a line for the dipping of parts in a fluidized bed of water containing epoxy, nylon, or vinyl powders;
- two lines for dipping parts in plastisol, one of which includes a step for applying a priming coat;
- a line in which plastisol is mechanically applied to specific areas of small metal parts;
- two lines for the spraying of parts with a polyester or epoxy powder; and
- a line for the electrostatic painting of parts.

Rework Operations

Unsatisfactory coating of the parts can result from inadequate control of the level of the coating material in the troughs; adhesion problems related to improper curing oven temperatures; variations in the speed of the parts conveyors; environmental dust; or inadequate coating thickness resulting from mechanical breakdowns. The plant uses three different rework operations to reclaim unacceptable finished parts.

- Epoxy, nylon, or vinyl coatings applied in the fluidized bed line and the coatings applied to 75% of the parts in the electrostatic paint line are removed by incinerating the parts in a natural gas oven at 1150° F. (The rework operation used for the electrostatically painted parts is determined by the type of paint used.)
- Plastisol coatings are removed by overnight immersion in MEK.
- The coatings of 25% of the parts rejected after the electrostatic painting and all of the parts rejected after the polyester powder spray lines are removed with a commercial acid stripping solution.

The reclaimed metal parts are sent back to the appropriate process line after reworking.

Water Treatment

The assessment team also analyzed the plant's water treatment facility. Waste water streams from the process lines are fed into three major collection pits; from there, the waste water feeds into a large tank. The pH of the water is adjusted as necessary and the fluid is pumped to a large sludge tank where solid sludge settles out. Plant personnel have not determined the nature of the sludge; however, a substantial amount of sludge has not yet accumulated on-site. The water that is separated from the sludge goes to a municipal sewer.

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 treatment and disposal costs are given in Table 1.

Table 2 shows the various opportunities for waste minimization that the WMAC team identified for the facility. The type and source of the waste, the minimization opportunity, the possible waste reduction and associated savings, and the implementation cost along with the payback time are described in the table.

As shown in Table 2, two sources of waste are the focus of the waste minimization opportunities analyzed and recommended by the WMAC. The first is the evaporation of MEK used as a primer thinner in the plastisol dipping and mechanical application lines. Three possible methods for reducing the amount of evaporation are described in the table. The other source of the waste is the rework operation. The generation of waste by the rework processes can be reduced either by reducing the number of parts that require reworking (through installation of controls or repair of defective drive components) or by using an alternative method to remove the defective coatings.

The quantities of hazardous waste currently generated by the plant and possible waste reduction depend upon the production level of the plant. All values stated should be considered in that context.

Issues for Further Consideration

In addition to the recommended waste minimization opportunities, the WMAC team indicated that plant personnel should continue to investigate the possible availability of a new, less hazardous stripper/thinner to replace MEK and that each waste water stream should be analyzed to determine its composition. The current method for handling the waste water in the plant is inefficient and imprecise.

Table 1. Summary of Current Waste Generation.

Waste Generated	Source of Waste	Annual Quantity Generated	Annual Waste Management Cost
MEK (used as a primer thinner)	Evaporation from plastisol dipping and mechanical application lines	8,400 gal	$0[1]
MEK	Evaporation from plastisol rework line	3,900 gal	0[1]
Plastisol sludge (contains plastisol & MEK)	Plastisol rework line	600 gal	0[2]
Spet acid stripping solution	Acid stripping rework line	2,100 gal	10,410
Stripped paint residue & residual spent stripper	Acid stripping rework line	250 lb	0[3]
Paint residue in paint tank	Electrostatic painting line	4,800 gal	20,020
Spent, contaminated primer	Plastisol lines	680 gal	3,560
Ash	Incineration oven in rework line	1,200 lb[4]	1,260

[1] Currently there are no costs for monitoring or controlling MEK emissions from evaporation; however, the MEK that evaporates must be replaced.
[2] Plastisol sludge is disposed of in municipal waste.
[3] The material is accumulating on-site. There are no current costs for waste management.
[4] Of the total 1,200 lb/yr of ash produced, 700 lb/yr resulting from the electorstatic painting rework is considered hazardous. The remaining ash is disposed of in municipal waste.

Table 2. Summary of Recommended Waste Minimization Opportunities.

Waste Generated	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years
Evaporation of MEK from plastisol dipping and mechanical appllication lines	Reduce open surface area of primer/MEK container.	3,160 gal	37.6	$11,240[1]	$3,000	0.3
	Cool MEK to reduce its partial pressure.	840 gal	10.0	3,000[1]	2,900	1.0
	Meter MEK concentration automatically to reduce peak evaporation rate.	1,400 gal	16.7	4,980[1]	12,400	2.5
Spent acid stripper from the rework line	Install interlocking controls on the conveyor's speed and paint volume flows in the electrostatic painting and powder spray lines.	1,510 gal	72.1	22,430[2]	24,600	0.2
Stripped paint residue and residual stripper from rework line		180 lb	72.1	134,040[3]		
Ash from the incineration oven	Replace defective drive system components in electrostatic paint line.	469 lb	67.0	2,530[4]	3,400	1.3
MEK used in rework line	Install a cryogenic-mechanical stripping system to remove coatings of rework parts.	3,900 gal	100.0	13,880[1]	150,000	2.6
Plastisol sludge		600 gal	100.0	0 [4]		
Spent acid stripper from rework line		2,100 gal	100.0	42,780[5]		

[1] Cost savings because less MEK needed.
[2] Includes $14,810/yr because less stripper is needed.
[3] The material is accumulating on-site. There are no current costs for waste management. The cost savings are because less coating material needed.
[4] Includes $1,900/yr because less paint needed.
[5] Includes $32,370/yr attributed to purchase of stripper.

☆U.S. GOVERNMENT PRINTING OFFICE: 1991 - 548-028/40036

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 Brian A. Westfall.

The EPA contact, Emma L. George, can be reached at:

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

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

BULK RATE
POSTAGE & FEES PAID
EPA PERMIT NO. G-35

Official Business
Penalty for Private Use $300

EPA/600/M-91/015