United States Environmental Protection Agency
Research and Development
Risk Reduction Engineering Laboratory
Cincinnati, OH 45268
EPA/600/M-91/047 Oct. 1991

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Printed Labels

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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 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 producing printed labels — approximately 14 billion labels/yr. Steel printing cylinders are nickel and copper plated, etched with the label patterns to be printed, chromium plated, and then used with ink applied to print the labels. About 75% of the cylinders are chemically etched, and the remainder are mechanically etched. Solvents used with ink concentrate and for cleaning press parts are recovered and sold to reclaimers. Spent reagents, filters, cleaning rags, and sludge are shipped offsite for disposal. Process wastewater and rinse water are treated by ion exchange and distillation. The team's report, detailing findings and recommendations, indicated that most waste other than water and paper consists of spent solvents, and that the greatest savings could be obtained by using recovered solvent instead of virgin solvents for cleaning at press side.

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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.

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.

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 produces printed labels. It operates 6,120 hr/yr to print approximately 14 billion labels.

Manufacturing Process

This plant prints label patterns on wide paper roll stock. About 80% of the labels are rolled onto cardboard cores, which are slit into narrow rolls. The remainder are cut into sheets, which are counted into stacks. Raw materials include reagents for nickel-, copper-, and chromium-plating and etching of printing cylinders, light-sensitive film, blue dye, printing ink concentrates, solvents, filter media, cleaning rags, cotton, and paper stock.

Plating and etching of the steel printing cylinders used to print the labels involve the following steps:

- The cylinders are degreased and washed. (Used cylinders are first dechromed in an acid bath containing a dechrome salt and then machined to remove previously etched label patterns).
- The cylinders are nickel plated in a tank containing a solution of nickel sulfate, nickel chloride, and boric acid. After rinsing, the cylinders are copper plated in a tank containing copper nuggets in a solution of sulfuric acid and a hardness additive.
- After rinsing, the plated cylinders are polished with pumice and washed with detergent.
- About 75% of the cylinders are chemically etched. Using pattern negatives, a base film is developed by a photographic process. (Silver is recovered for sale.) After a photoresist coating is applied to the printing cylinders, the patterned film is applied and the cylinders are exposed to high-intensity light. A blue dye is then applied for development, and the photoresist and dye coatings are hardened in isopropyl alcohol.
- The cylinders are etched in ferric chloride solution containing copper sulfate, and then rinsed in water. About 90% of the cylinders are sent to the printing process at this stage; the remaining 10% are chrome plated first in a solution of chromic acid and sulfuric acid.

The following steps are carried out in printing the labels:

- Ink concentrates are mixed with solvents for desired color and drying times and applied to the paper using an impression type of press.
- After each color is applied the ink is dried on the line in an electric or gas-fired oven. Up to 6 colors can be applied to the paper in one line.
- After each run, press parts are cleaned using solvents and rags.
- About 80% of the printed paper is slit into narrow rolls and packaged. The remainder is cut into sheets.

Existing Waste Management Practices

Solvent vapors from the printing-line drying ovens are recovered in three parallel carbon adsorption beds and regenerated with steam. The effluent steam is condensed producing a solvent layer that is decanted, neutralized with hydrogen peroxide and caustic soda, and sold to reclaimers. Sodium acetate produced in the neutralization is shipped offsite for disposal.

Spent reagents, lathe waste, and spent dye are shipped offsite for disposal. Solvent-laden rags and cotton from cleaning press parts are also shipped offsite for disposal. Spent filters, scrap paper, and obsolete label patterns are discarded with municipal trash.

Water from plant operations is treated in an ion exchange unit and discharged to public water facilities.

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 waste 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 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 by the WMAC team, two other measures were considered. These measures were not analyzed completely because of insufficient data or minimal savings as indicated below. They were brought to the plant's attention, however, because these approaches to waste reduction may increase in attractiveness with changing plant conditions.

- Water from the plant's solvent recovery system is sprayed into the firebox of an incineration boiler for disposal. An option to use this slightly contaminated water as boiler feedwater was not recommended because of a lack of information on the possible effect of the contained solvent on the heat transfer surface of the boiler and on the rest of the steam system.
- Advance preparation of solvent-laden rags used to clean press parts would reduce the quantity of solvent lost by evaporation. This measure was not analyzed further because minimal savings would be expected.

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	Source of Waste	Annual Quantity Generated	Annual Waste Management Cost
Solvent vapors	Drying oven exhaust. Solvent vapors in drying oven exhaust are adsorbed in carbon beds, desorbed by a steam purge, condensed, decanted from the steam condensate, and shipped to a reclaimer.	300,000 gal	$1,028,869[1]
Spent ink/solvent mixture	Condensed inks, mixed with blended solvents, are used in printing. The spent mixtures are shipped offsite for disposal.	34,540 gal	49,482
Spent blue dye mixture	Blue dye solution, used in preparing printing cylinders, is recycled to the process. When spent, it is shipped offsite for disposal.	1,100 gal	5,314
Solvent vapors	Solvents used in etching and printing evaporate to the plant atmosphere.	189,055 gal	541,868[1]
Spent reagent solutions (Sodium acetate, ferric chloride, hydrochloric acid, and chromium, nickel and copper salts)	Spent reagents from plating, etching, and solvent recovery operations are shipped offsite for disposal.	22,118 gal	35,388
Spent rinse water	Rinse water from plating and etching operations, and fume scrubber effluent, are passed through an ion exchange resin bed and discharged to POTW	252,910 gal	5,000
Spent cotton, rags and polishing cloths	Solvent-laden cotton and rags from cleaning, and pigment-laden polishing cloths, are shipped offsite for disposal.	1,760 gal[2]	12,800
Sludge from water treatment	Sludge generated on regeneration of ion exchange resin used for water treatment is shipped offsite for disposal.	2,090 gal	5,700
Paper waste	About 4,200,000 lb/yr of scrap paper is sold. The remainder, 5,600,000 lb/yr, is disposed of as landfill.	5,600,000 lb	39,600
Ink solids	Waste ink solids from printing operations are shipped offsite to be burned as fuel.	1,650 gal	13,500
Lathe waste (turnings, pumice, copper fines)	Waste from machining and polishing printing cylinders is shipped offsite for disposal.	495 gal	900
Spent ink filters	Used ink filters from printing operations are shipped offsite for disposal.	550 gal[3]	4,000

[1]Includes savings on raw materials.
[2]32 barrels of spent cotton, rags, and polishing cloths.
[3]10 barrels of spent ink filters.

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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
Spent Solvent	Used recovered solvent instead of virgin solvent for cleaning press parts.	None	-	$284,294[1]	$0	0
Spent safety solvent	Used recovered solvent instead of safety solvent for cleaning.	None	-	59,443[1]	0	0
Ink/solvent mixture	Automate mixing of ink, extender, and solvent to reduce overmixing and evaporative loss.	5,225 gal	75	47,085[1]	288,800	6.1
Safety solvent vapors	Replace a cleaning tank lid to reduce solvent evaporation loss.	2,833 gal	50	9,604[1]	500	0.1
Spent ink filters	Rinse spent ink filters with solvent and reuse	363 gal[2]	66	5,016[1]	0	0

[1]Includes savings on raw materials.
[2]6.6 barrels per year of spent ink filters.

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