Waste Minimization Assessment for a Paint Manufacturing Plant

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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 Colorado State University inspected a plant blending and mixing raw materials into paints, coatings, stains, and surface-treating products. For water-based paints, water, latex, resins, extenders, and pigments are mixed and blended. For oil-based paints, solvents replace water and latex, and plasticizers, tints, and thinners are also added. These batches are then transferred to letdown tanks where additional ingredients are incorporated. After testing, the paints meeting specifications are filtered, canned, labeled, and packaged for shipping. Hazardous wastes result when the mixing vessels, let-down tanks, and lines are cleaned. For example, cleaning a letdown tank after a water-based paint has been blended requires about 35 gal water; after a 400-gal tank for a solvent-based paint, about 5 gal mineral spirits. Because the spirits are sent off-site for recovery, most of the waste results from cleaning up after mixing water-based paint. This waste is hazardous because it contains mercury used as the bactericide. Although the plant reuses rinse water, recovers solvent, and has adopted other measures to reduce waste, the team report, detailing findings and recommendations, suggested that additional savings could result from installing a pipe cleaning system, using a solvent-recovery system based on distillation, and substituting an organic material for the mercury bactericide.

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 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.

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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 and Operations

This plant produces paints, coatings, stains, and surface-treating products at an overall rate of about 1.1 million gal/yr for regional distribution on a schedule of 2080 hr/yr for 52 wk. It’s operations primarily involve blending and mixing of raw materials, followed by product testing and packaging and by cleaning of vessels and lines. Color separation in the product is obviously important, and each lot must meet a variety of other customer specifications.

Individual lots of water-based and solvent-based paints are mixed in a variety of tanks from 200- to 1000-gal capacity. For this initial step, ingredients for water-based paints include water, latex, resins, extenders, and dispersed pigments. For solvent-based paints, the materials are generally similar in type, but obviously solvent replaces water and latex. Other new ingredients include plasticizers, tints, and thinners.

After batches are made up, they are transferred to so-called letdown tanks, where additional water (or solvent), resins, preservatives, anti-foaming agents, thickeners, and bactericides are added. Batch testing encompasses at least color, viscosity, and gloss, and those lots that meet specifications are filtered and charged to cans for labeling, packaging, and shipping.

Waste Generation and Present Waste Minimization

The principal waste streams are the result of equipment cleaning, especially from water-based paints. For example, rinsing the let-down tanks ordinarily requires about 35 gal of rinse water, but that amount increases to 53 gal if light paint is to be blended after dark paint. The hazardous nature of water rinses results from the mercury used as a bactericide in the paint.

In some instances, rinse water from the mixing tanks is held in 500-gal tanks and used in the letdown tanks (instead of fresh water) to formulate future batches of water-based paint. The rinses are separated according to the color intensity of paint in the tanks from which they were derived. For example, rinses from white paint formulation amount to about 70% of the total, and they are invariably used again.

Waste rinses not used again are piped to holding and flocculation tanks; alum is added to lower the pH, flocculant is added to precipitate some solids, and supernatant liquid is removed for reuse in other paint formulations.

Tanks used for solvent-based paints are rinsed with mineral spirits at a rate of about 5 gal/400 gal tank. These washings are sent off-site for recovery, followed by recycling or sale as fuel.

In addition to reusing rinse water and recovering solvent, this plant has adopted the following measures to reduce waste generation:

- cleaning equipment before the paint dries and hardens;
- eliminating hazardous materials, except for mercury in the bactericide added to outdoor water-based paint;
- avoiding hazardous container waste by purchasing the bactericide in water-soluble bags that dissolve during paint formulation;
- scheduling batch formulations so that light colored paints precede dark ones and thereby reduce the total volume of rinses;
- reducing the inventory of raw materials to avoid degradation and spoilage and to ensure a high-quality product that can be sold; and
- using bag filters to collect dust.

Table 1 summarizes the principal sources of waste, their amounts, and the associated costs.

Waste Minimization Opportunities

Table 2 offers a brief description of current plant practice, the recommended waste minimization opportunity, and savings and cost data. Considered individually, the three recommended WMOs could save over $22,000/yr, which represents about 25% of current waste management costs. Each has a simple payback time less than 1 yr.

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.

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Table 1. Summary of Current Waste Generation

<table>
<thead>
<tr>
<th>Source of Waste</th>
<th>Hazardous Waste Generated</th>
<th>Annual Quantity Generated</th>
<th>Annual Waste Management Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment cleaning by water washing</td>
<td>Mercury water and paint</td>
<td>26,700 gal</td>
<td>$3,740 $46,040(^1)</td>
</tr>
<tr>
<td>Equipment cleaning by solvent washing</td>
<td>Mineral spirits</td>
<td>27,200 gal</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\) Off-site

Table 2. Summary of Recommended Waste Minimization Opportunities

<table>
<thead>
<tr>
<th>Present Practice</th>
<th>Proposed Action</th>
<th>Waste Reduction and Associated Savings</th>
</tr>
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</table>
| Water rinses remove paint from tanks and pipes        | install a pipe-cleaning system consisting of 3 different-sized foam plugs or 'pigs' to be sent throughout the pipes by compressed air. Paint is thus forced from the lines and to the canning line filter. The use of water and amount of waste are lower. (This WMO is applicable to nonwhite paints.) | Waste reduction = 1,780 gal/yr  
Cost reduction = $11,110/yr  
Implementation cost = $1,600  
Simple payback = 2 mo                                                                 |
| About 15 gal solvent per batch of paint is drummed and sent off-site for disposal. | Use a solvent recovery system based on distillation, and ship the small amount of remaining solid to a hazardous waste disposal site. | Waste reduction = 3,300 gal/yr  
Cost reduction = $5,420/yr  
Implementation cost = $4,950  
Simple payback = 11 mo                                                                 |
| A bactericide containing mercury is being used in water-based paints. | Eliminate the bactericide from water-based interior paints and substitute an organic material. (This WMO is applicable to nonwhite paints.)  
There is no cost difference between these additives. | Waste reduction = 3,100 gal/yr  
Cost reduction = $5,560/yr  
Implementation cost = none  
Simple payback is immediate. |