



ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Manufacturer of Plastic Containers by Injection Molding

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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 plastic containers by injection molding. The manufacturing process involves melting of a plastic resin and injection of the melt into molds in the shape of the container to be manufactured. The cooled and solidified container is removed from the mold, the mold is cleaned with solvent when required and the injection process is repeated. A portion of the containers are also made by blow molding which involves use of compressed gas to move the resin melt onto the walls of the mold. The rest of the operation is similar. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options identified for pollution prevention include change in equipment to eliminate use of hydraulic oil, change in mold cleaning procedures, and modifications to metal machining operations. It should be pointed out that this facility had already initiated an aggressive pollution prevention program. 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.

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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 the manufacturing of plastic containers by injection molding (1 of the 30 assessments performed) and



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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. Because 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 approximately 1.5 million plastic containers every day. The facility melts pellets of plastic resin and using either injection molding or blow molding pro-

duces the containers. The containers are typically sold to other manufacturers for use in packaging their products.

The facility is located in a suburban area and employs about 320 people. This facility has already undertaken an aggressive pollution prevention and energy conservation program.

Manufacturing Processes

The production of the plastic containers requires melting of the starting plastic resin which is purchased. For injection molding, mechanical force, presently hydraulically produced, is used to push the melt into molds in the shape desired for the product. Blow molding uses compressed gas, frequently compressed air, to move the melt onto the walls of the mold. The type of mold is different for the two procedures. When necessary, the molds are cleaned with a solvent, currently 1,1,1-trichloroethane, to assure ease of movement of the melt and to facilitate good surface characteristics in the molded product.

The facility also makes and maintains the molds themselves which entails some metal machining.

Existing Waste Management Activities

The company has already instituted an aggressive program of pollution prevention and energy conservation. Many changes in practice have either been made or are planned in the near future.

The process for producing the plastic containers produces relatively little waste or pollution. The resin is purchased and is completely used. Occasionally, a color change may result in a few containers which are off-specification or incomplete molding occurs resulting in a poor quality product. In these situations, the flawed containers can be ground and used as feed stock for later production runs. On the rare occasions where such reuse is not possible, the material is handled as nonhazardous industrial waste. The hydraulics of the injection molding process leak and the resulting waste oil becomes contaminated with cooling water, metal fragments and dirt. Approximately 26,000 gal of such waste is generated annually. Presently the stream is passed through a separator and the water is sent to the POTW for treatment, while the oil is shipped offsite as a hazardous waste. Approximately 13,000 gal of such oil is produced annually.

The molds and the lines through which the melt passes are cleaned with solvent, currently 1,1,1-trichloroethane. Current practice is to undertake this cleaning judiciously on an as needed basis. Minimum volume of solvent is used. This is a change from past practice which required use of large volumes of solvent at regular intervals. This type of change has significantly reduced solvent usage. Currently 2300 lb of the solvent is sent for disposal offsite annually.

The mold machining operation uses a water-based vegetable oil mixture as a metal-working fluid for lubricating and cooling during machining operations. This fluid is recirculated and is estimated to have a life span of six months. Approximately 1200 gal of this material are produced each year and are disposed of offsite as hazardous waste.

The appearance of the facility shows that the management and employees recognize the waste reduction value of ease of movement of raw materials, good maintenance of equipment, and spill control and spill prevention activities.

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.

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.

It should be noted that the economic savings of the minimization opportunity, 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. Also, no equipment depreciation is factored into the calculations.

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

Regulatory Implications

There are no significant regulatory implications to pollution prevention initiatives at this facility. The management of the facility, without regulatory pressure, has moved strongly in the area of pollution prevention and energy conservation because of economic considerations and for personal environmental concerns. However, international agreements addressing ozone depletion and global warming may further inhibit the use of 1,1,1-trichloroethane. Also, 1,1,1-trichloroethane is 1 of 17 chemicals which EPA has targeted under a voluntary program with industry (the 33/50 Industrial Toxics Program) to reduce releases to the environment. This program may lead to reduced use of the solvent.

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Table 1. Summary of Current Waste Generation

<i>Waste Generated</i>	<i>Source of Waste</i>	<i>Annual Quantity Generated</i>	<i>Annual Waste Management Costs</i>
<i>Waste Hydraulic Oil</i>	<i>Leaks from the hydraulic system on the injection molding machines</i>	<i>13,000 gal</i>	<i>\$ 6,500</i>
<i>Waste Machining Oil</i>	<i>Mold machining lubrication and cooling after reaching the end of its useful life</i>	<i>1,200 gal</i>	<i>4,500</i>
<i>Spent 1,1,1-Trichloroethane</i>	<i>Cleaning of molds and injection lines</i>	<i>2,300 lb</i>	<i>1,500</i>

Table 2. Summary of Recommended Waste Minimization Opportunities

Waste Stream Reduced	Minimization Opportunity	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Payback Years *
		Quantity	Percent			
Waste Hydraulic Oil	Filtration or centrifugation of oil allowing reuse (Potential use of this option will require some investigation of whether or not the reclaimed oil will have the necessary performance characteristics as a hydraulic fluid.)	6,500 gal	50	\$13,000	\$10,000	0.8
	Find and repair leaks more expeditiously	1,300 gal	10	2,600	0	immed.
	Replace hydraulic molding machines with direct electrical drive (This option had been selected by the company prior to the assessment. While exact replacement costs are not known, they are substantial. Although there are savings of about 75% on electrical costs with the new equipment, the capital costs suggest that a change of this magnitude occur primarily when it is time to change equipment anyway.)	13,000 gal	100	23,450	substantial capital investment	
Waste Machining Oil	Prolong useful life by cleaning and biocide addition	400 gal	33	1,670	5,000	3
Mold Cleaning Solvent	Change to biodegradable terpene-based solvent	2,300 lb	100	(Obviously, a different waste stream will be generated and will present reduced levels of environmental risk. Without a comparison of the relative effectiveness of the two solvent system it is difficult to estimate the volume of waste from this new approach. It is possible that this material can be recycled. If we assume that the volumes are the same and that the purchase prices are the same we can estimate a savings in treatment cost of approximately \$1000 per year.)		

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

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