United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/S-94/003 September 1994

EPA ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Screwdrivers

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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 waste but who lack the expertise to do so. In an effort to assist these manufacturers, 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). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at Colorado State University performed an assessment at a plant that manufactures screwdrivers—over 30 million/yr. Plastic handles are fabricated from virgin and recycled plastic beads. Five plastic extruders are used to form plastic rods that are cut to length and machined into handles. The finished handles are painted and then assembled into screwdrivers with metal blades forged in another plant. The team's report, detailing findings and recommendations, indicated that the waste stream generated in the greatest quantity is waste plastic and that significant cost savings could be realized by pelletizing the plastic scrap before its sale to a recycler.

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 University City Science Center, Philadelphia, PA.

Introduction

The amount of 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 waste generation is to reduce or eliminate the waste at its source.

University City Science Center has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of 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 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 $75 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 and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experience for

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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 locate the sources of waste in the plant and identify 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 manufactures screwdrivers for national distribution. It operates 8,760 hr/yr to produce more than 30 million screwdrivers annually.

Manufacturing Process

The plant produces plastic-handled screwdrivers from plastic handles that are formed in this plant and metal blades that are forged in another plant. Clear and colored plastic beads are the principal raw materials used by this plant to make the handles.

A mixture of 70% virgin and 30% recycled plastic is dried in desiccant dryers and fed to an auger that moves the plastic through the heated barrel of one of five extruders. The heated plastic is forced through dies to create the desired shape. Upon leaving the extruder, the resulting plastic rod is immersed in a water bath for cooling. A puller or tractor at the end of the cooling bath is adjusted as needed to maintain or reduce the diameter of the rods. The rods are cut to workable lengths using a saw, and cooled further on an automated rack for 20 min or on a separate rack for 24 hr depending on the cross section of the rod.

The rods are cut to the appropriate size for handles on specialized screw machines and lathes. Both types of machine use a mixture of oil and water as a spray-on coolant. Next, drilling and doweling operations are performed on the handles. After the handles have been cut to shape and machined, they are sent through a washer for removal of shavings, dust, and residual machine coolant.

The finished handles are then treated with liquid isobutyl acetate (IBA) and acetone. First, the handles are dipped in IBA to remove the dullness from the machined plastic. Next, the handles are exposed to acetone vapor, which serves to soften the plastic, remove blemishes, and generate a smooth, shiny surface.

After the IBA/acetone treatment, the ends of the handles are painted using solvent-based paint. Product names are stamped on the barrels of the dried handles using foil tape.

The blades of the screwdrivers, which are forged in another plant, undergo minor processing such as sandblasting and cleaning in this plant. Then the blades are pressure-fitted into the handles. The assembled screwdrivers are inspected, packaged, and shipped.

An abbreviated process flow diagram that also describes the waste generation in this plant is shown in Figure 1.

Existing Waste Management Practices

This plant already has implemented the following techniques to manage and minimize its wastes:

- Waste plastic from machining of product handles is baled and shipped offsite for recycle.
- Dry machining that generates no cutting oil waste is used in drilling/doweling operations.
- Waste oil from screw machines and lathes is shipped offsite to be reblended into boiler fuel.
- Aqueous cleaners are used instead of solvents for cleaning screwdriver handles and blades.

Waste Minimization Opportunities

The type of waste currently generated by the plant, the source of the waste, the quantity of the waste, the waste management method, and the annual waste management cost are given in Table 1.

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. The minimization opportunity, the type of waste, 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 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 the financial savings of the minimization opportunities result from the need for less raw material and from reduced present and future costs associated with waste management. 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 also should 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, two additional measures were considered. These measures were not completely analyzed because of insufficient data, minimal savings, implementation difficulty, or a projected lengthy payback. Since one or more of these approaches to waste reduction may, however, increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Install a solvent recovery unit to recover spent acetone for reuse onsite.
- Replace solvent polishing of plastic handles with ultraviolet painting coatings.

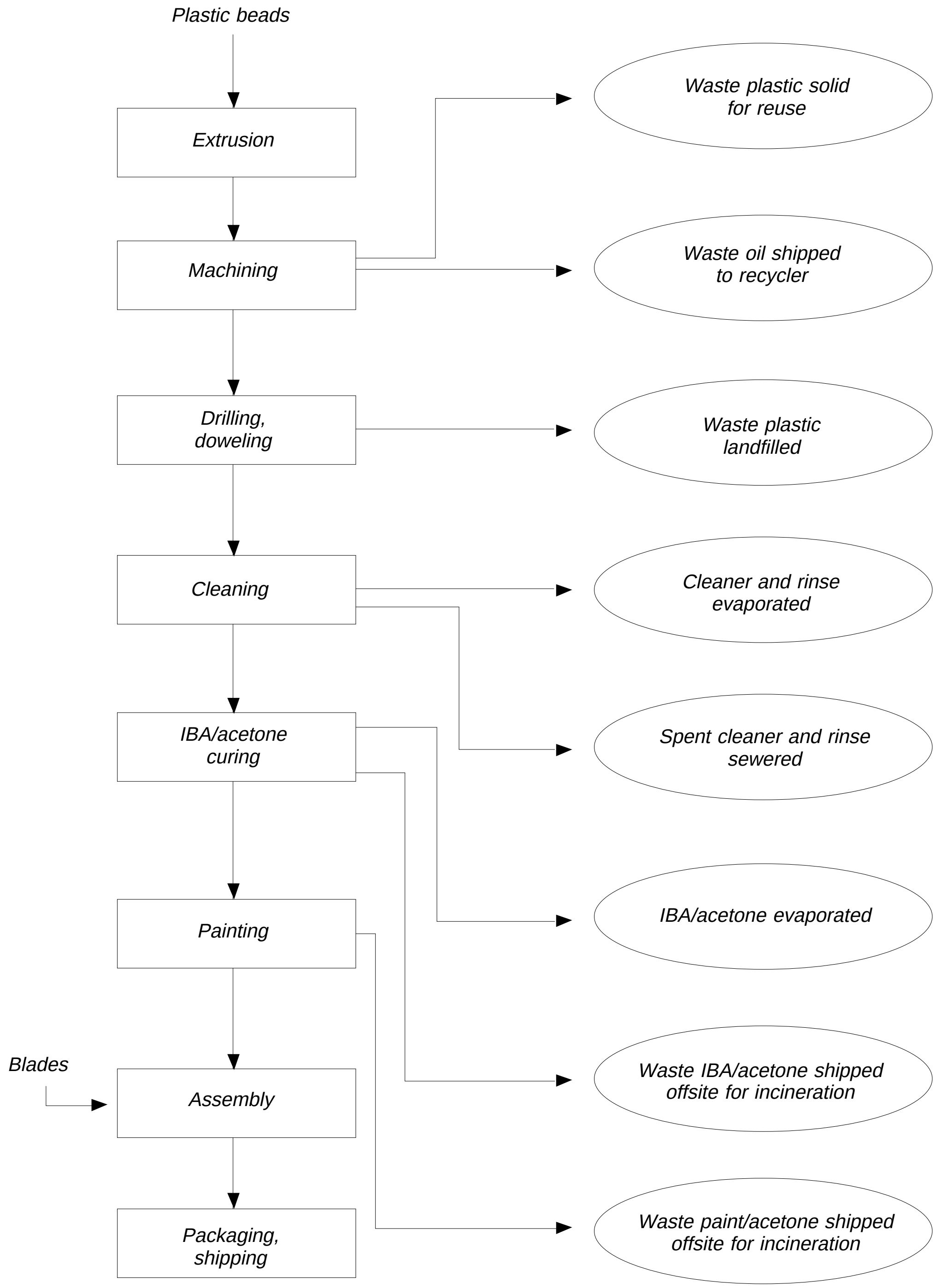

Figure 1. *Abbreviated process flow diagram that describes the waste generation in this plant.*

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 (lb)*	*Waste Management Method*	*Annual Waste Management Cost**
Waste plastic	*Cutting and machining of extruded plastic*	*500,640*	*Baled; shipped offsite for reuse*	*$545,800*
Waste plastic	*Spilled from bales of waste plastic*	*24,960*	*Landfilled*	*39,990*
Waste plastic/metal	*Drilling and doweling of plastic handles*	*10,960*	*Landfilled*	*17,590*
Waste oil	*Machining*	*19,100*	*Shipped offsite; reused as fuel*	*10,130*
Spent cleaner	*Washing of handles*	*21,660*	*Sewered*	*490*
Rinse water	*Rinsing of handles*	*21,660*	*Sewered*	*490*
Spent acetone	*Curing of handles*	*11,870*	*Shipped offsite; incinerated*	*13,020*
Evaporated acetone	*Curing of handles*	*90,850*	*Evaporates to plant air*	*29,980*
Spent isobutyl acetate	*Curing of handles*	*1,300*	*Shipped offsite; incinerated*	*2,250*
Evaporated isobutyl acetate	*Curing of handles*	*32,920*	*Evaporates to plant air*	*18,730*
Solvent-based paint	*Painting of handles*	*26,380*	*Shipped offsite; incinerated*	*51,980*
Evaporated solvent	*Painting of handles*	*19,270*	*Evaporates to plant air*	*6,360*
Cooling water	*Plastic extruders*	*5,392,240*	*Sewered*	*12,900*
Petroleum naphtha	*Cleaning of blades and maintenance*	*8,850*	*Shipped offsite; recycled*	*4,550*

* *Includes waste treatment, disposal, and handling costs and applicable raw material costs.*

Table 2. *Summary of Recommended Waste Minimization Opportunities*

Minimization Opportunity	Waste Stream Reduced	Annual Waste Reduction Quantity (lb)	Annual Waste Reduction Per cent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Install an automatic plastic pelletizer to replace the baler used for plastic scrap collection. Currently, the scrap plastic is shipped overseas to a recycler after it is collected and baled. The pelletizer will compact the waste plastic and thus reduce the volume of the waste shipments to the recycler. Secondly, the pelletizer will eliminate the current breaking of bales that leads to landfilling of scrap plastic. Lastly, a higher price can be obtained from national markets that recycle plastic pellets.	*Waste plastic*	—[1]	—	*$85,590*	*$67,000*	*0.8*
Eliminate use of isobutyl acetate for screwdriver handle curing. Trial operations at the plant have shown that product quality will be maintained without the polishing.	*Spent isobutyl acetate* *Evaporated isobutyl acetate*	*1,300* *32,921*	*100* *100*	*20,980*	*0*	*Immediate*

[1] *The waste plastic spilled from bales that is currently landfilled (24,960 lb/yr) will be shipped to the recycler instead of being landfilled.*

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