United States Environmental Protection Agency
Research and Development

Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

EPA/600/S-94/013 September 1994

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Felt Tip Markers, Stamp Pads, and Rubber Cement

Richard J. Jendrucko*, Todd M. Thomas*, 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 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 That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992).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 the University of Tennessee performed an assessment at a plant that manufactures felt tip markers, stamp pads, and rubber cement. Plastic components for the markers are formed in injection molding machines. A porous filler is inserted into the marker case and ink is injected into it. The endplug, nib, and cap are added to the marker, which is then labeled and packaged. The first step in stamp pad production is the injection molding of plastic double-hinged stamp pad cases. Three types of stamp pads are manufactured: felt, foam, and self-inking. The pads are prepared and inserted into the cases. Rubber cement is manufactured by mixing synthetic rubber strips and solvent. The team's report, detailing findings and recommendations, indicated that a large quantity of scrap plastic is generated by the injection molding of markers and stamp pad cases, and that significant cost savings could be achieved by segregating scrap plastic and reusing it in subsequent production runs.

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.

* University of Tennessee, Department of Engineering Science and Mechanics
** 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 (Philadelphia, PA) 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 the University of Tennessee 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 graduate and undergraduate students who participate

Printed on Recycled Paper

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

The plant produces several varieties of felt tip markers, stamp pads, and rubber cement. It operates 6,120 hr/yr to produce > 2 x 10^6 lb/yr of product.

Manufacturing Process

Polypropylene, polystyrene, and polyethylene pellets, liquid and powdered dyes, and solvents for ink mixing are the principal raw materials used for making markers and stamp pads. Rubber strips and solvents are the major raw materials required for rubber cement manufacture.

Felt Tip Marker Production

In order to manufacture felt tip markers, polypropylene and polystyrene pellets are placed in a hopper and mixed with colored pellets. The pellet mixtures are metered into injection molding machines in which the three parts of the marker are formed (the case, cap, and endplug).

The filler, a porous ink reservoir that is to be inserted into the marker case, is produced in a parallel operation. Cellulose acetate or polyester fiber is fed into a machine that stretches and relaxes the material. Next, cellophane is wrapped around the filler piece, and a long cylindrical form is automatically cut into individual pieces.

In a third parallel operation, solvent or water is mixed with appropriate dyes to make marker ink.

During final assembly of markers, the fillers are inserted into the molded cases, the inks are needle-injected into the fillers, and the molded endplugs are attached. The next step is the attaching of nibs (small pieces of felt that wick the ink from the filler) in the tip of the marker body. Molded caps are snapped into place, labels are applied to the markers, and the finished products are packaged.

An abbreviated process flow diagram for felt tip marker production is shown in figure 1.

Stamp Pad Production

Three types of stamp pads are manufactured by the plant: felt, foam, and self-inking. Polystyrene pellets and black and grey dyes are mixed together and metered into injection molding machines where double-hinged stamp pad cases are formed. Felt pads are made by layering and cutting felt and asphalt sheets. A cloth overwrap is added and then the entire pad is inserted into a molded case. Water-based ink is injected into the pad and the finished stamp pad is labeled, packaged in cellophane, boxed, and shipped. For foam stamp pad production, pre-cut foam pieces are dipped in water-based ink and passed through a wringer machine to remove excess ink. The pad is inserted into a molded case, which is labeled, packaged in cellophane, boxed, and shipped. Self-inking stamp pads are manufactured by first blending dimethyl phthalate, powdered dyes, and PVC resins in a covered tank. The mixture is poured into individual trays, which are conveyed through a natural gas-fired oven for curing and then air-cooled. A pad base material is placed in the bottom of a case and the ink-impregnated pad is placed on top. The assembled pads are labeled, wrapped in cellophane, boxed, and shipped.

An abbreviated process flow diagram for stamp pad production is shown in figure 2.

Rubber Cement Production

To produce rubber cement, synthetic rubber strips and rubber solvent are mixed together in a tank and stored in a storage tank. The contents of the storage tank are pumped to a filler machine where the rubber cement is pumped into individual bottles traveling on a conveyor. The filled bottles are capped, packaged, and shipped to customers.

Existing Waste Management Practices

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

- Waste cardboard is baled and sold to a recycler.
- Plastic waste from the injection molding machines is reground and sold to an outside firm for reprocessing after which it is returned to the plant for reuse.
- Hydraulic oil from the injection molding machines is filtered to extend its useful life.
- Liquid hazardous waste streams are segregated by primary component.
- Attempts have been made in the past to recycle dimethyl phthalate. However, recycling has been discontinued because of varying product quality and employee health concerns.

Waste Minimization Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the annual waste management cost for each waste stream identified 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 simple payback time are given in the table. The

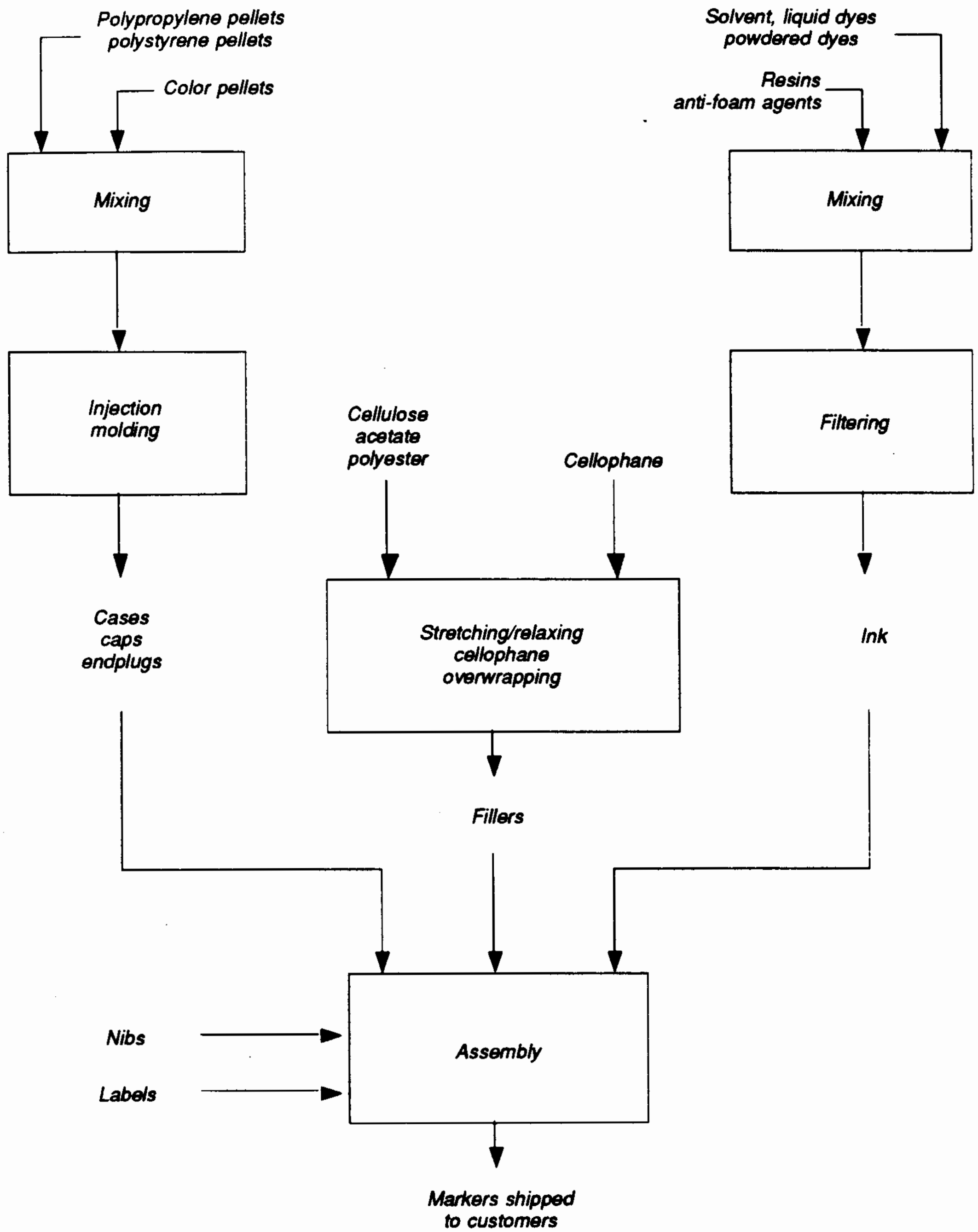

Figure 1. Abbreviated process flow diagram for felt tip marker production.

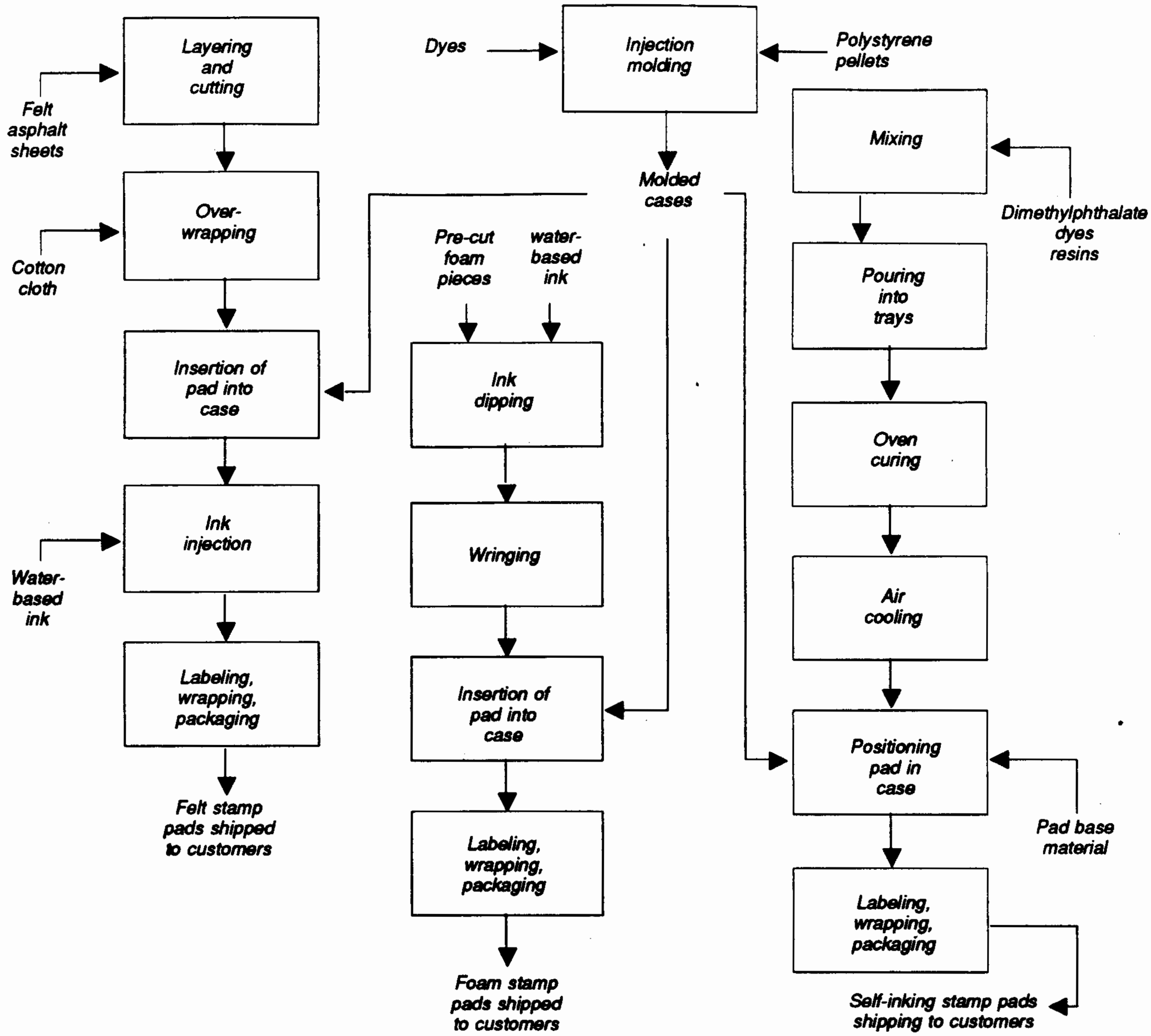

Figure 2. Abbreviated process flow diagram for stamp pad production.

Table 1. *Summary of Current Waste Generation*

Waste Stream Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb)	Annual Waste Management Cost*
Off-specification filler overwrap	Filler machine in felt tip marker production	Shipped to municipal landfill	4,730	$500
Empty dye containers	Felt tip marker and stamp pad production	Returned to vendor for reuse	3,600	500
Evaporated n-propyl alcohol	Ink mixing in felt tip marker production	Evaporates to plant air	41,470	16,170
Excess plastic runners	Injection molding in felt tip marker production	Ground; returned to supplier for reprocessing	16,600	1,980
Unusable filler pieces	Filler machine in felt tip marker production	Shipped to municipal landfill	2,020	1,000
Hydraulic oil filters	Filtering of hydraulic oil from injection molding machines	Shipped offsite for incineration	170	2,280
Contaminated ink filters	Ink mixing in felt tip marker and stamp pad production	Shipped to municipal landfill	2,360	1,640
Hydraulic oil/detergent solution	Cleanup in felt tip marker and stamp pad production	Shipped offsite for disposal as hazardous waste	3,400	10,530
Synthetic oil	Air compressors	Shipped offsite for incineration	2,410	8,620
Off-specification markers	Felt tip marker production	Donated to charitable organizations	56,250	90
Off-specification markers	Felt tip marker production	Shipped to municipal landfill	506,250	830
Scrap packaging material	Felt tip marker and stamp pad production	Shipped to municipal landfill	560	500
Plastic scrap	Color changes in injection molding in felt tip marker and stamp pad production	Returned to supplier for reprocessing	5,500	660
Color-streaked marker components	Color consistency problems in felt tip marker production	Ground; returned to supplier for reprocessing	165,140	19,690
Ink system wash water	Cleanup in felt tip marker production	Treated onsite; sewered	106,240	50,630
Plastic pellets/hydraulic oil	Spills in felt tip marker and stamp pad production	Shipped to municipal landfill	8,830	1,640
Ink system wash solvent	Cleanup in felt tip marker production	Reused in black ink production	210	0
Scrap self-inking stamp pads	Improper curing of self-inking pads	Shipped offsite for disposal as hazardous waste	21,830	55,540
Wash water	Stamp pad production	Treated onsite; sewered	11,950	5,700
n-propyl alcohol wash-out	Ink mixing in stamp pad production	Shipped offsite for incineration	1,530	2,010
Evaporated n-propyl alcohol	Washout of ink mixer in stamp pad production	Evaporates to plant air	380	150
Unused inking mixture	Self-inking stamp pad production	Shipped offsite for incineration	1,100	5,540
Empty solvent containers	Stamp pad production	Returned to vendor for reuse	900	500
Scrap cellophane overwrap	Packaging of stamp pads	Shipped offsite to recycler	790	420
Off-specification plastic cases	Injection molding of stamp pad cases	Returned to supplier for reprocessing	2,030	240
Off-specification felt stamp pads	Stamp pad production	Shipped to municipal landfill	10,160	500
Contaminated plastic floor covering	Stamp pad production	Shipped offsite for disposal as hazardous waste	50	630
Resins and powder dyes	Stamp pad production	Shipped offsite for incineration	50	560
Wash water	Ink mixer in stamp pad production	Treated onsite; sewered	27,890	13,290
Waste felt inserts	Improper cutting during stamp pad production	Shipped to municipal landfill	3,750	500
Waste foam inserts	Poor ink transfer during stamp pad production	Shipped to municipal landfill	4,500	500
Rubber cement residue	Rubber cement production	Shipped to municipal landfill	380	500
Evaporated rubber solvent	Mixing of rubber cement	Evaporates to plant air	15,600	0
Wastewater treatment sludge	Onsite WWTP	Accumulating onsite in drying pond	N/A[1]	0[1]

* Includes waste treatment, disposal, and handling costs and applicable raw material costs.
[1] Waste is accumulating onsite; no waste was shipped offsite during the past year.

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)
Segregate scrap plastic from injection molding by color and reuse in subsequent production runs.	Excess plastic runners Plastic scrap Color-streaked marker components	9,340 3,090 61,930	56 56 38	$ 5,100[1]	$0	Immediate
Modify the self-inking stamp pad production process to reduce pad thickness by one-half so that individual pads with surface defects can be combined to produce one pad with an acceptable visible top surface.	Scrap self-inking stamp pads	19,650	90	20,050[1]	0	Immediate
Improve maintenance of injection molding machines to reduc leaking of hydraulic oil.	Hydraulic oil/detergent	2,380	70	7,370	17,400	2.4
Filter and reuse synthetic oil removed from air compressors.	Synthetic oil	2,170	90	7,450[1]	0	Immediate

[1] Total savings have been reduced by an annual operating cost required for implementation of this opportunity.

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 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. 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 may result when the opportunities are implemented in a package.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, several additional measures were considered. These measures were not analyzed completely 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.

- Line the ink mixing tanks with Teflon inserts to minimize the amount of residual ink adhering to tank walls after mixing and draining in order to reduce the amount of washout waste generated during clean-up.
- Reduce the scrap rate in the automated felt tip marker assembly line by improving the scheduling of production runs and maintenance of the line.
- Utilize reusable, washable ink filters to recover resins and dye pigments collected during filtration following ink mixing and use them in production of black ink.
- Modify the solvent-based ink mixing tanks to minimize solvent evaporative losses.
- Purchase a sludge dryer to reduce the weight of the wastewater treatment sludge in order to reduce disposal costs.

This research brief summarizes 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**.

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/S-94/013