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ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Remanufacturer of Automobile Radiators

Kevin Gashlin and Daniel J. Watts*

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 remanufactures automobile radiators. The process involves cleaning the radiator, locating and repairing any leaks, painting, and reinstallation. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options identified include changes in the cleaning procedure, more efficient rinsing operations, and change of paint from solvent-based to water-based. 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.

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 remanufacturing of automobile radiators (1 of the 30 assessments performed) and 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.

* New Jersey Institute of Technology, Newark, NJ 07102

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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 refurbishes motor vehicle radiators, both from automobiles and from heavier commercial vehicles. In a real sense, this type of facility is in the pollution prevention business by extending the useful life and allowing reuse of equipment which otherwise would find its way into the waste stream. The process used involves removal of the radiator from the vehicle, cleaning the radiator, finding and repairing any leaks, painting, and reinstallation into the vehicle. This facility is located in an urban area and employs about 20 people.

Remanufacturing Process

The remanufacturing process is conceptually simple—the radiator is removed from the vehicle, cleaned, leaks detected and repaired, painted, and reinstalled in the vehicle. These individual steps however have potential for waste generation and each requires separate consideration from a pollution prevention perspective.

The removal process has potential for generation of waste streams by capturing freon from air conditioning equipment in the vehicles and from collecting ethylene glycol antifreeze contained in the radiators.

The cleaning process is rigorous. The radiator is immersed in a tank of caustic solution (typically 40% to 50 % sodium hydroxide) which is heated to 140-200 °F. The radiator remains in this tank, frequently called a boil-out tank, for 15 to 60 min. The objective of this cleaning step is to soften or remove deposits, scale, corrosion, or other foreign materials from the radiator. After the cleaning, the radiator is removed from the boil-out tank and the caustic solution is allowed to drain. The radiator is then rinsed using approximately 5-10 gal of water in a rinse tank. This rinsing is most frequently accomplished using a flow through system with fresh tap water. The primary objective of this step is to remove adhering caustic solution and any loosened scale from the inside and outside of the radiator.

The rinsed radiator is leak tested in a test tank. Leak testing involves hooking a compressed air line to one end of the radiator, plugging the other end, and submerging the radiator in the test tank. Leaks are located by the stream of bubbles which appear in the water and are repaired by soldering. The soldering involves application of a flux or muriatic acid to prepare the surface, followed by spot heating and application of the solder. The soldering usually takes place while the radiator is supported on a rack over the test tank.

After leak repairs are completed, the radiator is painted using a solvent-based black enamel paint and reinstalled in the vehicle. The painting is done in a spray booth.

Existing Waste Management Activities

At the time of the assessment, the facility had questions about its waste management practices and an interest in exploring pollution prevention options. At the time of the assessment, the freon from the air conditioning system was vented to the atmosphere when the radiator was removed from the vehicle. Similarly, the engine coolant was discharged to the POTW. No information was available about the quantity of this material which was generated. Following the assessment, the freon is captured, purified and reused onsite. Similarly, the antifreeze solution is collected and recycled. Although these streams are peripheral to the radiator remanufacturing, the changes represent advances in pollution prevention at the facility. Data to measure the impact of these changes is not yet available.

The boil-out tank generates waste which can be described as a highly alkaline sludge containing heavy metals. The usual practice is to dump the boil-out tank when the build up of sludge on the bottom is sufficient to interfere with the insertion of the radiator. In addition, the supernatant liquid from the boil-out tank is periodically partially discharged to the POTW. Both the sludge and the aqueous discharge are highly alkaline and the metal content frequently exceeds the limits acceptable for discharge. The sludge accumulates at the rate of about 3 drums per year and is sent for land disposal. It was not possible to determine the volume of the discharge to the POTW.

The flow through the rinse tank is estimated to be about 300 gal of water per day. This flow is discharged to the POTW and any sludge which is collected in the tank is combined with the sludge from the boil-out tank for disposal. The test tank, about 30 gal, is dumped to the POTW whenever it becomes so cloudy as to prevent easy detection of leaks. The frequency of dumping depends upon the use of the tank, and to a very large extent the turbidity of the test tank depends upon the effectiveness of the preceding rinsing step. The test tank is dumped about once each month. Any sludge in this tank is also collected and combined with the boil-out tank sludge.

The radiators are spray painted with solvent-based paint. Approximately 600 gal of paint at 63% solvent levels is used annually. This means that 378 gal of solvent is released to the atmosphere. The filters from the spray booth which captured overspray were dried and sent for disposal as non-hazardous waste.

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.

The cost savings are calculated both in terms of avoided costs of waste disposal and recovery of any value of raw material used again. Also, no equipment depreciation is factored into the calculations.

This facility affords two areas of opportunity for pollution prevention—the painting area and the water quality and quantity management area.

At the time of the assessment two types of options were developed for the painting process—improve the spray procedure to reduce the volume of overspray and use a water-based paint to paint the remanufactured radiators. There was no water-based paint available for this purpose. Since the assessment, however, the facility has discovered, evaluated, and adopted for use a water-based latex paint. The change was not without difficulty, however, because some of the customers of the business complained that they had received an inferior paint job because the appearance was not the same as that of previous jobs. This was overcome through discussion and education with the customers.

The water management problem is somewhat more complex. Two types of concern are the pH of the system and the metal content of the system. In addition there is an interest in reducing the volume of sludge which the remanufacturing process generates. To a large degree reduction of the quantity of sludge is independent of the process used because it results from the cleaning of foreign materials from the used radiators which are processed through the facility.

One approach to reducing the boil-out tank problem is to eliminate that process entirely. An alternative process called "rodding" is essentially a manual reaming. This coupled with mechanical and spot cleaning has been used in some similar facilities in place of the boil-out tank. This alternative eliminates the boil-out and rinse tank difficulties.

If it is decided to continue with the caustic boil-out tank approach, then the goal should be to reduce the total water usage. One way to accomplish this is to develop a counter-flow rinsing technique which would require the addition of at least one more tank. The objective would be to keep as much active chemical in the boil-out tank as possible. The modification to the present procedure would involve increased attention to remove as much caustic solution as possible when the radiator is removed from the bath. This would mean increased drip time to allow as much liquid as possible to drip back into the boil-out tank. In addition, it would be desirable to use compressed air to force out as much of the liquid as possible which may be inside the radiator.

This nearly drip-free unit should be placed in the rinse tank and rinsed in the usual way. The dripping and air-forcing procedure should be repeated here. The rinsed radiator should then be immersed in a newly added tank, which can be termed a drag-out tank for further removal of contaminants. Following this step, again with appropriate drip time and conditions, the radiator can be placed in the leak detection tank.

To make this system most effective, the water from lightly contaminated tanks would be used as make-up water for more heavily contaminated tanks. For example, because the boil-out tank is heated, water is lost through evaporation. Water from the rinse tank can be used to replace that lost water in the boil-out tank. The drag out tank water can be used to refill the rinse tank, and the leak tank can be used to refill the drag out tank. Tap water should be used only in the leak tank. If sludge or solids appears in any of the tanks except the boil out tank, it can be removed by a simple filtration prior to transferring the water to the next tank.

This approach concentrates the metals and caustic in the boil out tank and maintains relatively constant levels in the other tanks. This process eliminates much of the discharge to the POTW. In order to make this practicable, it is necessary to avoid contamination of these tanks with other materials. For example, the practice of soldering the radiators while they rest over the leak tank should be stopped. This approach allows flux and solder to drop into the tank, contaminating the water. The soldering should be done elsewhere where the residues can be captured and handled more appropriately. Ideally, a non-lead solder with the necessary performance characteristics should be identified and used.

Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
Alkaline Metal-Containing Sludge	*Solids from boil-out tank and from rinse and leak tanks*	*3 drums*	*$1,650*
Aqueous Waste to POTW	*Flowthrough from rinse tank and occasional discharge from other tanks*	*100,000 gal (estimate)*	*30*
Volatile Solvents	*Drying of solvent-based paint*	*378 gal*	*(no direct treatment costs)*

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Table 2. Summary of Recommended Waste Minimization Opportunities

Waste Stream Reduced	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years *
Alkaline Metal-Containing Sludge	Convert to rodding and mechanical cleaning. This approach also eliminates much discharge to POTW.	3 drums	100	$1,650 (It should be recognized that this technique does produce solid waste which must be managed and the approach is highly labor intensive.)	$200	0.1
POTW Discharge	Implement counterflow rinsing and tank refill procedures leading to zero discharge.	100,000 gal	100	30 (This option must be considered not in light of current management costs, rather it should be compared with pretreatment costs for the entire POTW discharge which likely would soon be required for facilities of this type to remain in operation. This cost would be expected to be substantially higher than the option addressed here.)	25,000 (estimate)	833
Volatile Solvents	Change to water-based paints	378 gal	100	0 (This option represents essentially no net savings and no net cost, but is a positive pollution prevention initiative.)	0	none

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

Where the loss of water by evaporation from the boil-out tank is not rapid enough to allow the levels of contaminants in the other tanks to remain in a workable range, it may be necessary to treat the rinse water. This may be as simple as addition of a storage/settling tank for the rinse water or may get more complex depending upon conditions at the individual facility. Monitoring of pH and acid addition to maintain neutrality may be necessary.

When it is necessary to remove sludge from the boil-out tank, it is suggested that the tank contents be filtered, the solids dried or compressed and the liquid returned to the tank for reuse. The solids should be disposed of as hazardous waste, or more preferably, sent to a secondary recovery facility to reclaim the metal values.

Regulatory Implications

There are no significant regulatory issues which would impede the implementation of pollution prevention initiatives at this facility. In fact, in view of the occasional exceedance of acceptable limits to the POTW, it is likely that the facility would have to install some type of pretreatment capability. Acceleration of identification and implementation of pollution prevention practices may allow the facility to avoid the need for pretreatment by eliminating discharges to the POTW. It is expected that the process alterations to accomplish the pollution prevention approach would be substantially less costly than installation of a pretreatment capability.

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Pollution Prevention Research Branch
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

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