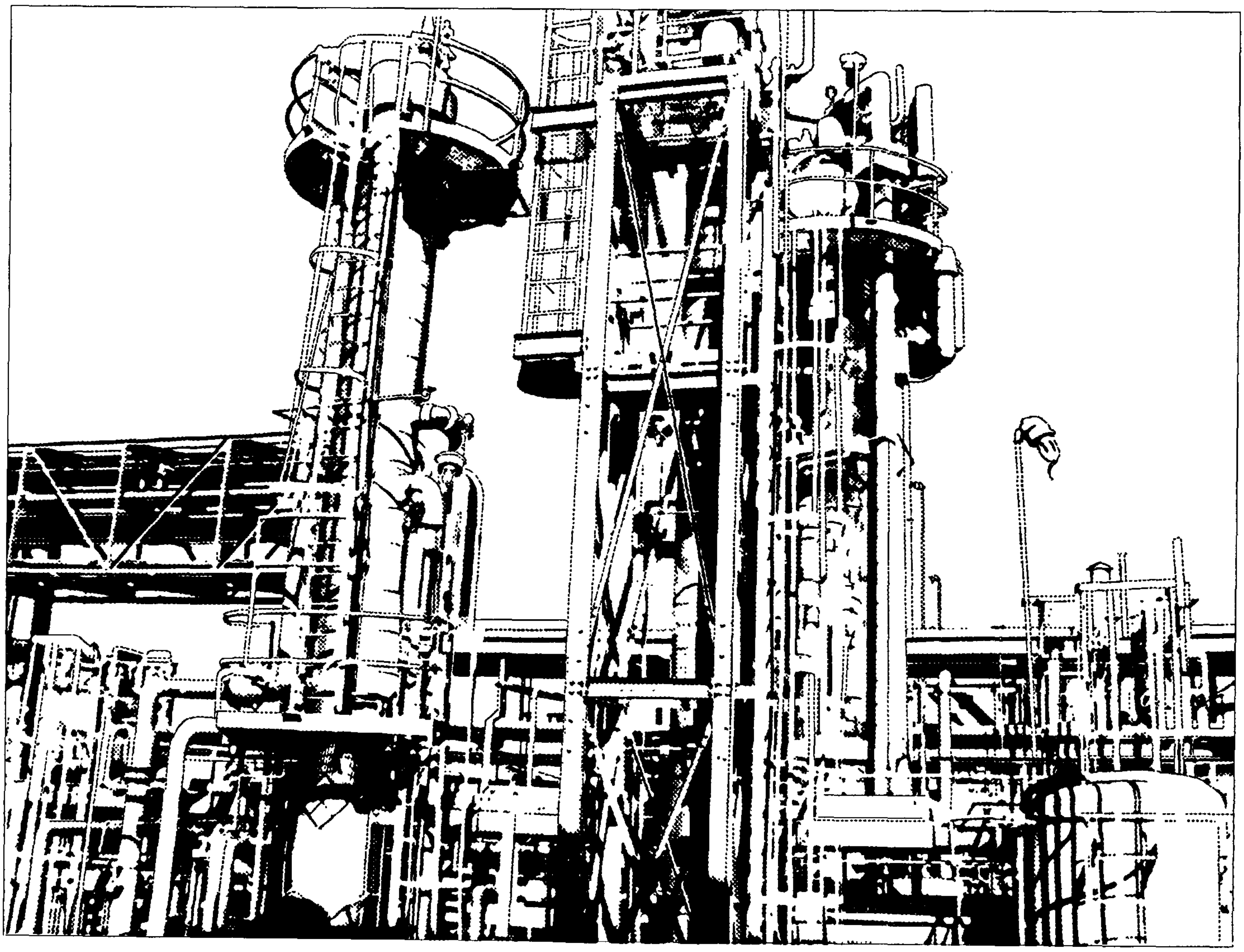
United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-92/046
April 1992

EPA

Pollution Prevention Case Studies Compendium



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POLLUTION PREVENTION
CASE STUDIES COMPENDIUM

by

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EPA Contract No. 9-C8-031-TNSE

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RISK REDUCTION ENGINEERING LABORATORY
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U.S. ENVIRONMENTAL PROTECTION AGENCY
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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

This report is the first concise collection of summaries of pollution prevention demonstrations, assessments, and research projects conducted by the Pollution Prevention Research Branch. The Branch is charged with defining, evaluating, and advancing the technology for the implementation of a national pollution prevention program. It also provides technical assistance to other sections of EPA for the purpose of reducing or eliminating pollution hazards.

The information contained here will serve as a reference work and technology transfer vehicle to disseminate research results and promote the implementation of pollution prevention activities.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

The Pollution Prevention Research Program encourages the development and adoption of processing technologies and products in the United States that will lead to reducing the aggregate generation rates for pollutants entering the various environmental media. It includes projects to improve the understanding of environmental problems that might be amenable to pollution prevention approaches, and projects that demonstrate innovative pollution prevention approaches and technologies. Pollution Prevention Research supports studies and research and demonstration projects that are designed to further the utilization of source reduction and to a lesser degree recycling as preferable environmental improvement strategies. Projects within the program are supported through in-house activities, contracts with outside organizations, and cooperative agreements with universities and other government agencies.

The Risk Reduction Engineering Laboratory (RREL) serves as the lead organization within the EPA's Office of Research and Development for research related to pollution prevention. Spearheading pollution prevention research within RREL is the Pollution Prevention Research Branch (PPRB) of the Waste Minimization Destruction and Disposal Research Division. Efforts cover all sectors identified in EPA's Pollution Prevention Strategy (January, 1991), i.e., manufacturing, agriculture, energy and transportation, municipal water and wastewater, federal facilities and municipal solid waste. The program also contains a technology transfer element for incorporating results from other's research and for disseminating the results of the program's efforts.

As a major part of the effort to disseminate the results of its research, PPRB has produced this compilation of case studies. These studies are the culmination of some of the major current research efforts being conducted in the area of pollution prevention. It is a compilation of summaries of pollution prevention demonstrations, assessments and research projects conducted within the Branch. We hope that this compendium will facilitate the development and adoption of pollution prevention techniques throughout the United States and other countries.

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ACKNOWLEDGEMENTS

This report was prepared by Mr. Johnny Springer, Jr., EPA's Project Officer in the Pollution Prevention Research Branch of the Risk Reduction Engineering Laboratory, Cincinnati, Ohio. Appreciation is given to the large number of contributors to this report. Contributions were made by USEPA's Office of Research and Development, various Federal Departments, state pollution prevention and research organizations, and members of industry.

Some draft information used for this report was edited by Mrs. Marion Curry for the U.S. Environmental Protection Agency under Contract No. 9-C8-031-TNSE, for EPA's Office of Research and Development.

INTRODUCTION

As a major part of the effort to disseminate the results of its research, the Pollution Prevention Research Branch has produced this compilation of case studies. These studies are the culmination of some of the major current research efforts being conducted in the area of pollution prevention. It is a compilation of summaries of pollution prevention demonstrations, assessments and research projects conducted within the Branch.

The compendium is separated into four sections, featuring four of the Branch's key programs. The Waste Reduction Innovative Technology Evaluation (WRITE) Program is a technology demonstration program conducted in cooperation with six states and one local government. The focus of the research is to perform technical and economic evaluations of pollution prevention technologies. The Waste Reduction Evaluations at Federal Sites (WREAFS) Program focuses on performing waste minimization assessments at various Federal facilities. The Waste Minimization Assessments Program is designed to focus on the evaluation of the use of waste minimization assessments in hazardous waste generating facilities in New Jersey. The University-Based Assessments Program targets small and medium-sized businesses in its assessment program. This program utilizes Waste Minimization Assessment Centers in Colorado, Kentucky and Tennessee to conduct waste minimization assessments for businesses which lack pollution prevention expertise. All three assessment programs follow the procedures outlined in the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988)

An overview of each program is provided at the beginning of each section of the compendium. The case studies are cross referenced according to key words in an index at the end of the compendium. The Pollution Prevention Research Branch personnel roster is listed on page vii to facilitate contacting the EPA Project Officer. Information is also provided on availability of full reports and the EPA Project Officer who conducted the research. Case studies of individual EPA project summaries and environmental research briefs which have EPA document numbers (EPA/xxx/xxx/xxx) are available from EPA's Center for Environmental Research Information (CERI): U.S. Environmental Protection Agency, Center for Environmental Research Information, 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. Information on obtaining project summaries for other reports is available by contacting the EPA Project Officer referenced.

WASTE REDUCTION INNOVATIVE TECHNOLOGY EVALUATION PROGRAM (WRITE)

The Waste Reduction Innovative Technology Evaluation (WRITE) Program is a research demonstration program designed to evaluate the use of innovative engineering and scientific technologies to reduce the volume and/or toxicity of wastes produced from the manufacture, processing, and use of materials. It encourages the interaction of government and industry in the demonstration and evaluation of available innovative production and recycling options for reducing waste generation.

The objectives of the WRITE Program are:

(1) To establish reliable performance and cost information on pollution prevention techniques by conducting evaluations or demonstrations of the more promising innovative technologies.

(2) To accomplish an early introduction of waste reduction techniques into broad commercial practice.

(3) To encourage active participation of small and medium-sized companies in evaluating and adopting pollution prevention concepts by providing support to these companies through State and local government agencies.

(4) To encourage the transfer of knowledge and technology concerning pollution prevention practices between large, medium-sized, and small industries.

(5) To provide solutions to important chemical-, wastestream-, and industry-specific pollution prevention research needs.

Under the WRITE Program, EPA and seven cooperating state and county governments (California, Connecticut, Illinois, Minnesota, New Jersey, Washington, and Erie County, New York) evaluate and demonstrate the engineering and economic feasibility of selected waste reducing technologies in a manufacturing or fully operational setting.

Research efforts under the WRITE Program focus primarily on source reduction and the recycling and reuse of waste materials. The WRITE Program has completed, ongoing and/or future technology evaluations in the areas of: printed circuit board plating, paint mixing/stripping, plating solution recovery, water-based inks as substitutes for solvent based inks, alternative oil filtration systems for diesel engines, acetone recovery, cutting fluid recycling, biodegradable solvents, CFC replacement/recovery, vacuum distillation, ion exchange, ultrafiltration and others.

EPA acknowledges and appreciates the cooperation of the following organizations in the administration of the WRITE Program:

California: California Department of Health Services (DHS)

Connecticut: Connecticut Hazardous Waste Management Service (CHWMS)

Illinois: Illinois Hazardous Waste Research and Information Center (IHWRIC)

Minnesota: Minnesota Technical Assistance Program (MnTAP)

New Jersey: New Jersey Department of Environmental Protection (NJDEP)

Washington: Washington Department of Ecology

Erie County, New York: Erie County Department of Environment and Planning, Division of Environmental Compliance Services

COMPUTERIZED PRINTED CIRCUIT BOARD PLATING SYSTEM

INTRODUCTION

This study was technically and economically evaluated under the California/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program, and was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL), the California Department of Health Services (DHS), and General Dynamics Pomona Division (Pomona).

General Dynamics Pomona Division builds various tactical defense weapons, primarily air defense missiles, and gun systems. In 1984, General Dynamics established a corporate environmental program with individual Division responsibility for hazardous waste reduction, including reductions in the use of toxic substances.

As a result of implementation of this corporate policy, several waste reduction process modifications have been instituted at the Pomona Division. A reduction of 97 percent in the annual discharge of hazardous (about 10,600 tons), liquid, and solid wastes, and a reduction of 95 percent in volatile organic contaminant (VOC) emissions (about 17.5 tons) have been reported by Pomona through a combination of waste reduction and treatment technologies.

WRITE METHODOLOGY

The waste minimization technology employed at Pomona was screened for technology applicability, source reduction potential, extent of process modification, and cost-effectiveness. The Worth Assessment Model used was developed by EPA specifically for the WRITE Program. As a result of applying the model, the computerized printed circuit board plating system was chosen for further analysis.

The technical and economic evaluation was conducted during site visits, and additional information required was obtained through subsequent follow-up conversations with Pomona staff and system suppliers. As economic objectives were centered around return on capital, internal rate of return, and payback periods which are considered company sensitive information, a simple payback for each process was calculated.

TECHNOLOGY DESCRIPTION AND EVALUATION

Chemcut Corporation installed a new computerized printed circuit board plating system at General Dynamics in July of 1988, at a cost of $4,100,000. This new plating system completely eliminated rinse tanks from the process by use of a unique spray-rinse configuration contained in a transporter hoist system that passes over the plating bath tanks. This computerized hoist system allows the circuit boards to be rinsed for only a short duration after their immersion in a process solution. Rinse water discharge from this new process is less than 10 gallons per minute (gpm) versus 60 gpm from the old process. This reduction in wastewater discharge allowed for a corresponding reduction in metal recovery system sizing. The use of spray rinse versus a dip rinse can also be a major design factor if water supply limitations must be considered or if space is limited in locating the plating line.

Copper spheres in anode baskets are also used in the new system instead of a conventional anode bar-and-hook system that was utilized in the old plating system. This allows a 1:1 ratio of anode to cathode for a very even plating across the panel and through the holes.

In conjunction with the installation of the new production equipment, Chemcut Corporation was required to provide a non-sludge-producing treatment system for all waste streams generated by the process. This resulted in the installation of a new copper-recovery system using short-bed ion exchange columns and electrowinning technologies. This system now produces salable scrap copper metal, eliminating a major waste stream to the conventional sludge-producing waste treatment system.

Cost savings in labor and waste treatment were found to be the major cost parameters, resulting in a favorable net annual operating savings between the original and newly installed printed circuit board plating systems. The payback period for the new system was estimated to be 8.3 years. Annual cost savings of $130,000 in waste treatment and disposal were determined from the recovery of copper from rinse water and process tank solutions, which were previously treated and disposed as a hazardous sludge. An annual cost savings for water usage was estimated to be $10,000 based on a net overall decrease in rinse-water discharges of 50 gpm.

Report Title: Evaluations of Waste Minimization Technologies at the General Dynamics Pomona Division
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown

Key Words: tactical defense weapons; computerized printed circuit board plating system; eliminated rinse tanks; copper-recovery system; ion exchange; electrowinning

COMPUTERIZED SULFURIC ACID ANODIZING SYSTEM

INTRODUCTION

This study was technically and economically evaluated under the California/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program, and was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL), the California Department of Health Services (DHS), and General Dynamics Pomona Division (Pomona).

General Dynamics Pomona Division builds various tactical defense weapons, primarily air defense missiles, and gun systems. In 1984, General Dynamics established a corporate environmental program with individual Division responsibility for hazardous waste reduction, including reductions in the use of toxic substances.

As a result of implementation of this corporate policy, several waste reduction process modifications have been instituted at the Pomona Division. A reduction of 97 percent in the annual discharge of hazardous (about 10,600 tons), liquid, and solid wastes, and a reduction of 95 percent in volatile organic contaminant (VOC) emissions (about 17.5 tons) have been reported by Pomona through a combination of waste reduction and treatment technologies.

WRITE METHODOLOGY

The waste minimization technology employed at Pomona was screened for technology applicability, source reduction potential, extent of process modification, and cost-effectiveness. The Worth Assessment Model used was developed by EPA specifically for the WRITE Program. As a result of applying the model, the computerized sulfuric acid anodizing system was chosen for further analysis.

The technical and economic evaluation was conducted during site visits, and additional information required was obtained through subsequent follow-up conversations with Pomona staff and system suppliers. As economic objectives were centered around return on capital, internal rate of return, and payback periods which are considered company sensitive information, a simple payback for each process was calculated.

TECHNOLOGY DESCRIPTION AND EVALUATION

In December 1988, General Dynamics replaced its 35 year old chromic acid aluminum anodizing system with a new computerized sulfuric acid anodizing system which utilized computerized hoists and on-demand rinsing. The new system, supplied by NAPCO, Inc., enabled General Dynamics to eliminate a major source of chromium emissions.

General Dynamics used chromic acid in the original aluminum anodizing process due to military contract specifications. Typically, the much less corrosive chromic acid is used when parts are either subject to stress or contain blind holes (e.g.. trapped areas, recesses, porous castings) in which anodizing solution could be entrapped. Chromic acid is also used for detection of fine surface flaws on finished parts. This process, in spite of its higher operating costs, is used by the aerospace industry, the military, and military contractors.

General Dynamic's motivation for converting to a sulfuric acid anodizing system was that its original chromic acid system could not be modified cost-effectively to meet production requirements and maintain compliance with current and anticipated air and water regulatory requirements. Besides the chemical substitution to eliminate chromium releases, the addition of automated hoists and the on-demand water bath rinse system helped to reduce wastewater treatment requirements. This system reduces treatment requirements by avoiding unnecessary drag-out of immersion fluids and by reducing rinse water usage and wastewater treatment requirements by reducing water consumption and by monitoring the conductivity of the rinse water in the tank. By using this on-demand water process, rinse water requirements were reduced from approximately 15-20 gallons per minute (gpm) to approximately 6-8 gpm.

The capital cost of the new sulfuric acid anodizing system was $955,000 and included the computerized hoist and on-demand anodizing rinse systems. The operating and maintenance costs were lower for the new system when compared to the old chromic acid system because it is less energy intensive, it has a smaller plating interval, and wastewater treatment costs are less. Because sulfuric acid is much more conductive as an electrolyte, the anodizing process requires less power. The cost savings for electricity were estimated to be $10,900, based on an annual decrease in electrical consumption. The sulfuric acid process is also much faster than chromic acid, thus resulting in less process time required for a given film thickness. This results in lower operating costs due to increased through-put potential.

Wastewater treatment costs are less for the new system due to a decrease in metals removal requirements. The sulfuric acid process requires only aluminum reduction resulting in a nonhazardous sludge as compared to aluminum and chromium reduction in a chromic acid system which requires additional tanks and chemicals for treatment and settling. The disposal costs for the aluminum sludges generated from the sulfuric acid process are less than the hazardous chromium and aluminum sludge generated from the chromic acid process.

Additional cost savings are realized with the addition of computerized hoists and on-demand spray rinse systems. Both of these systems have reduced labor requirements; water consumption has been reduced from 20 to 8 gpm. The cost savings in reduced water consumption has been estimated to be $2,300 annually. General Dynamics also expects that the computerized hoist system will lower costs associated with rejects and rework.

Report Title: Evaluation of Waste Minimization Technologies at the General Dynamics Pomona Division Plant
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown
Key Words: tactical defense weapons; computerized sulfuric acid anodizing system; computerized hoists; on-demand rinsing; chromium; chemical substitution; water consumption

ROBOTIC PAINT FACILITY

INTRODUCTION

This study was technically and economically evaluated under the California/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program, and was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL), the California Department of Health Services (DHS), and General Dynamics Pomona Division (Pomona).

General Dynamics Pomona Division builds various tactical defense weapons, primarily air defense missiles, and gun systems. In 1984, General Dynamics established a corporate environmental program with individual Division responsibility for hazardous waste reduction, including reductions in the use of toxic substances.

As a result of implementation of this corporate policy, several waste reduction process modifications have been instituted at the Pomona Division. A reduction of 97 percent in the annual discharge of hazardous (about 10,600 tons), liquid, and solid wastes, and a reduction of 95 percent in volatile organic contaminant (VOC) emissions (about 17.5 tons) have been reported by Pomona through a combination of waste reduction and treatment technologies.

WRITE METHODOLOGY

The waste minimization technology employed at Pomona was screened for technology applicability, source reduction potential, extent of process modification, and cost-effectiveness. The Worth Assessment Model used was developed by EPA specifically for the WRITE Program. As a result of applying the model, the robotic paint facility was chosen for further analysis.

The technical and economic evaluation was conducted during site visits, and additional information required was obtained through subsequent follow-up conversations with Pomona staff and system suppliers. As economic objectives were centered around return on capital, internal rate of return, and payback periods which are considered company sensitive information, a simple payback for each process was calculated.

TECHNOLOGY DESCRIPTION AND EVALUATION

The General Dynamics paint production operations facility was completed in December 1988 to replace manual mixing and hand spraying of metal parts in naval weapons systems. It includes computer-controlled robots (a GRI OM 5000 Unit) which allows quick, automated precision painting. A proportional paint mixer was also added, which feeds preselected quantities of individual paint components directly to a paint spray nozzle thus eliminating batch makeup operations. Electrostatic spray guns and automatic waste cleaning solvent collection systems were also introduced to allow for recycle and reuse of waste paint. Spray paint booths are also available for touch-ups. Stills are used for recycling paint cleaning solvents.

The painting facility uses both oil- and water-based paints. For oil-based paints, polyurethane thinner is used for paint thinning and equipment cleaning. A thinner containing isopropyl alcohol and xylene is used with water-based paint. Paint waste was reduced from 42 tons in 1987 to 31 tons in 1988, and were further reduced to 17 tons in 1989. About 1,000 gallons of polyurethane cleaning solvent per year is now being recycled through the paint shop solvent stills, resulting in approximately 60 to 100 pounds of still bottoms per week, or about 5,000 pounds per year. The still bottoms and waste paint are sent off site for incineration.

Paint purchases decreased from 6,530 gallons in 1988 to 5,230 in 1989; solvent purchases decreased from 2,500 gallons in 1988 to 1,080 gallons in 1989. These decreases are mainly due to changes in equipment and operating purchases in the paint shop, but also partially due to changes in inventory and decrease in production rates.

Only polyurethane solvent (for oil-based paints) is currently being recycled in the stills. When distilling the water-based paint solvent, which contains isopropyl alcohol and xylene, the recycled solvent separates into two layers, a water and a solvent layer. Even when the water is removed by draining, water contained within the solvent prevents the solvent from being reused for thinning and cleaning. Potentially, the water can be removed by adding a water separator upstream and a molecular sieve downstream of the stills.

The installation cost of the robotic painting system was $1,400,000. The system included a parts conveyor, computer-controlled robots, electrostatic spray guns, proportional paint mixing, and cleaning solvent collection equipment. The Disposal of 42 tons of waste in 1987 would have cost about $73,000 at the current disposal rates of $420 per drum, plus $7,000 per truckload for transportation (80 drums). The disposal costs of

21 tons in 1989 would be about $36,000. The payback period from a waste disposal standpoint alone would be 40 years. This substantially overstates the payback period, however, because the savings in labor costs from painting and waste disposal and any decrease in rejects in parts were not included, as it was considered company sensitive information. Payback for the solvent stills is only about 4 years, but would be less if all cleaning solvent were being recycled.

Report Title: Evaluation of Waste Minimization Technologies at the General Dynamics Pomona Division Plant
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown
Key Words: paint production operations; naval weapons systems; computer-controlled robots; proportional paint mixer; electrostatic spray guns; isopropyl alcohol; xylene; polyurethane solvent; distillation; molecular sieve

PLASTIC BEAD-BLAST PAINT STRIPPER

INTRODUCTION

This study was technically and economically evaluated under the California/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program, and was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL), the California Department of Health Services (DHS), and General Dynamics Pomona Division (Pomona).

General Dynamics Pomona Division builds various tactical defense weapons, primarily air defense missiles, and gun systems. In 1984, General Dynamics established a corporate environmental program with individual Division responsibility for hazardous waste reduction, including reductions in the use of toxic substances.

As a result of implementation of this corporate policy, several waste reduction process modifications have been instituted at the Pomona Division. A reduction of 97 percent in the annual discharge of hazardous (about 10,600 tons), liquid, and solid wastes, and a reduction of 95 percent in volatile organic contaminant (VOC) emissions (about 17.5 tons) have been reported by Pomona through a combination of waste reduction and treatment technologies.

WRITE METHODOLOGY

The waste minimization technology employed at Pomona was screened for technology applicability, source reduction potential, extent of process modification, and cost-effectiveness. The Worth Assessment Model used was developed by EPA specifically for the WRITE Program. As a result of applying the model, the plastic bead-blast paint stripper system was chosen for further analysis.

The technical and economic evaluation was conducted during site visits, and additional information required was obtained through subsequent follow-up conversations with Pomona staff and system suppliers. As economic objectives were centered around return on capital, internal rate of return, and payback periods which are considered company sensitive information, a simple payback for each process was calculated.

TECHNOLOGY DESCRIPTION AND EVALUATION

The plastic bead-blast paint stripper at General Dynamics was installed in June 1988, to replace methylene chloride stripping. Reusable plastic beads or media are used in this mechanical stripping operation, which is similar to sand blasting. Paint is stripped from the hangers used to hold parts being painted in the paint shop and from parts having paint defects.

The plastic bead-blasting booth is a Pauli and Griffin Pram Machine approximately 3 cubic feet and uses size 20 to 30 mesh Poly Plus beads. The unit is used only on an as-needed basis, generally a few hours per week.

Waste generated during the operation of the plastic-bead blasting unit consists primarily of paint chips with a small amount of spent plastic beads which is sent off site for incineration. Stripping by methylene chloride resulted in about 10,000 pounds per year of toxic solvent contaminated with paint sludge, which was also sent off site for incineration. The bead-blast paint stripper was installed at a cost of $18,000. This system eliminated the disposal of about 10,000 lb/year with a cost of approximately $10,000. Both the methylene chloride and bead-blast waste are disposed by incineration resulting in waste disposal costs of $10,000 for methylene chloride and $5,000 for bead-blast waste. A cost savings of $5,000 for disposal of paint chips and spent plastic beads was realized when compared to methylene chloride disposal and the capital cost of the unit. The payback period from a waste disposal perspective is about 3.6 years. This does not consider differences in operator time, maintenance requirements, and stripping materials which will vary depending on parts being stripped, whether methylene chloride stripping is being done by spray-on or dip tank methods, skill of operator, and recovery of stripping material.

Report Title: Evaluation of Waste Minimization Technologies at the General Dynamics Pomona Division Plant
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown
Key Words: tactical defense weapons; robotic paint facility; plastic bead-blast paint stripper; methylene chloride stripping; incineration; paint chips

FREON RECOVERY STILLS

INTRODUCTION

This study was technically and economically evaluated under the California/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program, and was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL), the California Department of Health Services (DHS), and General Dynamics Pomona Division (Pomona).

General Dynamics Pomona Division builds various tactical defense weapons, primarily air defense missiles, and gun systems. In 1984, General Dynamics established a corporate environmental program with individual Division responsibility for hazardous waste reduction, including reductions in the use of toxic substances.

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WRITE METHODOLOGY

The waste minimization technology employed at Pomona was screened for technology applicability, source reduction potential, extent of process modification, and cost-effectiveness. The Worth Assessment Model used was developed by EPA specifically for the WRITE Program. As a result of applying the model, the freon recovery system was chosen for further analysis.

The technical and economic evaluation was conducted during site visits, and additional information required was obtained through subsequent follow-up conversations with Pomona staff and system suppliers. As economic objectives were centered around return on capital, internal rate of return, and payback periods which are considered company sensitive information, a simple payback for each process was calculated.

TECHNOLOGY DESCRIPTION AND EVALUATION

Three Freon recovery stills manufactured by Recyclene were installed in December 1988, to collect and distill waste from solvent degreasing operations throughout Pomona at a cost of $240,000, plus $40,000 for add-on equipment to address operating problems. Recovered solvent is tested and reformulated under a quality assurance program to ensure that all the manufacturer's specifications are met before returning it to material stores for reissue to production operations. Still bottoms are dried in the distillation process and sent off site for incineration.

Prior to the installation of these stills, a single Freon recovery still was installed in November 1985, to extend the life of Freon used in conveyorized cleaners. This extended the solvent change out period to once per year, and saved 35,000 lb annually in Freon purchases.

Testing of the Freon recovery stills in 1988 indicated that the distillation process was working, but that the Freon being recycled was contaminated with water, which degraded the quality of the recovery product. The Pomona Division has installed separators to remove water and molecular sieves to further dry the Freon after distillation. The additions to each still cost $13,000, plus installation, but allow the Freon recovery to be operated as planned to produce a quality recycled solvent.

Reduction in Freon purchases through 1988 have primarily come through improved operations' procedures such as extended change out times for Freon, and reduction in evaporative losses. A baseline of 421,000 pounds of Freon for 1988 was used to calculate reductions in Freon usage attributable to the use of the three Freon stills, which are assumed to be utilized at full capacity for the first time in 1989. The capital cost of the stills was $270,000 with annual operating costs considered negligible. The amount of Freon recycled or the amount of avoided purchases were 212,473 lb, which at $1.64 per lb, was $384,456. The cost to incinerate 11,183 pounds of still bottoms was $8,000 with a cost savings from avoided Freon disposal equal to $148,583. The total cost savings were $489,039 with a payback period of 0.55 years. This is a minimum payback number based on recycling all of the Freon that is not lost through evaporation and drag-out losses.

Report Title: Evaluation of Waste Minimization Technologies at the General Dynamics Pomona Division Plant
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown

Key Words: tactical defense weapons; freon recovery; solvent degreasing; distillation; conveyorized cleaners; separator; molecular sieve

AN ADVANCED REVERSE OSMOSIS SYSTEM FOR NICKEL PLATING BATH SOLUTION RECOVERY

INTRODUCTION

This study was performed under the California/EPA WRITE program, and was a cooperative effort between EPA's Pollution Prevention Research Branch, under the Office of Research and Development, the Alternative Technology Division of the Toxic Substances Control Program within the Department of Health Services (DHS) of the State of California, Hewlett-Packard (HP), and Water Technologies, Inc. (WTI). Science Applications International Corporation (SAIC) provided technical support on this WRITE project.

The effectiveness of an Advanced Reverse Osmosis System (AROS) in the recovery of nickel plating bath solution and rinse water was evaluated and the costs were compared with that of an existing chemical precipitation treatment system at the Hewlett-Packard Facility in Sunnyvale, California. HP's existing wastewater treatment system for plating wastes involves precipitation of metals as hydroxide salts.

The AROS is a reverse osmosis (RO) unit with specially adapted membranes that do not require pH adjustments to neutral. The unit includes a microprocessor control to manage the RO membranes, and a continuous monitoring system that monitors the influent, permeate, and concentrate for temperature, flow rate, and conductivity.

The RO membranes clean rinses to pre-specified standards and concentrate plating salts, in order to recycle both rinse water and plating salts. An AROS can reconcentrate dilute solutions to at or near bath strength (typically a concentration of 40% to 70%) without evaporation or additional concentration technology.

TECHNICAL ANALYSIS

HP tested the AROS on a nickel plating system consisting of two plating baths followed by a "dirty" rinse tank and then a "clean" rinse tank. The rinse water flows countercurrent to the flow of the items being plated. Four liquid streams of the AROS unit were sampled on October 17, 1990 to obtain a one day snapshot of the system's operation. Removal efficiencies obtained based on the actual data were used to prepare a technical evaluation of the system. Sample analysis included nickel, chloride, sulfates, pH, total dissolved solids, conductivity, color, and total organic carbon. The AROS unit produced a composite permeate that was satisfactory as clean rinse water makeup, its intended purpose. Similarly, the concentrate was of quality (40% to 50% plating bath concentration) that could be used as nickel plating bath solution makeup.

ECONOMIC ANALYSIS

Economic analysis is based on data obtained from Hewlett-Packard. At HP, the AROS unit only treated a small fraction, e.g. about 3% of the total plating wastewater flow. HP estimates that the net annual savings from use of the AROS unit would be approximately $17,100/yr. THe AROS unit costs approximately $75,000, which represents approximately $63,000 for the AROS unit plus another $12,000 for permanent installation and training of operating personnel. The payback period is 4.4 years.

CONCLUSIONS

The AROS unit performance was considered excellent. The Hewlett-Packard evaluation showed an estimated net annual savings of approximately $17,000/year through use of the AROS unit. Under company policy this savings was insufficient to justify the capital expenditure of approximately $75,000. Hewlett-Packard decided not to purchase the AROS unit.

Because the AROS unit treated a small increment of the wastewater flow at HP, it was difficult for the AROS unit to be cost effective; however, in a different setting, the AROS unit might be very cost effective.

Report Title: The Evaluation of an Advanced Reverse Osmosis System at the Sunnyvale, California Hewlett Packard Facility
Report Availability: Immediate
EPA Project Officer: Lisa M. Brown
Key Words: reverse osmosis; nickel plating bath solution recovery; chemical precipitation; hydroxide salts; microprocessor control; continuous monitoring

CHEMICAL SUBSTITUTION FOR 1,1,1-TRICHLOROETHANE AND METHANOL IN AN INDUSTRIAL CLEANING OPERATION

INTRODUCTION

EPA's Pollution Prevention Research Branch in the Office of Research and Development along with APS Materials, Inc. (APS), a small metal finishing company in Dayton, Ohio, participated in a joint research project to evaluate the substitution of a dilute, terpene-based cleaner for 1,1,1-trichloroethane (TCA) and methanol in their degreasing operations. TCA is used as a cold solvent degreasing agent in many industrial degreasing processes. APS generates TCA and methanol waste from their plasma spray deposition process operations. Waste TCA and methanol were being generated at the rate of 1/2 barrel each per month. Disposal of these solvents had become increasingly difficult.

BACKGROUND

APS plasma sprays parts for aircraft engines, orthopedic implants, and other applications. In their biomedical parts division, APS primarily coats cobalt/molybdenum parts and titanium parts with a titanium alloy. To achieve a strong, adhesive coating, the cobalt/molybdenum parts and titanium parts were cleaned with TCA and methanol respectively. After first passing through a series of preparatory steps, the part was then immersed in a pail containing TCA or methanol. The pail was placed in an ultrasonic bath containing warm water for 15 minutes. Contaminants from previous cleaning steps are removed in this cleaning process. The part then continues on through the finishing process.

TECHNICAL ANALYSIS

The focal point of this project was to replace TCA and methanol with the dilute terpene-based cleaner. To accomplish this, some equipment modifications were made. A heater was added to the old ultrasound bath. A deionized water system was purchased along with a stainless steel bath and immersion heater. A heat gun was purchased to quicken the drying process. Other than these equipment additions, the cleaning procedure remained unchanged.

The purpose of the sampling and analysis project at APS was to support a qualitative judgement of the cleaning capabilities of the substitute cleaning solution. The sampling and analysis protocol was set up in three phases. The first two phases investigated the proficiency of the cleaning solvents. Analyses revealed that the dilute limonene solution adequately removed contaminants and no residual limonene was detected on the parts.

The third phase of the analysis examined the quality of the coating bond for parts cleaned with the terpene based solution. The before and after tensile strength results were comparable. Overall, the bonding strengths were actually slightly better for the dilute limonene cleaner.

ECONOMIC ANALYSIS

Although the new cleaning system used the same cleaning method, some capital expenditures were needed to alter the process. Capital cost included purchasing of the ultrasound with heater, 5 gal. stainless steel rinse vessel, immersion heater, heat gun, and installation of a deionized water system. The capital cost totalled $1793. The net annual cost savings for the project was $4800/yr. with a payback period of 4.5 months.

CONCLUSIONS

In summary, a terpene-based cleaner can adequately clean metal parts without adversely affecting the performance of the plasma-arc coating application. APS has deployed the water-based cleaner in all operations where specifications do not dictate the use of TCA or methanol. APS is also currently performing studies to determine the optimal life of the cleaner in order to minimize cleaner use. Elimination of the disposal problems, maintenance of plasma-arc coating quality, annual cost savings and the short payback period make the use of terpene-based cleaners attractive to other metal cleaning/coating operations.

Report Title: Chemical Substitution for 1,1,1-Trichloroethane and Methanol in an Industrial Cleaning Operation
Report Availability: Immediate
EPA Project Officer: Lisa Brown/Johnny Springer
Key Words: terpene-based cleaner; 1,1,1-trichloroethane; methanol; cold solvent degreasing; plasma spray deposition; aircraft engines; orthopedic implants; cobalt/molybdenum parts; titanium parts; ultrasonic bath; deionized water system; cleaning capabilities; limonene; coating bond

WASTE REDUCTION EVALUATIONS AT FEDERAL SITES PROGRAM (WREAFS)

The Waste Reduction Evaluations at Federal Sites (WREAFS) Program consists of a series of demonstration and evaluation projects for waste reduction conducted cooperatively by the U.S. Environmental Protection Agency (EPA) and various parts of the Department of Defense, Department of Energy, and other Federal agencies. The WREAFS Program focuses on waste minimization research opportunities and technical assessments at Federal sites. The objectives of the WREAFS Program include: (1) conducting waste minimization workshops; (2) performing waste minimization opportunity assessments; (3) demonstrating waste minimization techniques or technologies at Federal facilities; and (4) enhancing waste minimization benefits within the Federal community.

The WREAFS Program facilitates the adoption of pollution prevention/waste minimization practices through technology transfer. New techniques and technologies for reducing waste generation are identified through waste minimization opportunity assessments and may be further evaluated through joint research, development, and demonstration projects. The waste minimization opportunity assessments follow the procedures outlined in the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). The major phases of a WREAFS assessment are:

(1) **Planning and Organization**: organization goal setting;

(2) **Assessment**: careful review of a facility's operations and wastestreams and the identification and screening of potential options to minimize waste;

(3) **Feasibility Analysis**: evaluation of the technical and economic feasibility of the options selected and subsequent ranking of options; and

(4) **Implementation**: procurement, installation, implementation, and evaluation (at the discretion of the facility surveyed)

In Fiscal Year 1992, the WREAFS program will focus on providing technical research support to the Tidewater Interagency Pollution Prevention Program (TIPPP). The concept of TIPPP is to take advantage of the capabilities of well-defined communities to develop an integrated multi-media pollution prevention plan that includes both short- and long-term projects with results that are transferable to other communities. TIPPP will sponsor a number of joint EPA/DoD/NASA community R&D projects that require demonstration before being accepted within the public and private sectors. For WREAFS, the TIPPP effort is the next logical step towards the ultimate goal of establishing an overall Federal Cooperative on pollution prevention.

SCOTT AIR FORCE BASE

INTRODUCTION

As part of the WREAFS program, a waste minimization assessment of Scott Air Force Base has been conducted. The base is part of the Military Airlift Command (MAC), and operates and maintains a fleet of C-9 medical aircraft. The assessment focuses on the non-destructive wheel inspection process. Non-destructive inspection (NDI) was of special interest to EPA because of the widespread use in the military and commercial airlines. In addition, assessments of the paint stripping/parts cleaning and printed circuit board manufacture were carried out.

EXISTING WASTE MANAGEMENT ACTIVITIES

Non-destructive Inspection (NDI)

As part of the preventative maintenance practices on the C-9 aircraft, landing wheels are inspected for signs of fatigue with a liquid dye penetrant method used at Scott AFB. The primary wastes produced by this method are penetrant, emulsifier, and developer. Waste penetrant is drummed and picked up by a waste handler for incineration in a cement kiln. The Defense Reutilization and Marketing Office (DRMO) currently classifies the penetrant waste as a RCRA D001 waste. The 100-gal batch of emulsifier is changed out about every six months and sent to the sewage treatment plant. Developer batches of approximately 100 gal are changed out on about the same frequency as the emulsifier batches. Like the emulsifier, the developer is sent to the sewage treatment plant. Due to the levels of sodium chromate present, the batches meet the criteria for a RCRA D007 waste.

Painting/Paint Removal/Parts Cleaning

The paint shop handles all aerospace ground equipment (AGE) for Scott AFB. Paint booths are normally used. Approximately 24 one-gal kits of polyurethane paint are used each year. About 90% of the paint used at the paint shop is polyurethane. The wastes generated by painting are overspray solids, booth compound, booth wastewater, waste paint and thinner, and volatile organic compounds (VOCs). About 220 gal of sludge and scum are placed in 55-gal drums and hauled away each year to the appropriate facility. Booths are periodically coated with a protective film called booth compound to prevent adhesion to the metal walls. As the compound deteriorates, a new coating is then applied and the old compound is discarded in a sanitary landfill. The booth water is drained to the sewage treatment plant. Paint thinner is used to clean paint gun nozzles. The mixed thinner and paint, along with unused paint, are placed in 30-gal drums for disposal by Safety-Kleen, Inc. VOCs are released during atomization of the paint by the spray guns.

Parts to be painted are dry-sanded or dipped into a bath containing a multi-layer stripping solvent. This solvent is used until contaminated with paint sludge; it is then drummed and hauled away as a hazardous (F002) waste. Parts requiring a clean, grease-free surface for subsequent processing such as inspection or repainting are brought into the Cleaning Shop. The parts are wiped off and then immersed in a bath of solvent degreaser. The part is then removed, scrubbed with a brush and rinsed. The USAF uses a contractor to recycle the contaminated solvent. The solvent is primarily mineral spirits and is classified as a RCRA D001 waste.

WASTE MINIMIZATION OPPORTUNITIES

Non-Destructive Inspection (NDI)

The primary contaminant (the penetrant) floats on or near the surface because of its low density. This characteristic makes possible an inexpensive method of periodically skimming the top layer of fluid in these tanks. By skimming off the top layer and adding fresh makeup emulsifier or developer, respectively, contaminants floating at or near the surface can be removed, and suspended contaminants can be diluted.

To eliminate the need for the wet chromate solution, new systems use a dry, non-hazardous (silica-based) developer. Changing to the silica-based developer would be technically feasible. The dry developer is technically equivalent and meets the same specifications as the current wet developer.

Painting/Paint Removal/Parts Cleaning

The plastic media blasting equipment should be used to eliminate the use of organic solvents in paint stripping. Conversion from wet operation to dry painting booth operation would result in volume reduction of wastes associated with painting. The Air Force is implementing the use of high volume, low pressure (HVLP) paint guns. The amount of overspray solids and VOCs generated can be substantially reduced.

CONCLUSIONS AND RECOMMENDATIONS

The results of the study indicate that the fastest payback (0.24 year) would be from penetrant skimming option. The capital outlay needed for this option is estimated to be only $330. Switching from a wet developer to a dry developer had a payback period of 27.5 years. This option has moderate capital investment but low cost savings. If Scott AFB later determines that the wet developer should be treated as a D007 waste, the disposal costs for wet developer will increase and Option 3 will have higher cost savings.

Project Summary Title: Waste Minimization Opportunity Assessment: Scott Air Force Base
Project Summary Availability: Immediate
EPA Project Officer: Jim Bridges/Anne Robertson
Key Words: C-9 medical aircraft; non-destructive wheel inspection; paint stripping; parts cleaning; printed circuit board manufacture; dye penetrant; paint booths; polyurethane paint; paint thinner; stripping solvent; paint sludge; Safety-Kleen 105 degreaser; mineral spirits; silica-based developer; plastic media blasting; high volume, low pressure (HVLP) paint guns

FITZSIMMONS ARMY MEDICAL CENTER
OPTICAL FABRICATION LABORATORY

INTRODUCTION

To promote waste minimization activities in accordance with the national policy objectives established under the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act of 1976 (RCRA), the Risk Reduction Engineering Laboratory (RREL) of the USEPA Office of Research and Development is supporting WREAFS. The WREAFS Program focuses on waste minimization research opportunities and technical assessments at Federal sites. The present project focused on a waste minimization opportunity assessment (WMOA) conducted at the Fitzsimmons Army Medical Center (FAMC) Optical Fabrication Laboratory (OFL) in Denver, Colorado.

EXISTING WASTE MANAGEMENT ACTIVITIES

One of the sites chosen for performance of a waste minimization opportunity assessment (WMOA) under the WREAFS Program is the Fitzsimmons Army Medical Center Optical Fabrication Laboratory (FAMC/OFL) in Denver, Colorado. Glass lens fabrication operations at the OFL generate three RCRA hazardous wastes (waste lead-bearing lens blocking alloy (RCRA D008), alkaline washwater from ground and polished lens cleaning and deblocking operations (D002), and spent Stoddard solvent from the tool cleaning operations (D001) and one nonhazardous waste (ground glass fines from lens grinding and polishing operations). The waste lead-bearing blocking alloy particulates are reclaimed and recycled at the OFL (to the extent possible); the alkaline washwater is discharged to the wastewater treatment plant and ultimately used on the FAMC grounds for irrigation; and spent Stoddard solvent is recycled off-site through a contractor operation. The nonhazardous ground glass fines are collected from the present on-site grinding coolant filtration operations and disposed of at a local sanitary landfill.

Results of the WMOA conducted at the OFL identified three waste minimization opportunities involving materials in use at the OFL. These options are summarized below.

WASTE MINIMIZATION OPPORTUNITIES

Waste Alkaline Washwater

Alkaline washwater from the glass lens cleaning/deblocking operation is currently discharged from the OFL after passing through a trap to collect large particulates of the lead-bearing lens blocking alloy. This wastewater is discharged periodically from the glass lens washing machines at the rate of approximately 200 gal/mo, at a pH of about 13 to 14, and is drained to the FAMC on-site central water treatment facility. Although this waste is not discharged off-site, it is ultimately discharging lead (both as dissolved lead and submicron particulates) to the groundwater under the site. It is proposed that this possibility be avoided in one of two ways:

(1) Use of a source reduction technique--the substitution of a non-lead-bearing blocking alloy.

(2) Use of a recycling technique--introducing a cartridge filter in the line leaving the trap from the lens washing/deblocking operation in order to catch the submicron-size alloy particulates. This technique could recover up to 500 lb/yr of particulate material that would ultimately be recycled to the lens blocking operation.

Glass Fines from the Glass Lens Grinding Operation

The OFL presently generates about 37.5 ton/yr of a mixture of waste glass fines and water from the lens grinding operation. This material is not a hazardous waste under the RCRA definition. The OFL currently sends this waste to a local landfill, thereby incurring both the transportation and landfilling costs. These fines, when dry, could generate particulate emissions, thus creating possible inhalation problems, during transportation if they are transported in uncovered or improperly covered containers or at a landfill if they are improperly covered or managed. A potential use for this material is as feedstock in glass or ceramic tile production by a local facility. It is assumed that this facility would use the OFL waste material, and, consequently, the land disposal cost could be eliminated.

CONCLUSIONS AND RECOMMENDATIONS

Of the three waste-related opportunities developed at the OFL by the WMOA, two represent waste reduction for RCRA hazardous wastes, while the remaining option represents an opportunity to reduce or eliminate nonhazardous waste. None of these options represent substantial capital outlays or appreciable operating cost savings. In fact, one waste minimization option--substituting a nonhazardous lens blocking alloy for the present hazardous material--represents a substantial operating cost increase. The only positive value of the option is the potential elimination of an environmental pollution problem if it can be shown at FAMC that a source of lead pollution in groundwater needs to be eliminated.

Project Summary Title: Waste Minimization Opportunity Assessment: Optical Fabrication Laboratory, Fitzsimmons Army Medical Center, Denver, Colorado

Project Summary Availability: Immediate (EPA/600/2-91/031)

EPA Project Officer: Kenneth R. Stone

Key Words: optical fabrication; glass lens; lead-bearing lens blocking alloy; alkaline washwater; lens cleaning; deblocking; spent Stoddard solvent; ground glass fines; source reduction; recycling

FORT RILEY, KANSAS

INTRODUCTION

To promote waste minimization activities in accordance with the national policy objectives established under the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act of 1976 (RCRA), the WREAFS Program focuses on waste minimization research opportunities and technical assessments at federal sites. The present project focused on a waste reduction assessment at the U.S. Army Forces Command (FORSCOM) maintenance facilities at Fort Riley, Kansas.

Results of the Fort Riley, Kansas waste minimization assessment identified two waste reduction opportunities in a multi-purpose building (Building 8100) used for automotive subassembly rebuilding, lead acid battery repair as well as a number of other Army maintenance operations. The two waste reduction opportunities are summarized below.

EXISTING WASTE MANAGEMENT ACTIVITIES

Waste Battery Acid

Battery acid (32-37 percent sulfuric acid) containing trace concentrations of lead and cadmium is currently drained from both dead batteries and batteries requiring repairs, e.g., replacement of battery terminals, and shipped in 15-gallon drums to the Defense Reutilization and Marketing Office (DRMO) storage facility at the installation for ultimate disposal as a hazardous waste. Instead, it is proposed that the waste acid be gathered in a holding tank, particulates removed, and the waste acid adjusted in concentration to 37 percent sulfuric acid (using 60 Baume commercial sulfuric acid) as needed for reuse in reconditioned or new batteries. The buildup of dissolved metal impurities in this recycling system is prevented by purging part of the acid from the system. It is assumed in this assessment that 25 percent of the acid is purged and 75 percent is reused. The acid being purged is neutralized and treated for trace heavy metal removal to allow on-site disposal as nonhazardous waste.

Automotive Parts Washer Wastewater

Dirty aqueous alkaline detergent solution from automotive parts cleaning, which contains trace concentrations of lead, chromium and cadmium at a pH >12 as well as the oil, grease and dirt removed from the automotive parts, is currently drained to an on-site nonhazardous waste evaporation pond. This waste, heretofore regarded as nonhazardous, is currently being reclassified as a RCRA hazardous waste due to its characteristics (D007, D008) and will have to be disposed of as a hazardous waste through DRMO. The proposed waste minimization option for this waste stream would involve the use of equipment external to the automotive parts washer. The proposed process would include emulsion breaking to cause emulsified oils to float, removal of demulsified oils and other tramp oils and grease by skimming, filtration to remove particulates in an in-line cartridge filter, and addition of fresh alkaline detergent as necessary, followed by recirculation of the cleaned washwater to the automotive parts cleaner. Buildup of impurities in the recycled washwater is prevented by purging 25 percent of the used alkaline detergent and recycling 75 percent. The material being purged is neutralized with an appropriate amount of waste battery acid and precipitated trace heavy metal impurities are removed to allow disposal of the purge stream as a nonhazardous waste

Some in-plant experimentation will be needed to determine what type of filter elements are best suited to this operation, whether multiple cartridge filters are needed, for how many cycles the recovered wastewater is effective in cleaning automotive parts, etc. The uncertainty in the proposed procedure is reflected in a 25% contingency in the capital cost estimate.

WASTE MINIMIZATION OPPORTUNITIES

The battery repair shop generates 7,200 gal/yr of RCRA hazardous waste (classifications-D002, D006, D008) at a disposal cost of $27,900/yr. Current raw material cost is $11,530. Recycling of the reformulated battery acid would require a capital investment of $15,200 but would save $36,000/yr in operating costs. This would yield a payback of 0.42 years.

Automotive parts washing generates 29,000 gal/yr of RCRA hazardous waste (classifications-D007, D008). This waste is currently drained to an on-site evaporation pond. If it were disposed of as a RCRA hazardous waste via DRMO at the same cost per gallon as the waste battery acid, the disposal cost would be $112,000/yr. Current raw material cost is less than $100/yr. Recycling of purified alkaline detergent solution would require a capital investment of $19,800. This option would save $107,100/yr in operating costs, leading to a payback period of 0.18 years.

CONCLUSIONS AND RECOMMENDATIONS

In light of the short payback periods of the two waste reduction options identified, implementation of these options should be considered. Successful application of these options at Fort Riley creates the potential for application of similar waste minimization options in at least ten other U.S. Army FORSCOM installations.

Project Summary Title: Waste Minimization Opportunity Assessment: Fort Riley, Kansas
Project Summary Availability: Immediate (EPA/600/S2-90/031)
EPA Project Officer: James S. Bridges
Key Words: maintenance facilities; automotive subassembly rebuilding; lead acid battery repair; sulfuric acid; recycling; automotive parts cleaning; recycled washwater

HOSPITAL POLLUTION PREVENTION CASE STUDY

INTRODUCTION

In this study, EPA's Risk Reduction Engineering Laboratory (RREL) and the Department of Veterans Affairs (DVA-Cin) chose to look for pollution prevention alternatives for minimizing the discarded medical supply wastestream. VA-Cin is uniquely suited to such a study is directly attributable to its cost sensitivity. The need to deliver services under a fixed budget has led DVA-Cin to both adopt environmentally clean practices on its own, and to continue clean practices that cost-reimbursement hospitals had abandoned.

According to DVA-Cin personnel, approximately 80 percent of the hospital's supplies are disposed of after a single use. The DVA-Cin saw an additional increase in the use of disposables in the last 2-3 years due to concern by hospitals over both patient safety and staff occupational exposure to the AIDS virus. Therefore, the increase results from greater usage of existing disposable supplies (i.e.,single-use sponges for patient surgery, and disposable gloves and masks worn to protect hospital staff) rather than from the use of newly developed disposable items.

EXISTING WASTE MANAGEMENT ACTIVITIES

On average, hospitals generate between 0.5 and 4 pounds of infectious waste per patient each day. The DVA-Cin facility produces approximately 0.6 pounds of infectious waste per patient each day, placing it at the low end of the spectrum. However, there are inconsistencies in how hospitals from different States define what is infectious waste. For example, DVA-Cin classifies its laboratory waste as general trash after autoclaving. Inflating the DVA-Cin's quantity of infectious waste to reflect lab wastes would raise the generation rate to 0.87 pounds per patient each day - still quite low in comparison to other hospitals. DVA employs waste segregation to minimize infectious waste volume and also uses cloth gowns instead of disposable gowns.

For this study, a site assessment team was assembled with representatives from DVA-Cin, EPA, and an EPA contractor to track the flow of disposables throughout the hospital and review procedures, uses and consumption with department heads. Over a two-day period, the assessment team visited these DVA-Cin departments: Laboratory Services; Surgery; Surgical Intensive Care Unit (SICU); 5 South (a patient floor);

Medical Intensive Care Unit (MICU); Hemodialysis; and the Outpatient Clinic.

A major concern for RREL in conducting this assessment was to look for those areas in which research and development may support advancing new alternatives. In learning of the concerns, difficulties and successes of the health care profession, RREL hopes to expand EPA's experience in the medical waste area and provide a solid basis for planning future research. Suggestions for further research in the health care industry are presented below:

RESEARCH AND DEVELOPMENT OPPORTUNITIES

Evaluate Reuse Potential in Single-Use Devices - Using the rigorous investigation of Hemodialyzers as an example, a cooperative effort could be established between EPA and representatives of the health care community to undertake the research of other potential reusable single-use devices and provide substantive data to either support or reject reuse considerations for these items.

Quality Assurance - Research conducted by the EPA in cooperation with health care professionals, other Federal agencies (such as the Food and Drug Administration), and trade associations can form the basis for developing a protocol for reuse, giving hospitals a standard under which to set down operating procedures and institutional policies.

Hidden Cost Factors - Confusion exists in comparing the relative costs of disposables versus reusables. The EPA may wish to conduct analytical studies in conjunction with health care facilities in order to fully develop and quantify the cost of using disposable and reusable products, respectively, as an aid in decision making.

Development of Reprocessing Capacity - As health care cost containment gains increasing importance, reprocessing may become cost effective for some items. The potential for promoting some reprocessing capability should be explored, particularly in those areas exhibiting a high density of medical facilities.

Developing a Reusable Market - The EPA and DVA should consider working together in developing procurement guidelines for the DVA which will stimulate the production and distribution of reusable and recyclable products.

OBSERVATIONS

DVA-Cin was very pleased with the study and considers the final report a very usable document for other VA medical facilities. For its part, the EPA hopes to learn from future cooperation with DVA, seeking the health care professionals advice and guidance in planning and implementing research programs to respond to the needs of the medical community in the areas of hazardous waste, infectious waste, and other waste streams. Opportunities to reduce these wastes do exist, and additional opportunities will be uncovered through research. Research will also provide the data on which to make operational decisions of benefit to health care facilities, while favoring environmental considerations.

Project Summary Title: Hospital Pollution Prevention Case Study
Project Summary Availability: Immediate (EPA/600/S2-91/024)
EPA Project Officer: Kenneth R. Stone
Key Words: medical supply; disposables; infectious waste; cloth gowns; medical waste; health care; hemodialyzers; reusable single-use devices; reprocessing; market; quality assurance

AIR FORCE PLANT NUMBER 6

INTRODUCTION

The evaluation of emulsion cleaners at Air Force Plant 6 project is part of the Waste Reduction Evaluation at Federal Sites (WREAFS) Program conducted within the Pollution Prevention Research Branch. The WREAFS program consists of a series of demonstration and evaluation projects for waste reduction conducted cooperatively by the U.S. Environmental Protection Agency (EPA) and various divisions of other federal agencies. The purpose of this project is to provide assistance to Air Force Plant 6 personnel by documenting the relevant work by other aircraft fabrication facilities to support comparison of cleaner qualification performance with trichloroethylene for the vapor degreaser operations at Air Force Plant 6.

PLANT BACKGROUND

Air Force Plant No. 6, located in Marietta, Georgia, is operated for the Air Force by Lockheed Aeronautical Systems Company. The facility is part of the Aeronautical Systems Division (ASD), whose headquarters is located at Wright-Patterson Air Force Base near Dayton, Ohio. There are six vapor degreaser units that utilize trichloroethylene (TCE) to prepare steel and aluminum parts for a variety of subsequent manufacturing steps in the production of C-130 aircraft. The eventual goal of the facility is to substitute water-soluble emulsion cleaners to obviate use of 650,000 pounds of TCE.

The final report has been compiled for this project. The report contains information on the evaluation of various substitute cleaners on the conformance of the emulsion cleaners to be implemented at Air Force Plant No. 6 with specific qualification test criteria. The document contains the specifications for qualification tests in 17 areas. It also contains a list of ten cleaners that were targeted for evaluation. The information for this report was developed by documenting research performed by Boeing Aircraft, Air Force Engineering Service Center (AFESC), General Dynamics, Lockheed Missile and Space Company (LMSC), Martin Marietta and Northrop. The report contains a table summarizing the status of cleaner substitute evaluations conducted by the represented companies. The document concludes with a chart that compares the performance criteria of the various companies to the criteria required by Lockheed. Also, data and information for the report was accumulated from emulsion cleaner manufacturers/suppliers and an international workshop on solvent substitution.

EPILOGUE

EPA is working in cooperation with Lockheed Aeronautical Systems Company-Georgia and Air Force Aeronautical Systems Division to investigate the potential for implementing emulsion cleaners as a replacement for trichloroethylene (TCE). The substitution of emulsion cleaners for TCE is currently being implemented at Air Force Plant No. 6 and EPA will be cooperating with Lockheed and Air Force personnel to document the successes, problems and costs associated with the change. The results can then be transferred to similar facilities in the Department of Defense or the Department of Energy, and can serve to expedite the use of emulsion cleaners at other facilities.

Report Title: Evaluations of Cleaners for Solvent Substitution at Air Force Plant 6
Report Availability: Immediate
EPA Project Officer: Johnny Springer
Key Words: emulsion cleaners; aircraft fabrication; cleaner qualification performance; trichloroethylene; vapor degreaser; steel; aluminum parts; substitution

WASTE MINIMIZATION ASSESSMENTS PROGRAM

(ARROW)

This project is designed to evaluate the use of waste minimization assessments in thirty hazardous waste generating facilities (across ten industries) in New Jersey. The assessments are being initiated by the New Jersey Institute of Technology (NJIT) personnel and will follow the EPA recommended procedure outlined in the Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003). The New Jersey Department of Environmental Protection (NJDEP) refers to the project as "Assessment of Recycling and Recovery Opportunities for Hazardous Waste (ARROW)".

Initial industries being studied include:

- Electrical Power Generation
- Graphics Control Manufacturing
- Paints and Coatings Manufacturing
- Printing
- Lubricant Production
- Transportation Vehicle Maintenance
- Leather Finishing
- Educational Facilities

NUCLEAR POWERED ELECTRICAL GENERATING STATION

INTRODUCTION

The Hazardous Substance Management Research Center at New Jersey Institute of Technology in association with the New Jersey Department of Environmental Protection and the EPA's Risk Reduction Engineering Laboratory has undertaken a demonstration program to evaluate the effectiveness of the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988).

The assessment process was coordinated by a team of technical staff from New Jersey Institute of Technology with experience in process operations, basic chemical experience, and knowledge of environmental concerns and needs. Because the Manual is designed primarily to be applied by the staff of the facility, the degree of involvement of the NJIT team varied according to the ease with which the staff could apply the Manual.

PLANT BACKGROUND

The facility is an electrical power generating plant. The energy is produced by a nuclear generator. The product of the facility is energy. Hazardous wastes are generated predominantly during the times when power generation is not in operation. (Radioactive wastes are not included in this study.) Moreover, it is apparent from the results of the assessment that the bulk of the hazardous waste from the facility is produced from construction and maintenance activities largely when the energy generation activity is shutdown.

EXISTING WASTE MANAGEMENT ACTIVITIES

The facility has implemented several effective steps to reduce waste generation at the facility. One successful idea involved making surplus materials available to employees for their personal use. Also, the facility increased its investigation into opportunities for selling surplus materials to commercial users. Ordering and warehouse procedures were improved to reduce overstocking and surplus materials. Innovative material handling procedures such as purchasing materials in large containers and dispensing them in"just the right amount" containers were developed.

WASTE MINIMIZATION OPPORTUNITIES

This facility produces electrical energy by a process which depends upon heating water by a nuclear source. The operation of the facility results in the formation of radioactive waste which is managed according to the appropriate federal regulations. The high costs of waste management for this type of waste has encouraged significant waste reduction efforts in this area throughout the industry. The focus of this assessment--non-radioactive waste--has similarly benefited from waste reduction efforts, although the assessment has identified additional options which could be implemented. Three departmental operations have been found to be associated with the generation of waste: Maintenance, Site Services, and Operations. In addition, a significant source of waste for disposal is off-specification and partially used materials which are not easily associated with any specific operation or job process. Major waste streams identified were:

* Oil and Oil/Water Mixtures
* Coatings (Paints, Epoxy, Enamels)
* Solvents
* Grease
* Laboratory Reagents

Much of the waste oil stream results from a remediation project at the site and not directly from the operation of the facility. The other materials result frequently from regular equipment and facility repair and upgrade activities. Significant quantities of off-specification and partially used containers of materials are presented for waste management or disposal. Options identified for waste reduction included strengthened inventory controls, encourage "just-in-time" delivery of supplies, direct charge back of waste treatment expenses to the unit or project responsible for the waste, encourage the use of materials with reduced hazard level, and change frequency or material used for coating of surfaces.

ADDITIONAL OPTIONS IDENTIFIED

In addition to the options previously discussed other options were suggested. It was observed that occasionally containers of hazardous waste are found on the site away from the active secured sections which cannot be identified according to source. It is presumed that these materials are discarded by contractors or other non-employees. It is suggested therefore, that vehicles entering the facility be examined to assure that they do not leave such containers at the site.

A clear correlation was observed between the amount of full containers and usable materials presented for waste disposal and the scheduled inspections of the facility. It is postulated that such materials are discarded in order to demonstrate a neater appearance to the inspection team. Alternate storage arrangements for such situations should be developed.

Research Brief Title: Waste Reduction Activities and Options at a Nuclear Power Generating Facility
Research Brief Availability: December 1991
EPA Project Officer: Mary Ann Curran
Key Words: electrical power generating plant; nuclear; construction; maintenance activities; surplus materials; ordering ;warehouse procedures; material handling procedures; inventory controls

MANUFACTURER OF FINISHED LEATHER

INTRODUCTION

The Hazardous Substance Management Research Center at New Jersey Institute of Technology in association with the New Jersey Department of Environmental Protection and the EPA's Risk Reduction Engineering Laboratory has undertaken a demonstration program to evaluate the effectiveness of the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988).

In keeping with the objectives of field evaluation of the Waste Minimization Opportunity Assessment Manual, the participants were encouraged to proceed through the organizational steps outlined in the manual. The assessment process was coordinated by a team of technical staff from New Jersey Institute of Technology with experience in process operations, basic chemical experience, and knowledge of environmental concerns and needs. Because the Manual is designed primarily to be applied by the staff of the facility, the degree of involvement of the NJIT team varied according to the ease with which the staff could apply the Manual. In some cases, the NJIT role was only to provide advice, in other cases the team conducted essentially the entire evaluation.

PLANT BACKGROUND

The plant produces finished leathers which are sold to manufacturers of leather goods such as handbags, belts, shoes, and other items. The operation of the plant varies according to customer demand. Many different colors, textures, and designs must be incorporated into the product to meet varying customer requirement, forcing the operation of several special production steps on an irregular basis. The facility formerly tanned raw hides, but that process has been phased out as a result of changing supply and market conditions.

EXISTING WASTE MANAGEMENT ACTIVITIES

This facility receives tanned leather from various sources and transforms it into a product of higher commercial value by applying "various coatings and other surface modifications to make it more usable and appropriate for finished consumer products. The raw materials include, in addition to the leather itself, various water- and solvent-based coatings as well as some specialized colorants and other surface modification products. The solvents typically are aromatic and aliphatic hydrocarbons, esters, and alcohols.

A typical hide in the manufacturing process might receive one of several finishing steps. Newly received hides are prepared for finishing by washing, retanning if necessary, and drying. The aqueous wastes from these steps are sent to the POTW with regular monitoring to assure compliance. Some hides undergo surface modification by mechanical buffing. The resulting dust (<100 lbs/yr) is classified as a hazardous waste and is disposed of off-site. The back coating step applies essentially the final finish to the back of the leather while the base coating of the smooth side serves as the primer for additional finishes to be applied. The coatings are applied using an automated spray system. The facility has shifted largely to water-based coatings for these steps resulting in a significant decrease in solvent use. Any over-spray is captured by a water-screen or by filters and disposed of off-site. The next coating steps are accomplished using solvent-based materials. No satisfactory non-solvent based coatings have yet been identified for these finishing steps. The applied finishes are thermally dried with venting of solvent vapors to the atmosphere. Approximately 130 tons/yr of evaporated coating solvent are produced through oven drying and as a result of spills and leaks. The final steps in the manufacturing process are ironing, grading, measuring, and shipping - operations which are not significant waste-generating activities.

The facility has shifted to the use of water-based coatings, where possible, moreover, the technical staff continues to evaluate new commercial reduced-solvent products in order to make further reductions. An optical/computer interfaced system has been used to determine the shape and position of each hide presented for coating which is used to control the automated spray coating system, resulting in significant reduction of overspray.

WASTE MINIMIZATION OPPORTUNITIES

Several waste minimization options were enumerated. A 100% reduction in the disposal of buffing dust could be achieved by selling the material as a filler in a resin-based composite product. Solvent losses could be reduced by implementing several options. As satisfactory water-based materials appear on the market, solvent-based coatings can be replaced by water-based coatings. The automated spray coating equipment could be reprogrammed to compensate for required angle spraying. This could reduce waste by 65% when angle spraying is performed. A solvent capture system could be installed to allow for the capture and reuse of solvent. Depending on the type of solvent used, a 90% waste reduction could be achieved. Other improved operating procedures and minor equipment modifications were discussed.

In addition to the options previously discussed another option was suggested. It was observed that the wooden pallets and cardboard used for shipping hides to the facility might have increased value if recycled.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Finished Leather

Research Brief Availability: March 1992

EPA Project Officer: Mary Ann Curran

Key Words: finished leather; coatings; aliphatic hydrocarbons; esters; alcohols; aqueous wastes; automated spray system; water-based coatings; optical/computer interfaced system; solvent capture system

LOCAL SCHOOL DISTRICT (K TO 12)

INTRODUCTION

The Hazardous Substance Management Research Center at New Jersey Institute of Technology in association with the New Jersey Department of Environmental Protection and the EPA's Risk Reduction Engineering Laboratory has undertaken a demonstration program to evaluate the effectiveness of the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988).

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FACILITY BACKGROUND

The facility is a school district with a range of activities with potential for generation of waste which include vehicle maintenance and repair, building cleaning and maintenance, grounds keeping, instructional programs, and specialized programs such as science laboratories and art classes. The operations in the district are not centrally located. There is a common administration building. In addition, there is a high school for about 1,000 students, a middle school for about 500 students, and six elementary schools.

The assessment focussed on the administration building and the high school. Located at the administration building is a central warehouse for building and maintenance supplies including cleaners, floor care products, paints, and similar materials. Also at the administration building is the vehicle maintenance and repair facility. There is also a wood shop which has responsibility for building and repairing furniture and related items for use within the district. At the high school, paper-, computer-, and video-based instructional activities occur. In addition, hands-on instruction in areas with potential for waste generation also occurs in science laboratories, art classes, and vocational educational areas.

EXISTING WASTE MANAGEMENT ACTIVITIES

The waste minimization opportunities assessment carried out at a local school district identified empty paint cans, broken or spilled containers of hazardous materials, solvent wastes from motor parts degreasing, used oil, motor engine antifreeze solution, white paper, cardboard, aluminum cans, glass containers, waste chemicals from teaching laboratories, and vapors from art projects as primary sources of waste.

The district has already instituted several practices which have a positive impact on pollution prevention. As a result of the"Community and Worker Right-to- Know" initiatives, the following procedures were emphasized: ordering only the quantity of materials that can be used in a single year; stocking the materials near the point of use; conversion to the use of dry copiers replacing the former solvent-based systems. In addition, there has been a concerted effort to change to water-based paints and cleaners from solvent-based products where possible and to identify and use other products with reduced potential toxicity factors in all areas. Moreover, in keeping with municipal initiatives encouraging recycling - cardboard, white paper, aluminum cans, glass containers, and used motor oil are collected and recycled. In the industrial arts metal shop at the high school, cutting oil is recovered by allowing the metal fragments to settle and then filtering the decanted oil. No new oil for this purpose has been purchased since 1966. Wastes such as laboratory wastes are treated as hazardous wastes and collected by a contractor for off-site treatment.

WASTE MINIMIZATION OPPORTUNITIES

Several waste minimization options were described. The elimination of hundreds of empty paint cans could be realized by the purchase of paint in returnable containers. A 100% reduction in degreasing solvent wastes could be achieved by enlisting the services of a solvent supply and recycling contractor or acquiring a distillation apparatus. Utilization of antifreeze recycling technology would eliminate 300 gal of waste antifreeze solution annually. Laboratory wastes could be minimized by using smaller amounts of hazardous chemicals and improved inventory control. Hazardous art project wastes could be minimized by increased substitution of non-hazardous materials for various projects.

ADDITIONAL OPTIONS IDENTIFIED

Other options were identified which could be considered by the district but may be more pertinent when commercial technology improves. The district uses chlorofluorocarbons in refrigeration equipment and to a limited extent in motor vehicle air conditioning. There is already a commitment to change to substitutes with reduced impact upon the upper atmosphere. In addition, as mobile air conditioning becomes more common in district vehicles, a refrigerant recovery and reuse capability should be considered. In some areas such equipment may become a legal requirement. Consideration could be given to joint acquisition with the municipal government of recycling equipment such as antifreeze recycling or degreasing solvent distillation equipment. Ideally, the equipment should be easily movable to allow it to be taken to the facility where the need exits.

Research Brief Title: Waste Reduction Activities and Options at a Local Board of Education in New Jersey

Research Brief Availability: December 1991

EPA Project Officer: Mary Ann Curran

Key Words: municipal recycling; substitution; refrigerant recovery; solvent distillation; antifreeze recycling; cutting oil; paint waste; high school; administration building

A STATE DEPARTMENT OF TRANSPORTATION MAINTENANCE FACILITY

THE TRANSPORTATION MAINTENANCE FACILITY

The major activity at the facility is the maintenance of vehicles used by the Department, including automobiles and trucks, and to a more limited extent, large machinery used by the Department such as mowers. Other activities which are carried out at the facility include wood shop, metal shop, and collection and reuse or disposal of no longer useful materials. A waste reduction opportunity assessment was carried out in order to identify specific operations which generate waste at the facility and to propose a list of options for operational changes which have potential to reduce the waste which is generated and requires treatment or disposal. Because of the diversity of the activities at the facility, each individual operating area was examined for the purpose of identifying waste reduction opportunities.

WASTE REDUCTION OPPORTUNITIES

Oil: From the twelve maintenance facilities in the DOT system, approximately 14,000 gal of used oil are produced each year. This facility generated 2700 gal of used oil during fiscal year 1989. The facility practices recycling as the preferred management technique for waste oil. The oil handling procedure at present is to collect used oil in small drums near work stations and to periodically transfer the contents to a larger storage tank. Once the storage tank is full, a contracted recycler removes the material from the site where it is prepared for other beneficial uses.

There are three concerns that generate waste in the oil recycling operation. One is the sporadic appearance of oil/water mixtures in the storage tank. The second concern is the relationship between the generator and the contractor who collects the waste oil. The third area of concern is oil spills. The problems of occasional oil/water contamination and oil spills can be addressed by implementing improved housekeeping and materials handling procedures. The problem of timely removal of the waste oil by the contractor is being addressed by reexamining the purchasing process in terms of bidding and contracting to make the process more responsive to the time needs of the capacity of the oil storage tank. A future option may be to investigate methods for reducing oil usage.

Antifreeze: Approximately 2000 gal/yr of commercial antifreeze is used at this maintenance facility. The volume of the waste stream is larger because the coolant in the engine is a water solution, often about a 1:1 mixture. Current practice is to drain the cooling system of the vehicles periodically and replace the antifreeze solution with fresh liquid, discarding the old.

One waste minimization option for antifreeze use is to acquire the use of a commercial system which will prepare the antifreeze solution for reuse by filtration, pH adjustment, and additive addition, if necessary. The recycling of antifreeze would cause a decrease in new antifreeze purchases and in disposal costs.

Freon/CFCs: Freon and other chlorofluorocarbons are present at the facility because of their use in vehicle air conditioning systems. Based upon purchase data, the use of CFCs at the facility is about 140 lbs/yr. There are two substantial pathways for the loss of the material to the atmosphere. The first is loss through leaks which develop in the air conditioning systems in the vehicles. The second pathway results from the industry-wide repair procedure of recharging the system with fresh CFC, locating the leak, discharging the CFC to the atmosphere, etc.

Two waste minimization options would address the CFC problem. Development of a regularly scheduled preventative maintenance inspection of all vehicle air conditioning systems would create loss prevention through leak prevention by avoiding major leaks. Second, during the repair stage, use of a commercial CFC capture and reuse device would be advantageous. Such devices are capable of connection to the vehicle system for recovery of the CFC and have the ability to purify the material to quality standards which qualify it for reuse.

Paint: The largest quantity of wastes come from the painting operations themselves. Constructive steps have been taken towards pollution prevention by shifting from solvent-based paints to water-based paints when possible. Painting operations are also investigating alternative paint application systems.

Tires: There is an active program for recycling used tires. A contractor periodically picks up the collected tires (from throughout the DOT system) at this facility and takes them off-site for recycling. A possible waste reduction option may be to increase the useful life of the tire in service. This could be done by investigating a new modified tire rotation procedure. This could also be done by educating employees on driving and parking techniques which reduce tire wear.

The DOT maintenance facility has taken steps to minimize its drum/container wastes and serves as a collection point for other forms of scrap material. It is clear that this facility has a commitment to the concept of pollution prevention and is putting it to work in their operations.

Research Brief Title: Waste Reduction Activities and Options at a State Department of Transportation Maintenance Facility
Research Brief Availability: December 1991
EPA Project Officer: Mary Ann Curran
Key Words: oil recycling; housekeeping; materials handling procedures; purchasing process; antifreeze recycling; freon; chlorofluorocarbons; CFC recycling; alternative paint application systems; water-based paints; used tire recycling; tire rotation; transportation maintenance facility

A PRINTER OF FORMS AND SUPPLIES FOR THE LEGAL PROFESSION

THE LEGAL SUPPLY COMPANY

The printing company produces, on a quick turnaround basis, legal forms, business cards, and office supplies for the legal profession. The manufacturing operations of the facility involve two major procedures. Impressions are made using either an engraving process or a printing process. These activities and related procedures, including photo processes and etching, present potential opportunities for waste reduction.

An objective of the company for beginning a waste minimization opportunities assessment is to identify additional areas within the operation which may be candidates for waste reduction initiatives, as well as to identify various technical options which may address these opportunities. One objective of this study was to make the most efficient use of limited technical time resources by developing a concise listing of opportunity areas and technology options.

WASTE REDUCTION OPPORTUNITIES

Within the manufacturing process there are two major options--engraving or printing-- which are used for different purposes and products. The first step, a photographic operation, is common to both.

After the creative design, artistic and layout work are completed by the design group, a photographic negative is produced using a normal photographic process with typical development techniques. Subsequently, a phototransfer step is used to reproduce the image on a metal plate. Copper plates are used in the engraving process and aluminum plates in the printing process.

Currently, the developer and related solutions are managed as hazardous waste. Because of the silver content of the photographic process, it is possible that the liquid waste streams, particularly the spent developer solution, contain enough silver to support a silver recovery operation.

The Engraving Process

The primary step within the engraving process where waste reduction opportunities occur is in the etching operation. Fundamentally, the etching step accomplishes the chemical removal of unprotected copper from the copper plate creating depth differences on the plate which can be used to transfer the image to the paper. The chemical system uses a solution consisting of 55% ferric chloride and 45% hydrochloric acid. The spent acidic iron and copper chloride solution is currently disposed of at an annual cost exceeding $10,000.

Three waste reduction options can be proposed for this operation. The first option is to identify and use an off-site vendor which would regenerate the bath solution by copper removal, and return the renewed solution to the company for reuse. The second option would encourage the acquisition of electrolytic equipment to carry out the bath regeneration on site. The third option is to shift to a new chemical system using a cupric chloride solution as the etchant rather than the ferric chloride solution now used.

The final step in engraving plate preparation is plate cleaning. Removal of the polymeric photoresist protective coating is accomplished by immersing the plate in a bath of N-methylpyrolidone. Currently, the spent solvent from this cleaning process is handled as a hazardous waste. Two options provide opportunities for waste reduction. One is recovery and reuse of the organic solvent via distillation. The other option is to switch from a chemical cleaning process to a mechanical cleaning technique such as polishing, brushing or sandblasting.

The final operation in the engraving process is the impression itself. Ink sludge is generated by the cleaning of equipment at the rate of approximately 110 gal/yr. Two waste reduction options exist for this waste: dewatering via filtration, centrifugation or drying; or use of the ink solids as raw material in the manufacturing of the ink.

The Printing Process

Two fundamental differences between the engraving process and the printing process are the type of plate used and the composition of the ink used. The two areas within the printing process which present the most promising pollution prevention opportunities are in the impression step and in the equipment cleaning step. The impression step would involve a change from solvent based inks to a water based ink system. The equipment cleaning waste reduction option would involve a switch to water based cleaner.

Research Brief Title: Waste Reduction Options at a Printer of Forms and Supplies for the Legal Profession

Research Brief Availability: December 1991

EPA Project Officer: Mary Ann Curran

Key Words: forms; legal profession; engraving; printing; photo processes; etching; developer; silver; copper; electrolytic equipment; bath regeneration; cupric chloride solution; recovery; distillation; organic solvent; mechanical cleaning; dewatering; filtration; centrifugation; drying; solvent based inks; water based ink; water based cleaner

UNIVERSITY-BASED ASSESSMENTS PROGRAM

Philadelphia, Pennsylvania

The University-Based Assessments Program is a pilot project between EPA and the University City Science Center (UCSC) to assist small and medium-size manufacturers who want to minimize their formation of hazardous waste but who lack the in-house expertise to do so. Under agreement with the Risk Reduction Engineering Laboratory of the U.S. Environmental Protection Agency, UCSC's Industrial Technology and Energy Management (ITEM) division has established three waste minimization assessment centers (WMACs) at Colorado State University in Fort Collins, the University of Louisville (Kentucky), and the University of Tennessee in Knoxville. Each WMAC is staffed by engineering faculty and students who have considerable direct experience with process operations in manufacturing plants and who also have knowledge and skills needed to minimize hazardous waste generation.

The WMACs conduct waste minimization assessments for small and medium-size manufacturers at no out-of-pocket cost to the client. Each client must meet the following criteria:

* Standard Industrial Classification Code 20-39
* Gross annual sales of not more than $50 million
* No more than 500 employees
* Lack of in-house 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 education 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 locate the sources of hazardous waste in each 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 which details the WMACs findings and recommendations including cost savings, implementation costs, and payback times is prepared for each client. UCSC conducts follow-up interviews with the client to determine actual costs and benefits of the recommendations. Research Briefs are prepared and distributed by EPA to transfer the technical information to others. These Research Briefs are available from EPA's Center for Environmental Research Information. The full reports on this research are available from the University City Science Center, Philadelphia, PA 19104. At the completion of this pilot effort with UCSC, one hundred facilities will have waste minimization opportunity assessments with documented results of findings and recommendations.

MANUFACTURER OF PRINTED CIRCUIT BOARDS

INTRODUCTION

A plant that annually manufactures 4.3 million ft^2 of printed circuit boards was evaluated as part of EPA's University-Based Assessments Program. Both the screens used to transfer ink patterns to the circuit boards, and the circuit boards are manufactured at this facility.

WASTE GENERATION & MANAGEMENT ACTIVITIES

Producing Silk Screens

The necessary raw materials include photographic film sheets, Kodak developer, glue, methyl ethyl ketone (MEK), polyester mesh fabric, KIWOCOL3 screen emulsion, and tape. After a laser printer produces the pattern on film sheets, the film is developed with Kodak solution and rinsed. The mesh fabric is stretched and glued onto metal frames, and an emulsion is spread onto this screen. The film is taped to the screen and exposed to ultraviolet (UV) light to transfer the pattern to the emulsion coating. A water rinse removes exposed emulsion and leaves the inverse of the circuit pattern on the screen. The frames are heat cured.

Producing Circuit Boards

The necessary raw materials include pre-sized zinc/copper-coated fiber glass panels and screen printing inks. Initial reference holes (6 to 10) are punched on the panels that are then scrubbed in a mechanical wet scrubbing operation to remove protective zinc layer from the copper coating. Rinse water is filtered before being pumped to the plant's wastewater treatment system. Wastewater (23 mil gal/yr) from all the various processes undergoes treatment ($56,750); sludge (38,000 lb/yr) is landfilled ($14,160). Paper filters (2,700 lb/yr) containing copper, zinc, and brush particles are landfilled ($1,730).

After the panels are printed with etch-resist ink and inspected, they are etched. This etching process removes unnecessary copper coating and leaves the circuit pattern on the panel. Necessary raw materials include hydrochloric acid, chlorine gas, caustic soda, and Sur-Clean micro-etch solution. Panels are first conveyed through etch tanks of hydrochloric acid, dissolved gaseous chlorine, and recirculated rinse water. A four-stage cascade rinse and a stripping etch resist bath follow. Finally panels are micro-etched in a solution of Sur-Clean 92 to remove oxides, rinsed in a two-stage counter current rinse, and dried. When the solution is saturated with copper (192,000 gal/yr) , it is bled to a storage tank and recycled ($110,530). Etch tank fumes are diverted to a continuously operating fume scrubber. Water from this bath containing caustic soda beads is filtered to remove etch resist ink particles. Sludge (120 gal/yr) and paper filters (17,860 ft^2/yr) are landfilled ($1,730 and $1,900, respectively). Fumes go to the scrubber. Spent Sur-Clean solution goes to the plant's water treatment system, and fumes go to the fume scrubber.

Panels are then screen printed with a solder mask ink, which is UV cured at 300^{0}F; screen printed in white to identify board type; and screen printed in black on the underside to identify circuit components and again UV cured at 300^{0}F. Waste ink from all four screen-printing operations is scraped from machines and reused. Screen and machine-cleaning rags (48,000/yr) containing ink and xylene/propylene solvent are recycled off-site ($21,890). Broken screen mesh (23,880 ft^2/yr) containing emulsion is landfilled ($1,730).

Ten percent of the panels are solder coated--those that will not have surface-mounted components. Using this outmoded process relieves production on the SealBrite coating line. Micro-etching removes oxides. A two-stage counter current rinse and a hot-air drying follow. In a flux tank, Organo Flux is roll coated onto the panels, after which the panels are preheated and roll coated with tin/lead solder at 510^{0}F. Following a three-stage spray rinse, the panels are punched and cut into boards.

In the first stage of the punching operation, 1,500 to 2,000 holes are punched into panels (either following the solder coating or before the SealBrite coating) for component wiring. In the second, compound punching stage, the final wiring holes are punched and the panels are cut into boards. Panel webbing and slugs (643,500 ft^2/yr) are landfilled ($35,600).

Ninety percent of the products are SealBrite coated. This coating, whose function is similar to that of the solder coat, acts as a base for component attachment and is applied to punch boards. The necessary raw materials include sulfuric acid, hydrogen peroxide, SealBrite, SealBrite thinner, and isopropyl alcohol (used to clean the SealBrite tank). After the boards are micro-etched to remove oxides, they receive a high-pressure spray rinse, a four-stage cascade rinse, and a roll coating of SealBrite. The tank is clcaned twice a year and the bottoms drained to the plants waste treatment system. Water goes to the waste treatment system. Water is reused in the high-pressure spray rinse. Spent SealBrite solution (165 gal/yr) disposed off-site as a hazardous waste ($7,330); SealBrite thinner (275 gal/yr) evaporates. The boards are then inspected. About 5% (247,500 ft^2/yr) of the panel area is rejected and landfilled ($2,080).

CURRENT WASTE MINIMIZATION PRACTICES

Presently, the plant possesses a computer-controlled regeneration system which maintains cupric chloride etch solution. Excess ink is manually scraped from the screens and returned to the reservoir, and filter presses reduce the volume of wastewater sludge.

WASTE MINIMIZATION OPPORTUNITIES

A closed-loop, chilled-water system using recirculated water to cool the UV ovens and etch tanks could reduce wastewater 60% at an annual savings of $40,000. The payback period for the $76,640 implementation cost would be 1.9 yrs.

A steam generation system to heat spent etch solution and drive off a portion of the water would reduce the volume of spent etchant 35% at an annual savings of $33,510. The payback period for the $28,180 implementation cost would be 0.8 yr.

Substituting reusable polymer membrane filters for the copper- and zinc-containing paper filters in the mechanical wet scrubbing operation would reduce filter waste 96% and save $3,100 annually. The payback period for the $7,700 implementation cost would be 2.5 yrs. Additional recommendations, not completely analyzed, include:

- cleaning screens in an enclosed solvent cleaning system
- using reusable filters to remove ink from the stripping etch-resist caustic solution
- replacing cupric chloride solution with sulfuric acid/hydrogen peroxide etch solution
- investigating the possibility of recovering cupric chloride etch solution on-site

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Printed Circuit Boards
Research Brief Availability: March 1992 (EPA/600/M-91/022)
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: printed circuit boards; screen printing; SealBrite coating; zinc; copper; fume scrubbing; etching

MANUFACTURER OF CHEMICALS

INTRODUCTION

A plant that annually produces approximately 300 million lb of acrylic emulsions, low molecular weight (LMW) resins, and herbicides and other specialty chemicals was evaluated as part of EPA's University-Based Assessments Program. These three process lines are each described; because one LMW dispersant generates significant quantities of two hazardous wastes, it is described separately (II. Production of LMW Resin Dispersant).

WASTE GENERATION & MANAGEMENT ACTIVITIES

Production of Acrylic Emulsion and LMW Resin

The raw materials used to produce acrylic emulsions include monomers, additives, activators, and catalysts. Producing LMW resins involves monomers, additives, activators, and catalysts. Monomers are pumped from tanker trucks to storage, then to holding/premixing tanks, and sometimes to additive, activator, or catalyst holding tanks for mixing. From the premixing tanks, raw materials are mixed in one of three steam-heated, pressure-regulated reactors where the polymers are formed. The resulting acrylic emulsion polymers or LMW resin products are pumped to blend tanks where still other ingredients are added, e.g., formaldehyde as a preservative. At this point, acrylic emulsion polymers are pumped through tightly woven cloth filters to separate out unwanted clumps of product. Then the emulsion is pumped to storage tanks or directly into drums. The LMW resin product is directly pumped to storage tanks or into drums.

These two production processes generate several wastes on an annual basis. Burnable liquids are generated as a result of bad mixtures or bad reactions. They are also generated from incorrect temperatures or batch weight of solution. 15,400 lb of this material is disposed annually as hazardous waste at a cost of $77,110. Spillage and cleanup of material generates 15,400 lb of composited absorbed monomers which is disposed of as hazardous at a cost of about $77,110. Off-grade methylolacrylamide and acrylamide is generated in several ways. Sometimes, bad batches of commercial product are received. The material has a short shelf life and also off-grade material can result from operator or equipment error. From the combination of these circumstances, 5,100 lb of this material are disposed of as hazardous waste at a cost of $40,760. In addition, the acrylic emulsion process produces used filters and trapped product from the filtering process. 4,400 lbs. of this material is landfilled off-site at a price of $33,080. The LMW resin process produces unsalable LMW resins in the amount of 20,880 lbs, disposed of as hazardous waste for $116,200.

Production of LMW Resin Dispersant

Xylene, diisobutylene (DIB), and other monomers and additives are pumped to the reactors in the LMW production line. After polymers are formed in the reactors, the product undergoes separation in settling and storage tanks. Where an emulsion-line interface of DIB and the product is formed, it is removed. This material (25,750 lb) is disposed of as a hazardous waste at a cost of $79,860. During this processing, a DIB wet solvent is also separated from the product. 316,220 lbs of this material is burned on-site in a thermal oxidizer at a cost of $24,500.

Production of Herbicide and Specialty Chemicals

Chemicals are mixed in a pressure-and temperature-regulated reactor where a specified reaction occurs. The product is then pumped to a blend tank where substances to reduce the viscosity are added. From this blend tank, the products are loaded onto railcars and shipped. The highly acidic propionic acid generated by reaction is recycled to reactors for further use; the low-acidic content acid is used in the wastewater treatment system to neutralize caustic wastewater. 6000 lbs of propionic acid waste is generated from spills while loading and unloading material. $13,510 are spent to dispose of this material as hazardous. Annual cleaning of the reactor and blend tanks results in 1000 lbs of herbicide residues which are disposed of as hazardous at a cost of $24,150.

General Plant Wastes

A Tennessee Pollution Abatement System was installed mainly to remove vapors with irritating odors. A very small amount is organic vapors. Vapors (99.97%) from the monomer storage area; knock-out, reactor, and feed tanks; backfire preventers; and the lower explosive-limit monitors enter a natural-gas-fired thermal oxidizer at 1400°F. Stack gases (394,200 cu ft) pass directly to the outside atmosphere; recovered heat is used to heat boiler water. An on-site wastewater treatment facility treats wastewater from the resin line (including the LMW dispersant process), laboratory, air compressor, cooling water, and herbicide reactor and blend-tank cleanings. The 300,000 lb of wastewater sludge is landfilled at an annual cost of $456,800. The 126 million gal of treated wastewater is sewered at an annual cost of $2,121,700.

WASTE MINIMIZATION OPPORTUNITIES

To reduce the amount of off-specification products, upgrading the redundant sensing and control devices on the reactor raw material lines would reduce burnable liquids 75%, composited absorbed monomers 19%, off-grade methylolacrylamide/acrylamide 71%, and unsalable products 15%. The annual savings would be $139,810, and the payback period for the $365,080 implementation cost would be 2.6 yrs. The installation of a gas-fired dry-off oven in the wastewater treatment system would reduce the volume of sludge hauled off-site. Annual savings of $92,730 could be realized as a result of a $70,230 investment.

Research Brief Title: Waste Minimization Assessment for a Chemicals Manufacturer
Research Brief Availability: March 1992
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: acrylic emulsions; low molecular weight resins; herbicides; chemical production; thermal oxidizer

DAIRY

INTRODUCTION

A plant that annually produces 23.4 million gal of milk and milk products, fruit juice drinks, and jugs from high density polyethylene (HDPE) pellets was evaluated as part of EPA's University-Based Assessments Program. The raw materials associated with the various processes include raw milk, liquid juice concentrate, other ingredients such as chocolate powder, and HDPE pellets.

WASTE GENERATION & MANAGEMENT ACTIVITIES

After raw milk is received and pumped through a clarifier to remove undesirable solids, it is cooled to 36°F in a cooling press and transferred to one of three storage silos. About 40% of the cooled, stored milk is directed through a centrifuge to separate the cream from the milk, with the cream and the skim milk being stored separately. The cream is either transferred to the ice cream mix process or is packaged for sale as cream. A portion of the skim milk is transferred to the buttermilk process and a portion to the pasteurization and homogenization for packaging and sale; the remainder is blended with whole milk from the storage silo to obtain milk with different fat contents. The blended milks are sent to the pasteurized milk process, the chocolate milk process, or the ice cream mix process.

Milks with different percentages of fat and whole and skim milk are pasteurized and homogenized in two high temperature short time (HTST) presses: the first a regenerator (heat exchanger), and the second a vacuumizer where milk is steam heated to 172°F. After homogenization at 1,900 psi, the milk flows through the regenerator, transferring its heat to the incoming milk. Milk is then cooled to 36°F in a chilled water heat exchanger and to 32°F in a glycol cooling unit and then transferred to a 10,000-gal storage tank where it is stored at 33°F. From there the milk is bottled in cardboard cartons and plastic jugs and stored in a cooler. For buttermilk, skim milk is steam heated to 186°F, chilled, inoculated with culture at 75°F, chilled to 40° to 45°F, packaged, and stored. For chocolate milk , blend-tank milk is pumped to a mixing tank where chocolate powder and fructose are added. It is then pasteurized (as described above), stored, packaged, and stored again.

For ice cream mix, milk from the blend tank is blended with cream from the cream storage tank and with milk powder, fructose, stabilizers, and vanilla. The mixture is transferred to one of three holding tanks, from there to a HTST press (described in the pasteurization process), and from there to a 33°F storage tank. After being pumped to a filling machine, it is packaged and transferred to the storage cooler.

For fruit drinks, city water is pumped through a charcoal filter to remove debris and chlorine. This water is mixed (in a steam-heated mixing tank [168°F]) with preservative, liquid juice concentrate, and either sucrose or fructose. Following pasteurization in an HTST press, the juice is transferred to a surge tank, pumped to a filling machine,packaged in cartons or jugs, and transferred to a storage cooler.

Each of these processes produce waste:

- the 65,000-gal of milk solids annually collected from the clarifier in the raw milk processing line used off-site as fertilizer at a cost of $8,800;
- another 65,000 gal of spills and leaks annually collected in drip pans used off-site to feed hogs at a cost to the plant of $790;
- 394-,000 gal of uncontained spills and leaks of contaminated and uncontaminated milk annually collected in the waste pit and sewered;
- the 37,299,660 gal of wastewater from cleaning the physical containers and machinery needed for the processes (tank trucks, clarifier, storage tanks and silos, mixing tanks, pipelines, pasteurization presses, filling machines); from cleaning the plant (where the floor is not only washed as spills occur but all the floors washed once a day); and from the pasteurization processes (steam condensate) and the cooling processes (cooling water), with both sewered because of the risk of contamination, all at an annual cost of $194,190;
- the 6,300 gal of fruit juice spills annually sewered.

Producing the plastic jugs does create another waste. After the HDPE pellets are melted and extruded in molds for blow-molding gallon and half-gallon jugs, the jugs are trimmed of excess plastic. No disposal costs are presently associated with the 1,300 gal of dust that are generated.

CURRENT WASTE MINIMIZATION PRACTICES

The company already has:

- milk solids trucked off-site by a local farmer for fertilizer use,
- waste milk in drip pans taken off-site by a local farmer for hog feed, and
- wastewater and milk-contaminated waste streams combined to achieve dilution before being sewered.

WASTE MINIMIZATION OPPORTUNITIES

Recommendations for minimizing waste at the dairy centered on instituting a waste-water minimization plan--one that would include:

- an ongoing employee awareness program, e.g., employees learning how to place and empty drip pans,
- minimizing cleanup water use by using high-pressure and automatic shut-off hose nozzles, and
- installing an activated sludge treatment system to treat the pit-collected wastewater before it is sewered to avoid disposal surcharges because this waste does not meet disposal standards.

Employing these recommendations would reduce the uncontained milk waste 38% and the wastewater 90%, for an annual savings of $320,810. The payback period for the $661,200 implementation cost would be 2.1 yr.

Research Brief Title: Waste Minimization Assessment for A Dairy
Research Brief Availability: March 1992
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: dairy waste; milk (spilt); activated sludge treatment; wastewater; nozzle, high-pressure; nozzle, automatic shut-off

MANUFACTURING HEATING, VENTILATING, AND AIR CONDITIONING UNITS

INTRODUCTION

A plant manufacturing approximately 700,000 commercial and residential heating, ventilating, and air conditioning units was evaluated as part of EPA's University-Based Assessments Program. The plant produces fan coil units, electric heat components, air treatment units, accessory components (such as air volume control units), and air terminal units.

WASTE GENERATION & MANAGEMENT ACTIVITIES

Although manufacturing the fan coil and air terminal units is a major source of waste, the paint line generates the greatest amount of waste. All wastes from the manufacturing processes are considered hazardous and described in annual terms.

Manufacturing fan coil units generates several wastes. As aluminum sheet is drawn through the fin press to form fins for the heat exchanger component of the fan coil unit, 37,500 gal of lubricating oil from the fin press evaporates. The fins and coils are then joined in an expanding machine. The coil and fin assemblies are then brazed in a spot brazing machine. During brazing, 440 gal of brazing flux is lost in the form of fumes. Next, the assemblies are washed in a phosphate wash tank. This process yields 660 gal of phosphate sludge from tank sediment which is disposed of at a cost of $3,900. Next, the assemblies undergo Boehmiting (an etching process). As a result of Boehmiting, 1,980 gal of lime sludge are generated. The disposal cost for this material is $13,200. Eventually, assembly of the fin and coil components into fan coil units takes place. The assembly is performed with adhesives. One Hundred seven bbl of solvent-based adhesive on paper (overspray) and defectively glued insulation board are disposed of at a cost of $23,250. Forty-three bbl of water-based adhesive contaminated material (paper from overspray and insulation board) are disposed of as municipal (nonhazardous) waste at a cost of $2,365. Adhesive application requires the use of a carrier. This generates 345 gal of carrier waste lost due to evaporation. 1320 gal of hydraulic motor oil from the expander in the fan coil unit is also generated as waste at a management cost of $7,245.

Production of the air terminal units generates waste as well. Parts of the units are washed in a phosphate wash tank. This process yields 1,980 gal of phosphate sludge from tank sediment which is disposed of at a cost of $11,700. Final assembly of the parts to form the air terminal units results in the generation of 64 bbl of ethylene-vinyl acetate adhesive waste (paper and insulation board) which are disposed of at a cost of $13,905. Paint application generates additional waste. The overspray is collected in water and the water is separated and recycled. The remaining 6,875 gal of paint sludge is disposed of as hazardous at a cost of $72,375.

CURRENT WASTE MINIMIZATION PRACTICES

The plant had found water-based (nonhazardous) adhesives unsatisfactory because of long drying time; they may, however, return to them because the amount of waste is so great. The plant also intends to remove the paint line from the plant.

WASTE MINIMIZATION OPPORTUNITIES

The suggested waste minimization opportunities concern the adhesive overspray, paint sludge, and lubricating oil from the fin press in the fan coil unit production line.

Three different opportunities were suggested for minimizing the adhesive overspray, the defectively glued insulation board, and the adhesive carrier vapor problems:

- Attach insulation to sheet metal parts with screws, not adhesives. Waste would be reduced 100%, and the savings would be $58,350. The payback period for the $6,400 implementation cost would be 0.1 year.

- Replace all solvent-based adhesives with water-based adhesives. (An overhead conveyor would deliver dry, glued parts to the next operation.) The amount of solid waste would be the same but would be nonhazardous; all vapors would be gone; and the net savings would be $25,690. The payback period for the $31,740 implementation cost would be 1.2 years.

- Spot glue 10% of the surface area with quick-drying solvent-based glue and 90% with slow-drying water-based adhesive. The vapor would be reduced 90%; the solid waste would be nonhazardous; and the annual savings would be $23,120. The payback period for the $5,100 implementation cost would be 0.2 year.

To minimize paint sludge, the exhaust air flow rate from the paint booth could be cut back to reduce the waste 25% at an annual savings of $44,910. The payback period for the $2,100 implementation cost would be 0.1 year. By improving painting techniques (through retraining), overspray could be reduced 5% and $8,810 could be saved annually.

The payback period for the $3,500 implementation cost would be 0.4 year.

To minimize the lubricating oil vapor from the fin press, a recirculating air-oil condensing system could be installed to reclaim the evaporating oil. The waste would be reduced 50%, and $56,250 would be saved. The payback period for the $7,400 implementation cost would be 0.1 year.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Heating, Ventilating, and Air Conditioning Units
Research Brief Availability: March 1992 (EPA/600/M-91/019)
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: heating; ventilating; air conditioning manufacturing; paint overspray; adhesives; phosphate sludge; lime sludge; ethylene-vinyl acetate adhesive; adhesive carrier vapor

MANUFACTURING AUTOMOTIVE AIR CONDITIONING CONDENSERS AND EVAPORATORS

INTRODUCTION

A plant annually producing 400,000 condensers and evaporators for automotive air conditioners was evaluated as part of EPA's University-Based Assessments Program.

WASTE GENERATION & MANAGEMENT ACTIVITIES

On the condenser production line such materials as aluminum coils, tube stock, header assemblies, and extrusions; steel coils; and miscellaneous hardware are cut, bent, pierced, welded, brazed, and painted. These parts and assemblies go through many degreasing, rinsing, blowing off, and oven-curing sequences. In the course of these assembly line procedures, the following wastes are generated: cutting oil, 1,1,1-trichloroethane, methyl ethyl ketone (MEK), brazing slurry, and paint solids, liquids, and ash. No costs are associated with the parts of these wastes that evaporate: cutting oil, 1,1,1-trichloroethane, and MEK. The management costs to dispose of the gallons and pounds of waste that are generated amount to $53,000; contaminated paint solids and liquids are the most costly ($42,270).

The evaporator process line is similar to that of the condenser line except that paint is not applied to the evaporators. The parts do, however, undergo a chromate treatment process. Although, with these exceptions, the waste disposal costs are similar ($11,300 for the evaporator line and $10,730 for the condenser line), the disposal costs for the chromate surface treatment exceed $98,000. On both process lines, much wastewater is carried to a nonchromate wastewater facility where treatment produces 576 cu yd of waste-water sludge whose annual management cost exceeds $158,500.

The plant employs several other waste management measures. It operates an extensive wastewater treatment plant. The plant also captures some of the slurry runoff from the spray process in small runoff troughs on the spray brazing booths. Fume scrubbers on the brazing oven stacks capture slurry particulates from the stack gases. Toxic hexavalent chromic acid waste is converted to the trivalent form before removing it from the plant.

WASTE MINIMIZATION OPPORTUNITIES

The greatest waste management cost on the condenser line concerns disposal of contaminated paints; the greatest savings proposal also concerns the liquid and solid paint waste. By replacing the dip paint system with an electrostatic epoxy powder paint coating system, not only would there be more even coating of the complex surfaces, the waste could be reduced 100% and the savings, including costs of raw materials, would be $133,820. The payback period for the $130,320 implementation cost would be 1 yr.

An alternative to this waste paint disposal opportunity could be to modify the dip paint system. By increasing the time the parts drip into the paint tank and by tilting them back and forth, 40% of the pounds of paint waste could be reduced at a savings of almost $20,000. The payback period for the $25,440 implementation cost would be 1.3 yr.

By covering the 1,1,1-trichloroethane troughs on the condenser and evaporator process lines, the evaporative loss could be reduced 50% and the annual savings would be $14,000+, including raw materials. The payback period for the $1,880 implementation cost would be 0.1 yr.

Wastewater sludge could be reduced 75% by installing a dry-off oven to reduce the volume of hauled-off sludge, and a 1% reduction could be achieved by modifying the brazing slurry runoff to reuse 40% of the slurry. The first change would annually save almost $24,000 (over and above oven operating cost); cost $28,440 to implement; and be paid back in 1.2 yr. The second change could save almost $4,000, cost almost $5,000, and be paid back in 1.3 yr.

Additional recommendations, not completely analyzed but presented to the plant management, include:

- pumping the 1,1,1-trichloroethane to cleaning troughs rather than transferring it manually in buckets
- using an alternative fluxing system with less hazardous material
- analyzing treated water from the nonchromate system to determine if more could be reused

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Automotive Air Conditioning Condensers and Evaporators
Research Brief Availability: March 1992

Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center

UCSC Reviewer: Gwen P. Looby

EPA Project Officer: Emma Lou George

Key Words: automotive; air conditioning condensers; evaporators; cutting oil; 1,1,1-trichloroethane; methyl ethyl ketone (MEK); brazing slurry; paint solids; dry-off oven; electrostatic epoxy powder paint coating system

MANUFACTURER OF COMPONENTS FOR AUTOMOBILE AIR CONDITIONERS

INTRODUCTION

This plant manufactures three distinct product components for automobile air conditioners: charged air coolers, round tube plate fin (RTPF) condensers, and air conditioner tubes .

WASTE GENERATION ACTIVITIES

Charged Air Coolers

Sand-cast aluminum tanks are cleaned in an aqueous alkaline bath at 160°F, rinsed in successive stages, air dried, and inspected. Air and turbulator fins, headers, and side sheets are fabricated; hand-assembled into air coolers; brazed; and painted. The wastes include:

- lubricating oil, when coil stock is made into air fins, turbulator fins, headers, and side sheets and when extruded aluminum tubes are cut to length and deburred,
- scrap metal, when headers and side sheets are made from aluminum coil stock,
- spent solvent (trichloroethane, perchlorethylene) from degreasing operations, and
- paint booth wastes from solvent and paint from paint gun cleaning,water from the paint booth's water curtain, waste paint solids, and overspray.

Round Tube Plate Fin Condensers

Steel headers, aluminum hairpins, and aluminum coil stock (for fins) are fashioned into parts, degreased (perchlorethylene), dried , assembled into the condenser body, brazed, flushed with hot water, leak tested, oven dried, and dip painted. Wastes similar to those for the charged air coolers (above) are generated.

Air Conditioning Tubes

Aluminum coil tubing is cut to length, formed and straightened. About 39% of the product is degreased (trichloroethane). The other 61% is welded, pierced, and welded again before being degreased, dried, and leak tested. Cutting oils and solvent wastes occur.

WASTE MANAGEMENT ACTIVITIES

This plant generates several different types of waste annually. Approximately 40 barrels of spent oil are disposed of off-site. 25 barrels of still bottoms (one third of which is trichloroethylene, the remainder - perchlorethylene) are disposed of off-site. 1,384,000 gal of process wastewater are treated and put to the sewer. 255,377 lbs. of aluminum and steel scrap are sold for reuse. 20 barrels of paint sludge are disposed of as hazardous waste.

The plant presently has a solvent distillation unit to recover spent solvent and a secondary still to recover solvent from the first still's bottom. It has virtually eliminated sludge from its wastewater treatment system, and also sells scrap aluminum and steel (for $146,500/yr).

WASTE MINIMIZATION OPPORTUNITIES

By replacing the chlorinated hydrocarbon solvents with degreasers that can be directly sewered, waste disposal costs would be reduced $6,007/yr and raw material cost savings would amount to $62,640/yr. The payback period for the $20,700 implementation costs would be 0.3 yr. Note that of the 11,000+ gal of solvent used each year, 92% to 98% is lost to evaporation.

By not feeding water to idle rinse tanks and by converting these tanks to a counterflow rinse system, $33,235 would be saved each year. The payback period for the $3,480 implementation cost would be 0.1 yr. By converting present painting operations to electrostatic powder coating, solvent and wastes (water, paint solids, used plastic liners, spray booth coating) would be reduced or eliminated. Each year, waste disposal costs would be reduced $5,869 and raw material cost savings would amount to $22,885/yr. The payback period for the $100,640 implementation cost would be 3.5/yr.

By fabricating lightweight plastic tops to cover the degreasing units when not in use, solvent evaporation would reduce raw material costs at a savings of $26,375/yr. The payback period for the $3,600 implementation cost would be 0.1 yr.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Components for Automobile Air Conditioners
Research Brief Availability: March 1992

Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center

UCSC Reviewer: F. William Kirsch

EPA Project Officer: Emma Lou George

Key Words: automobile air conditioners; aluminum; steel; degreaser; trichloroethane; perchlorethylene; distillation; scrap; painting wastes; electrostatic powder coating

REFURBISHING RAILCARS, WHEEL SETS, AND AIR BRAKES

INTRODUCTION

A company rebuilding approximately 2,000 railcars a year was evaluated as part of EPA's University-Based Assessments Program.

WASTE GENERATION & MANAGEMENT ACTIVITIES

Refurbishing a railcar requires several steps which generate waste. The railcars are mechanically shaken to remove dirt and other residue from the cars. Next the cars are cleaned with a high pressure water spray. After the removal of any damaged parts, the paint removal process takes place. The paint removal process employs a steel grit blast system which slings steel grit against the car's metal surface. The paint chips and grit are conveyed to an outdoor cyclone. The cyclone separates the reusable steel grit from the paint dust and spent steel grit. 225 tons of steel grit and 214 tons of paint dust are shipped off-site for disposal as hazardous waste at a cost of $95,560 annually.

After the old paint is stripped away, primer is applied using hand-held spray guns. Once the cars are reassembled, the paint application takes place. The paint is applied using hand-held spray guns also. 56,042 lbs of overspray from paint and primer application processes are disposed of as hazardous waste at a cost of $36,860 on a yearly basis. Additionally, 6000 gal/yr of solvents used as paint thinners are lost due to evaporation.

To recycle axles from the railcars, the axle is washed in caustic solution to remove dirt and grease. 2400 lb/yr of sludge from this process are disposed of as hazardous waste at a cost of $5,350/yr. The plant also rebuilds air brake components. In the rebuilding process, external debris are removed from the components with a plastic bead blast system. As a result, 900 lb/yr of spent beads and paint residue are disposed of as a hazardous waste costing $5,200/yr.

The plant had already installed a water treatment facility, discontinued use of methylene chloride to wash the axles, and contracted with a vendor to reclaim solvent used to clean the air brakes.

WASTE MINIMIZATION OPPORTUNITY

Three of the recommended minimization opportunities centered on the painting operation:

- By installing an electrostatic spray system, primer and paint overspray losses would be reduced by 15% and solvent losses by 1.4%, at an annual savings of $11,080. The payback period for the $58,320 implementation cost would be 5.3 years.

- By improving the painters' techniques, use of paint and primer would be reduced 5% and solvent 5%, at an annual savings of $4,820. The payback period for the $3,500 implementation cost would be 0.7 year.

- By covering the painting areas with plastic sheets to collect paint and primer residue, the waste would be reduced 5% and $1,540 would be saved annually. There would be an annual operating cost but no capital implementation cost.

Another recommendation concerned the steel grit operation. Presently, 90% of the coatings are removed. Plant personnel indicated that removing 75% would not affect quality. By modifying this operation, 17% of the annual waste could be reduced at a savings of $24,980, including the cost of raw material. The payback period for the $13,500 implementation cost would be 0.5 year.

Additional recommendations (not included because of insufficient data, or difficult implementation, or lengthy payback period) that may become attractive include:

- custom design a system to separate spent steel grit (nonhazardous) and paint residue

- mechanically preclean the axle to remove some concentrated, relatively dry residue that otherwise becomes part of the wash system sludge

- install an ultrasonic axle wash system to eliminate the caustic wash

- eliminate air drafts to reduce paint overspray in the railcar painting sheds.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Rebuilt Railway Cars and Components

Research Brief Availability: Immediate (EPA/600/M-91/017)
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Brian Westfall/Emma Lou George
Key Words: railcar rebuilding; cleaning; railcars; paint; primer; overspray; separation; oil; electrostatic paint spraying.

MANUFACTURER OF PERMANENT-MAGNET DC ELECTRIC MOTORS AND REPLACEMENT PARTS

INTRODUCTION

A plant that annually manufactures approximately 13 million permanent-magnet DC electric motors and replacement parts was evaluated as part of EPA's University-Based Assessments Program.

The raw materials used in the various processes include iron and aluminum castings; steel tubing, shafting, and laminations; copper wire and commutators; poles; epoxy coating; varnish; adhesive; and cleaning chemicals. Fan components are purchased. The armature and the stator are made separately and then assembled.

WASTE GENERATION & MANAGEMENT PRACTICES

The armature assembly generates several sources of waste. During cutting and machining of steel shafts, 17,160 lb/yr of waste coolant is generated. This material is disposed of as a hazardous waste at a cost of $5,504/yr. The plant has already installed a coolant recovery system that recovers almost all coolant for reuse in machining tools. Scrap metal is also generated. 1-1/2 truck loads of this material are reclaimed annually.

Later, the assembled armatures are dipped into an epoxy powder dip tank. This process creates 5,175 lb/yr of waste epoxy dust which is collected in bag filters. This dust is disposed of as a hazardous waste at a cost of $3,948 annually.

Near the end of the armature assembly, varnish is applied. Occasionally, varnish becomes too thick for proper application. This results in the generation of 920 lb/yr of hazardous waste that is disposed of at a cost of $524/yr.

The stator assembly begins with the machining of steel tubing. Afterwards, the parts are cleaned in a 5-stage tank washing line to prepare the surface for adhesive fastening of magnetic poles. This cleaning process annually generates 3,520 lbs of zinc phosphate and caustic sludge which is disposed of as a hazardous waste. Wastewater from the tanks is neutralized and pumped to the sewer.

After final assembly of the motors, approximately 2% of the plant's products are painted black for cosmetic purposes. The spray-painting process generates several wastes. 7,920 lb/yr of spray paint booth wastes in the form of paint overspray, plastic sheets and air filters are disposed of as hazardous at a total cost of $6,151/yr. The water from the water curtain is too contaminated to be reused so it is disposed of as a hazardous waste (8,840 lb/yr) at a cost of $3,463/yr. 2,640 lb/yr of spent solvent from cleaning paint spray guns is disposed of as a hazardous waste at a cost of $719/yr.

WASTE MINIMIZATION OPPORTUNITIES

The two operations generating the most waste are the painting operations and the five-stage washer assembly line.

Alternatives to control liquid and solid paint wastes include:

- Replacing the water curtain spray booth with an electrostatic powder system to reduce solid paint wastes 93% and liquid wastes 100% at an annual savings of $10,230. The payback period for the $78,440 implementation cost would be 7.7 yr. Or,

- Replacing compressed-air paint spray guns with air-assisted airless paint spray guns to reduce paint overspray and increase paint adhesion. This would reduce both the liquid and the solid paint wastes 50%, with an annual savings of $5,850. The payback period for the $10,000 implementation cost would be 2.6 yr. Or,

- Replacing the water curtain spray paint booth by using a presently inactive electrostatic spray paint booth to reduce raw material costs and the amount of waste: 47% of the paint solids and 50% of the paint liquids at a savings of $9,970. The payback period for the $7,000 implementation cost would be 0.7 yr.

Ninety percent of spent epoxy powder could be recycled by installing an air-tight collection system at an annual savings of $14,470. The payback period for the $6,480 implementation cost would be 0.5 yr.

For a 100% reduction in the waste generated at the five-tank washer line in the stator assembly line, the use of the pole adhesive could be discontinued. Instead, the poles could be mechanically attached to the inside of the stators. The annual savings would amount to $31,760, and the payback period for the $110,880 implementation cost would be 3.5 yr.

Several additional recommendations, not completely analyzed, were brought to the manufacturer's attention for future reference. One recommendation was to install drag-out boards on the five-step cleaning operation tanks to drain solutions back into the tanks. Another recommendation suggested collecting the paint-spray-gun cleaning solvent for reuse. There is the possibility of using a detergent or a water-based solvent to clean dirty, metallic raw material. In the future, consideration should be given to converting the varnish spray system to a robotic dip system. And as an alternative to discontinuing the adhesive fastening process, an automatic metering system could be installed to reduce the amount of excess adhesive used to attach poles.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Permanent-Magnet DC Electric Motors
Research Brief Availability: March 1992
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: permanent-magnet DC electric motor manufacturer; paint wastes; epoxy powder; electrostatic paint spraying; adhesives

MANUFACTURER OF METAL BANDS, CLAMPS, RETAINERS, AND TOOLING

INTRODUCTION

A plant that annually produces 2 million lb of metal clamps, bands, retainers, and tools was evaluated as part of EPA's University-Based Assessments Program. The raw materials used for these products include stainless steel, carbon steel, forged iron blanks, zinc electroplating solution, brightener, and all the necessary cutting, cleaning, and rinsing chemicals.

WASTE GENERATION ACTIVITIES

To form the bands, 24-in. stainless-steel coils are cut and the sharp edges removed and beveled. The stainless-steel scrap is sold to a scrap metal dealer. To form the buckles, stainless and carbon steels are punched and crimped onto one end of the bands. For cylindrical bands, the open end is inserted into the buckle. For open-ended clamps, the buckle is only crimped onto one end. After inspection, the bands are packaged and stored for final shipment.

For customers who purchase the bands and buckles separately, the company fabricates specialized tools to apply and install the clamps and fittings. It is the manufacturing of these tools that creates the greatest portion of the plant's waste.

In the tool manufacturing process, many wastes are generated. In the ensuing discussion, all waste and disposal cost data are presented in terms of annual rates. First, iron blanks (which are forged off-site) are machined into tools on-site. Waste cutting fluid and hydraulic oil are generated from this process step at the rate of 660 gal/yr. This material is incinerated off-site at a cost of $70. After further processing, the tools are placed in electroplating barrels where they enter a metal cleaning line.

Initially, the tools undergo caustic cleaning. 1,120 gal of spent caustic cleaner (containing sodium hydroxide and sodium metasilicate) is pH balanced and discharged to the sewer system as industrial waste water. Next, the tools receive acidic electrocleaning. 560 gal of alkaline electrosoap solution is pH balanced and discharged as industrial waste water also. 170 gal of sludge from the caustic cleaning tank and the electrosoap tank is drummed and disposed of as hazardous waste at a cost of $1,200. After acidic electrocleaning, the tools proceed through the tap water rinse stage. This stage generates

650,000 gal of wastewater which is sewered at a cost of $750. The next stage of the cleaning process is the acidic cleaning. 560 gal of spent cleaner containing sodium fluoride is pH adjusted and sewered. Following this step, 650,000 gal of wastewater is generated with a disposal cost of $750 during the cascade rinse phase. The final step in the metal cleaning line is the acid stripping step. During this step, 170 gal of acid solution is disposed of as hazardous waste at a cost of $900.

Once the metal cleaning phase is completed, the tools pass through an electroplating line. This line involves acid zinc plating, rinsing and brightening. From the acid zinc plating line, 280 gal of solution containing sulfuric acid and ammonium chloride is disposed of as hazardous waste at a cost of $1,200. Wastewaters from the rinsing steps are recycled and reused; however, 230 gal of sludge is disposed of as hazardous waste costing $1,000. During the brightening step, 170 gal of hazardous waste in the form of solution containing nitric acid, chromium nitrate and ammonium bifluoride is disposed of at a cost of $700.

CURRENT WASTE MINIMIZATION PRACTICES

The plant has already taken the following waste minimizing steps:

- segregated excess metal for sale to a scrap dealer,
- treated plating-line rinse water (to remove metal contaminates) for reuse,
- employed air-agitation for zinc-plating-line rinses,
- filtered zinc plating solution to remove solid contaminants,
- discontinued using leaded steel, and
- employed cascade rinses in the metal cleaning and zinc plating lines.

WASTE MINIMIZATION OPPORTUNITIES

Presently the first rinse in the metal cleaning line uses tap water as make up. By redirecting the cascade rinse overflow to replace the tap water make up, 650,000 gal less of water will need to be purchased and sewered. The net annual savings would be $1,090. The payback period for the $470 implementation cost would be 0.4 yr.

By segregating high-grade from lower grade scrap, no waste reduction would occur, but the cash received from the recycler would increase.

To generate less sludge in the caustic cleaner tank, use deionized rather than tap water in the reagent baths on the metal cleaning and electroplating lines. The waste would be reduced by 150 gal/yr for a net savings of $1,370 after the rental cost of the ion exchange unit is considered. With no implementation cost, the payback is immediate.

To reduce water use in the tap-water and cascade rinses, flow reducers and flow meters could be installed on the metal cleaning line. This reduced use (124,800 gal/yr) would save $220/yr. The payback period for the $130 implementation cost would be 0.6 yr.

Increasing the drainage time over the caustic cleaner and electrosoap tanks would reduce waste by 250 gal/yr and save $340/yr with no required implementation cost.

Several other recommendations made to the company include:

- having a formal cutting-fluid management program to reduce the volume needing disposal,
- replacing kerosene with a nonhazardous cleaner,
- installing an automated pH adjuster for metal cleaning line effluent to prevent compliance problems, and
- installing splash guards on some machines to reduce loss of cutting fluids and lessen unnecessary cleanup.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Metal Bands, Clamps, Retainers, and Tooling
Research Brief Availability: March 1992
Assessment Responsibility: Colorado State University Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: metal bands; metal clamps; tool manufacturing; stainless steel; metal cleaning, caustic cleaners; acid cleaners; cascade rinse, zinc plating; brightener; sludge

MANUFACTURER OF ALUMINUM EXTRUSIONS

INTRODUCTION

A plant that annually manufactures over 36 million lb of aluminum extrusions was evaluated as part of EPA's University-Based Assessments Program. These extrusions are made for the use of other product manufacturers.

WASTE GENERATION ACTIVITIES

Virgin aluminum ingots, scrap aluminum, and alloying metals (e.g., copper, zinc, nickel) are melted in natural-gas-fired furnaces. The molten metal is then cast into logs in a water-quench hydraulic cast system, heat-treated and extruded into desired shapes; sheared; heat-treated again; and then buffed, anodized, or painted. Each year approximately 1.3 million lbs. are buffed and shipped; 14 million lbs. are anodized, colored, and sealed or anodized and sealed then shipped; and 21 million lbs. are painted and shipped. These three procedures (buffing, anodizing, and painting) create the wastes of interest.

CURRENT WASTE MANAGEMENT PRACTICES

The buffing procedure annually generates 26,000 lbs. of buffing compound sludge which is disposed in an on-site landfill along with 7,271 used buffing pads. The anodizing procedure annually is a major contributor to wastewater generation. Wastewater, fume-scrubber wastewater, and overflow water are sent to caustic or acid waste lagoons or to a reaction pit for further treatment and disposal. The painting operation generates wastewater also. Along with wastewater, painting generates 50,000 lbs. of contaminated air filters and plastic sheeting which are landfilled off-site as hazardous wastes. The cleaning of paint lines results in the evaporation of 13,130 gal of toluene annually and 1,430 gal/yr of spent toluene is disposed of off-site as a hazardous waste. Annually, 240,000 lbs. of trivalent chromic sludge are disposed of in an on-site landfill. 1,800,000 lb/yr of wastewater sludge are deposited in an on-site landfill also. Approximately 47,160,000 gal of wastewater are treated at this plant on a yearly basis.

Already, the plant is taking steps to change its hazardous wastes. The plant is currently transforming toxic hexavalent chrome to nontoxic chrome before off-site shipment. It is also controlling suspended and dissolved species concentrations in effluent water in an on-site wastewater treatment facility and using a water-spray fume scrubber in the anodizing area for air quality control.

WASTE MINIMIZATION OPPORTUNITIES

By replacing the solvent-based painting system with an electrostatic powder painting system, not only would the powder coating produce a more even coating, the spent and evaporated toluene, used air filters and plastic sheets, paint ash, and evaporated solvents would be reduced 100%. The net annual savings, which would include the lower cost of powder coatings, would be $1,084,440. The payback period for the $147,580 implementation cost would be 0.1 yr.

By installing an array of rinse spray nozzles in the anodizing line (above the detergent, etch, acid de-smut, anodizing, stannous sulfate, nickel fluoride seal, Sandoz bronze and Sandoz seal tanks) to spray water onto each parts rack as it is raised from the tank; by installing drag-out boards on all tanks in the line; and by increasing the drain time over the tanks, wastewater sludge would be reduced 0.2% at an annual savings of $52,900. The payback period for the $28,910 implementation cost would be 0.5 yr.

By installing an automatic metering system to minimize the amount of buffing compound used, the buffing compound sludge would be reduced 20%, at an annual savings of $6,590. The payback for the $25,960 implementation cost would be 3.9 yrs.

By installing a distillation unit, 80% of the spent toluene would be recovered--toluene that could then be used to clean the paint lines. The annual savings would be $17,030. The payback period for the $37,060 implementation cost would be 2.2 yrs.

By recovering and recycling caustic and acid solutions in the rinse tanks of the anodizing process line, raw materials lost in the rinsing operations would be recovered and water purchases reduced. Wastewater sludge would be reduced 0.2% and wastewater 85%. The annual savings would be $105,480, and the payback period for the $419,160 implementation cost (for dedicated reverse osmosis solution recovery system, an electrodialysis unit, in-tank air agitation units, and a lowered flow rate of water through the rinse tanks) would be 4 yrs.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Aluminum Extrusions
Research Brief Availability: March 1992
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George

Key Words: aluminum; aluminum extrusion waste; buffing; buffing compounds; anodizing; painting; paint wastes; electrostatic powder painting; Sandoz bronze; toluene; chromium

MANUFACTURER OF ALUMINUM CANS

INTRODUCTION

A plant producing 1 billion 12-ounce aluminum cans each year was evaluated as part of EPA's University-Based Assessments Program.

WASTE GENERATION ACTIVITIES

After the cans are formed, they pass through automated spray washing machines where they are cleaned and rinsed. The can is surface treated so the outside can receive a base coat of paint, a printed insignia, and a final coat of clear lacquer. The inside receives a water-sealed vinyl coating. Between these steps the cans are dried.

Most of the hazardous waste comes from the can washing operation. The rinse water from this operation contains oil, hydrofluoric acid, sulfuric acid, nitric acid, and ammonium fluozirconate. The water is treated on-site and discharged to the sewer. The sludge precipitated from the rinse water treatment process is laden with ammonium fluozirconate and must be hauled off-site for hazardous waste disposal. The printing and inking operations generate additional wastes. Tap water from rinsing operations generates 30,699,000 gal/yr. Sludge precipitated from the treated tap water is accumulated at the rate of 888,300 lb/yr. Also, painting operations yield 5,400 gal of paint waste. The total cost to treat and dispose of these three sources of waste is $249,850.

CURRENT WASTE MINIMIZATION ACTIVITIES

The company already recycles its scrap aluminum, keeps to a minimum its use of water and chemicals in the washing operation, uses a filter press to reduce the water content of the hazardous sludge before shipment off-site, and collects waste oil from the extruder coolant system.

WASTE MINIMIZATION OPPORTUNITY

The suggested waste minimization opportunity concerns the hazardous sludge. By substituting a nonhazardous reagent for the presently used 2%to 4% ammonium fluozirconate, the need to dispose of the sludge at a hazardous waste disposal facility would be eliminated, and $133,060 would be saved. Because there are no implementation costs, the payback period is immediate.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Aluminum Cans
Research Brief Availability: Immediate (EPA/600/M-91/025)
Assessment Responsibility: Colorado State University Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Brian Westfall/Emma Lou George
Key Words: aluminum can manufacturing; sludge; cleanings, aluminum cans; ammonium fluozirconate

MANUFACTURER OF TREATED WOOD PRODUCTS

INTRODUCTION

This plant produces treated wood products (crossties, poles, lumber) for regional distribution, annually processing about 1.7 million cubic feet of wood on a full-time schedule, 8,760 hours per year. The major process operations are debarking and trimming, treating lumber with a chromated copper arsenate solution in pressure cylinders (Wolmanizing), treating crossties and poles with a mix of creosote and No. 6 oil in pressure cylinders, and steam-cleaning the crossties and poles in the pressure cylinders to remove excess creosote. All these operations result in the formation of waste streams, and all except bark and wood chips are considered hazardous waste. This plant was evaluated as part of EPA's University-Based Assessments Program.

WASTE GENERATION ACTIVITIES

Solid wastes (bark and wood chips) from debarking and trimming are stored on-site, awaiting disposal, and are accumulating at a rate of 9,750 cubic yards per year at a waste management cost of $1,200/yr. Spent chromated copper arsenate solution (2% aqueous, 280 gal/yr) from Wolmanizing operations is shipped to a hazardous waste disposal facility at a cost of $700.

Steam cleaning of crossties and poles results in a condensate containing creosote and oil. After addition of a flocculating agent, settling, and decanting, the creosote layer is recycled to the process. The aqueous layer (720,000 gal/yr), after treatment with ozone and caustic soda to destroy soluble phenols and adjust the pH, is discharged to the sewer as industrial waste water at a cost of $4,175. Cleaning of the creosote treatment cylinders results in a creosote sludge. Some is shipped off-site for use as a boiler fuel, and the rest (16,550 gal/yr) is sent to a hazardous waste disposal facility at a cost of $16,625.

CURRENT WASTE MINIMIZATION PRACTICES

The plant has minimized the need for periodic cleaning by fitting the large storage tanks with conical bottoms to accumulate sludge. These storage tanks are heated to maintain proper viscosity and reduce sludge formation. Also, because the plant now employs Wolmanizing (a closed-loop process that does not require steam cleaning), waste containing chromated copper arsenate has been minimized.

WASTE MINIMIZATION OPPORTUNITIES

If a waste exchange program could be arranged with a user of scrap wood, the 9,750 cu yd of bark and wood chips could be removed, and the property leased for its storage would not be needed. This would save $1,200/yr and would cost nothing to implement.

Research Brief Title: Waste Minimization Assessment for a Plant Producing Treated Wood Products
Research Brief Availability: March 1992
Assessment Responsibility: Colorado State University Waste Minimization Assessment Center
UCSC Reviewer: J. Clifford Maginn
EPA Project Officer: Emma Lou George
Key Words: bark; wood chips; lumber treated; Wolmanizing; creosote; No. 6 oil; copper arsenate

MANUFACTURER Of MILITARY FURNITURE

INTRODUCTION

A plant that annually builds, to specification, approximately 12,000 units of furniture for use in military barracks was evaluated as part of EPA's University-Based Assessments Program. The plant uses heavy-density particle board, steel framing, rolls and strips of sheet steel, Formica, and assorted hardware to produce wooden, wood with steel frame, and steel furniture. To build the wooden units, Formica is laminated to the raw board; the glued laminations are cured in a press; the laminated boards are cut, drilled, and routed; and the units are partially assembled before packaging and shipping. The wastes from these operations do not pose disposal problems.

CURRENT WASTE GENERATION & MANAGEMENT PRACTICES

The procedures employed to build the metal units create several wastes. 715 gal/yr of toluene sludge is generated from the cleaning of metal stock by dipping in a toluene dip tank. This sludge is disposed off-site as a hazardous waste at a cost of $8,230. 172 gal/yr of toluene is lost due to evaporation. Before the metal parts are painted, they are cleaned. The cleaning process generates wastewater. After cleaning, the metal parts are painted. The painting operation generates several waste streams. Paint solids are combined with the wastewater from the cleaning operation yielding 7,515 gal/yr of wastewater. Spray-paint booths produce paint-laden air filters which collect overspray. Annually, 832 filters are disposed. Approximately 3,390 gal of paint are lost with the filters. 915 gal/yr of paint solvent are lost due to evaporation. Cleaning and maintenance of the paint spray guns produces 55 gal/yr of toluene sludge and results in 44 gal/yr in toluene losses due to evaporation.

The plant is already investigating steam cleaning to eliminate the five-stage metal cleaning operation. The use of dip painting has been minimized.

WASTE MINIMIZATION OPPORTUNITIES

The waste minimization opportunities concern the painting and toluene cleaning operations. By installing an electrostatic powder coating system to replace the spray and dip painting, not only will the parts be more evenly coated but there could be a 100% reduction of evaporated paint solvent, paint-laden air filters, wasted paint, evaporated toluene, and paint solids. The annual savings would be $49,770, and the payback period for the $145,880 implementation cost would be 2.9 yrs.

By protecting the clean metal stock from environmental dirt thus eliminating the need for subsequent toluene dip-tank cleaning, 100% of the toluene sludge and evaporated toluene could be eliminated. The annual savings would be $8,400, and the payback period for the $3,800 implementation cost would be 0.5 yr.

By repairing the lid to the toluene dip tank to reduce evaporative loss and by instituting a program to keep the lid closed when possible, 50% of the evaporated toluene could be saved. The annual saving would be $180 by reducing the need to replace evaporative loss, and the payback period for the $100 implementation cost would be 0.5 yr.

By installing an electrostatic spray system in building 3 and reinstalling one in building 4, the annual gallons of paint wasted would be reduced 29%. The annual savings would be $39,880, and the payback period for the $66,900 implementation cost would be 1.7 yrs.

If the above waste minimization opportunities concerning the spray paint process are not adopted, additional recommendations, not completely analyzed, are to:

- Install a state-of-the-art dip paint line,
- replace solvent-based paints with water-based paints, or
- use air-tight spray-gun cleaning tanks to reduce toluene evaporation.

Research Brief Title: Waste Minimization Assessment for a Manufacturer of Military Furniture
Research Brief Availability: March 1992
Assessment Responsibility: University of Tennessee Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: military furniture; paint wastes; toluene

MANUFACTURER OF COMMERCIAL ICE MACHINES AND ICE STORAGE BINS

INTRODUCTION

A plant that annually manufactureS 26,000 ice machines and 12,500 ice bins was evaluated as part of EPA's University-Based Assessments Program. The raw materials used in the various processes include galvanized and rolled steel sheets; brass; copper; and metal treating and cleaning chemicals.

WASTE GENERATION & MANAGEMENT ACTIVITIES

The manufacturing processes, the wastes from the processes and their methods of disposal and the annual amount and cost to dispose of the wastes are discussed below.

For cabinet components, galvanized and rolled steel sheets are cut, punched and drilled. These sheets are then cleaned and rinsed. The wastewater (2,569,900 gal/yr) from this process is pre-treated and then sewered at a cost of $4,320. The parts are then coated with iron phosphate/phosphoric acid spray to serve as a base for the powder coating. The wastewater (14,400 gal/yr) from this process is pre-treated and then sewered at a cost of $30. The parts are rinsed to remove excess phosphating solution. The wastewater (2,781,500 gal/yr) from this process is pre-treated and then sewered at a cost of $4,680. Before finally being coated with paint powder and baked, the parts are rinsed with chromate to provide a conversion coating. The rinse water (16,900 gal/yr) containing hexavalent chromium is recycled and ion exchange treated. The material is then sewered at a cost of $30.

For the flaker barrel, evaporator, and downchute assembly, after the brass tubes are milled, drilled, threaded, wrapped around the barrel, and then cooled, the brass shell is heated, shrink-fitted and brazed onto the assembly. The assembly is then sent through a bright dip process for corrosion protection. The spent solution (660 gal/yr) of copper sulfate and copper nitrate crystals is sent to the supplier who reclaims the copper at a cost of $1,620. After rinsing and draining, assemblies undergo chemical sealant and rinse treatments, including baths of soda ash, rinse, and sealant with isopropyl alcohol and potassium hydride. The wastes generated from these steps (12,300 gal/yr) are pre-treated and sewered. The finished barrel/evaporator assembly and the fabricated downchutes are insulated with polyurethane foam. The spray nozzle used for the foam insulation is cleaned and the waste (170 gal/yr) is disposed of as a hazardous waste at a cost of $1,770.

Separately, the evaporators undergo assembly. Copper parts are degreased and dipped in a 5% hydrochloric acid solution. The waste from this step (20,800 gal/yr) is pre-treated and sewered for $40. Eventually, the evaporator assemblies are cleaned in an enclosed washer. Again the wastewater from this process (3,120,000 gal/yr) is pre-treated and sewered at a cost of $5,240.

General plant wastes are generated during cleaning and maintenance operations. Spent petroleum naphtha is reclaimed. Also, hydraulic and vacuum pump oil is reclaimed. Sludge (18,200 gal/yr) is generated from on-site wastewater treatment operations and is disposed of in a sanitary landfill at a cost of $6,300.

CURRENT WASTE MINIMIZATION PRACTICES

Presently, the plant already has:

- replaced solvent-based paints with powder coatings;
- installed a high-pressure foaming system to reduce organic cleaning wastes in the bin-foaming area;
- segregated excess metal for recycling by a scrap metal dealer;
- developed preventive maintenance for metal-forming machinery;
- recycled waste oils and spent bright dip solutions, solvents, and ion-exchange cartridges;
- employed a closed-loop rinse (just before powder coating) for ion-exchange treatment; --reduced rinse-water flow rates to the lowest possible levels;
- employed counterflow rinsing so the initial rinse used water from the drainage collection tank;
- employed a dead-rinse tank to collect drag-out in the bright dip process;
- used drain boards following bright dip rinses;
- dewatered wastewater treatment sludge;
- replaced MEK with methylene chloride to clean foamer nozzles;
- employed drip bars in degreasing bath and acid bath of small parts washer; and
- defined a formal waste minimization policy.

WASTE MINIMIZATION OPPORTUNITIES

When the metal cabinet components are cleaned and rinsed, the two rinses generate well over 5 million gal of rinse water that are pre-treated and sewered. By redirecting the rinsewater overflow from the second rinse (following the iron phosphate treatment) to the first rinse, the fresh water used in the first rinse would be reduced by

2,171,520 gal/yr. The savings would be $4,630/yr, and the payback period for the $800 implementation cost would be 0.2 yr.

The flaker barrel evaporator assemblies are cleaned in a bright dip line. By cleaning these assemblies with a plastic media blasting unit, disposal of the spent brightener and subsequent rinses could be eliminated as could the purchase cost of the brightener. (The caustic bath, the sealer, and its rinse would then follow.) The waste could be reduced by 9,960 gal/yr; the total savings could be $3,950/yr. The payback period for the $5,000 implementation cost would be 1.3 yr.

Research Brief Title: Waste Minimization Assessment for A Manufacturer of Commercial Ice Machines and Ice Storage Bins
Research Brief Availability: March 1992
Assessment Responsibility: Colorado State University Waste Minimization Assessment Center
UCSC Reviewer: Gwen P. Looby
EPA Project Officer: Emma Lou George
Key Words: ice machine; ice storage bin; rinse water; chemical waste; bright dip process; brass; steel; copper

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*U S. Government Printing Office: 1992 — 648-003/41814