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DEMONSTRATION OF ALTERNATIVES FOR VAPOR DEGREASERS

Dean Menke - Center for Clean Products
Rupy Sawhney - Department of Industrial Engineering
University of Tennessee
327 South Stadium Hall
Knoxville, Tennessee 37996-0710
(615) 974-8979

INTRODUCTION

The "Cleaner Technology Demonstrations for the 33/50 Chemicals" is a cooperative agreement project between the Center for Clean Products and Clean Technologies and the U.S. EPA. Though originally designed to support the 33/50 Program, the results of this RREL-funded research will have a broad range of applications within industry and offer pollution prevention benefits beyond the 33/50 goals. The overall objective of this project is to evaluate substitutes of the 33/50 chemicals in order to encourage reductions in their use and release within specified priority use clusters. Priority use clusters, identified in the "Product Side of Pollution Prevention: Evaluating Safe Substitutes for the 33/50 Chemicals" report, are products and/or processes that consume a significant fraction of the 33/50 chemicals (1). The first evaluation, presented here, focused on the metal and parts degreasing priority use cluster and specifically substitutes for solvent degreasing processes that eliminate the use of the chlorinated degreasing solvent dichloromethane, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene.

In this study the Center for Clean Products worked directly with an industry partner to demonstrate substitute feasibility and to gain actual industrial information. Calsonic Manufacturing Corporation (CMC) is aggressively pursuing less polluting alternatives to solvent degreasing and agreed to participate as the Center's industrial partner to demonstrate solvent degreasing substitutes. CMC manufactures automotive parts included heaters, blowers, cooling units, motor fans, radiators, auxiliary oil coolers, and exhaust systems. Over the past four years, CMC had evaluated and implemented a number of environmental improvements to completely eliminate 1,1,1-trichloroethane (TCA) from their degreasing processes. This research focused on two of these improvements; an aqueous wash system which replaced five vapor degreasers of the radiator manufacturing line, and a no-clean processing alternative (i.e. application of an evaporative lubricant which does not require cleaning for subsequent processing) which eliminated two vapor degreasers of the condenser manufacturing line.

METHODOLOGY

The technical, environmental, economic, and national impact evaluations performed for the aqueous wash system and no-clean alternatives employed at the CMC facility had the following specific objectives:

1. technical evaluation
   - evaluated the substitutes' effects on process and product performance as compared to the solvent degreasing processes
2. environmental evaluation
   - evaluated the releases and off-site transfers of the 33/50 chemicals in the production process compared to the substitutes' chemical releases and transfers
3. economic evaluation
   - evaluated the costs, traditional and nontraditional, of the substitutes as compared to the 33/50 chemicals
4. national impact evaluation
   - evaluated and compared the overall life-cycle national environmental impacts of replacing the 33/50 chemicals with the substitutes

Data required to perform the technical, environmental, and economic evaluations were collected from CMC through data request tables, site visits, and interviews with CMC employees. Data request tables, completed by CMC employees and during site visits, allowed for the collection of process information including capital costs, operating and maintenance costs, utilities consumption, and production data. Questions concerning generation rates and disposal costs of waste (hazardous and non-hazardous) and wastewater accompanied the data request tables, as well as questions concerning permitting requirements. Tables and questions were directed at operations both before and after the process changes.

Site visits and interviews allowed Center staff to become familiar with the day-to-day operations of each CMC manufacturing line of interest. This information was used to extend the traditional economic evaluation by using activity-based cost accounting. Activity-based cost accounting specifically identifying the frequencies, durations, costs, and possible chemical emissions for every activity required to operate and maintain the solvent degreasers and alternative systems. Direct manufacturing activities, as well as indirect support activities (e.g. paper work, waste management, supervision) were identified and included in the evaluation.

These evaluations of CMC, supplemented by on-line databases and literature sources, were used to estimate the national environmental impacts that could occur if entire industrial sectors replaced solvent degreasing systems with the alternatives.

RESULTS

For this study, process and product performance were used as the two parameters to evaluate the technical feasibility of the alternative cleaning systems. As part of a continuous manufacturing line, the cleaning process (or no-clean alternative) has the potential to influence both of these parameters. Process performance was defined as the rate of production. Product performance was based on the part reject rate per unit of production which was determined from the leak test records of every unit manufactured. The production and part reject rates when the solvent degreasing processes were on-line were used as the baseline for comparisons with the alternative processes.

Production rates and part reject rates were both established through historical records and employee interviews. Evaluation of this data revealed that the production rate of either process line (radiator or condenser) was not affected by the change to the alternative system. Neither was the part reject rate of the condenser line, both before and after the process change to the no-clean alternative. The part reject rate for the radiator line, however, did significantly decrease after the aqueous wash system was installed. By implementing the aqueous wash system, and through the efforts of a Radiator Task Force established by CMC, the leak detection rate of the radiator line was decreased nearly 77 percent.

Though the alternative processes eliminated TCA releases and transfers from the radiator and condenser process lines, other chemical releases and transfers resulted from their implementation. Therefore, it was necessary to evaluate multiple medias (land, air, and water), as well as hazardous and nonhazardous wastestreams, to capture the full impact of the changes to the alternative processes.

Air releases and off-site transfers, reported to the 1992 Toxic Release Inventory (TRI), were the predominant releases and transfers of TCA from CMC's manufacturing facility. Table 1, below, summarizes these releases and transfers, and shows how they decreased over the past four years. TRI only requires facilities to report total releases and transfers of a chemical, not process-by-process releases or transfers. Therefore, specifically identifying the contribution to the overall reductions from either the radiator or condenser process lines was not possible. However, chemical use records for these process line, and employee interviews establish the following estimates:

1. the radiator process line, consuming 250,400 lb. of TCA for solvent degreasing in 1990, released 115,000 lb./yr. in 1990, 86,800 lb./yr. in 1991, and 0 lb./yr. in 1992; and
2. the condenser process line, consuming 88,550 lb. of TCA for solvent degreasing in 1992, released 75,500 lb./yr. in 1992, and 0 lb./yr. in 1994.

The implementation of these alternatives eliminated this consumption of TCA and the releases and transfers associated with its use.

The implementation of the aqueous wash system for the radiator line, however, generated an 8,400 gallon/day water wastestream. Treated at an on-site pretreatment facility, this wastewater represents a significant waste management change. A nonhazardous, oily wastestream, skimmed from the surface of the aqueous wash reservoirs, was also a newly generated wastestream of the aqueous wash system. The no-clean alternative, by applying an evaporative lubricant to eliminate the need for parts cleaning, generated a new source of volatile organic compound (VOC) emissions to air. Based on lubricant consumption records, and assuming 100 percent evaporation, approximately 4,000 pounds/year (1.7 pounds/day) of volatile organics are emitted to the air from this alternative process.

TABLE 1. CMC TRI-REPORTED RELEASES AND TRANSFERS OF TCA

Year	TCA Air Emissions (lb./yr.)	Percent Change	TCA Off-Site Transfers (lb./yr.)	Percent Change
1990	425,756	-	233,530	-
1991	194,622	-54.3	338,525	45.0
1992	176,239	-9.4	206,345	-39.0
1993	89,446	-49.8	194,975	-5.5
1994*	66,800	-25.3	109,000	-44.1

* Values estimated from eleven months of TCA purchase records and trends of previous years

The traditional economic evaluation, results of which are presented in Table 2, indicated return on investments in as little 0.3 years (CMC-determined RI for the condenser line). The activity-based costs accounting economic evaluation had not been complete at the time of this abstract publication. However, initial review of the activities recorded during site visits to CMC identified significant differences in the required activities between the solvent degreasing processes and those of the alternative systems. These differences centered around two operations; one being the activities required to manage toxic chemicals and toxic waste; the other was the costs associated with the treatment of the aqueous system's wastewater. These results will be available by the time of the presentation, and copies of the methodology and results will be available.

TABLE 2 - COMPARISON OF SPECIFIC TRADITIONAL COSTS

Costs	Radiator		Condenser	
	Degreasers	Aqueous System	Degreasers	Evap. Lube.
Capital Investment	not avail.	$463,595	not avail.	$44,000
Chemical Costs	$182,490	$21,400	$67,040	$4,720
Waste Disposal	$20,000	$12,430	$13,735	$0

Chemical releases and transfers occur through out their life cycles; from their production, use, and disposal. Significant changes in these emissions can occur if entire industrial sectors were to implement alternatives to solvent degreasing similar to those of CMC. Therefore, a life-cycle, multi-media approach to the national environmental impact evaluation was used to capture the overall environmental impacts of the alternatives.

Production facility releases and transfers of the chlorinated degreasing chemicals, in TRI reporting year 1992, totaled 1,286,823 lb. An estimated 34 percent of the chlorinated solvents produced in the U.S. were used in solvent degreasing applications in 1992 (2). Using a life-cycle approach, some fraction of the production emissions may be attributed to solvent degreasing; 34 percent to the production releases, establishing the potential upper boundary, equalled 440,000 lb. The EPA estimates that 24,500 solvent degreasers were operational in 1992 within the US (3). These solvent degreasers consumed approximately 440 million pounds of chlorinated solvents. Based on this information, the EPA also established a 1992 air emission baseline from these 24,500 solvent degreasers at 283.5 million pounds (4). Eliminating the use of chlorinated chemicals in solvent degreasing processes would greatly reduce or eliminate these emissions, both associated production releases and transfers, as well as the use and disposal releases and transfers. Phase-out regulations for TCA will reduce the use and releases/transfers of TCA regardless of the degree of which these alternatives are implemented.

The alternatives to solvent degreasing also have their life cycle environmental releases and transfers associated with them. Aqueous detergents may include in their formulations surfactants, saponifiers, chelators, corrosion inhibitors, and stabilizers. Specific examples from each of these additive classes were analyzed. Disposal of the water wastestreams may have significant effects on publicly owned treatment works (POTW). The POTW infrastructure of the nation was evaluated, and the potential impact the aqueous wash systems have on the infrastructure was established. A similar life-cycle approach was used to evaluate the mineral-spirits-based evaporative lubricants.

CONCLUSIONS

A significant number of studies are being conducted, or have been completed, which evaluate the effectiveness of cleaning alternatives. These studies primarily focus on one of the four evaluations performed in this study; little integration of all potential issues is attempted. This cooperative agreement with EPA expands the existing knowledge of alternatives to solvent degreasing by integrating technical, environmental, and economic issues, as well as addressing the life-cycle attributes of the alternatives on a nation scale.

The technical feasibility of CMC's process changes has proven to be positive. Significant reductions in toxic chemical releases and transfers were a result of the process changes, while other wastestreams were generated which required different management schemes. The traditional economic evaluation of this study did not reveal any unique conclusions. However, the activity-based cost accounting method did identify the costs associated with managing toxic chemicals and wastes, costs normally absorbed by the company as overhead. Finally, the national impact evaluation identified the importance of a life-cycle approach to evaluate pollution prevention projects. Though the alternatives evaluated in this research eliminate chlorinated chemical emissions, there are new wastestreams and wastestream constituents that must be addressed.

REFERENCES

1. Product Side of Pollution Prevention: Evaluating Safe Substitutes of the 33/50 Chemicals, EPA/600/R-94/178, U.S. Environmental Protection Agency, Office of Research and Development, September 1994

2. Product Side of Pollution Prevention: Evaluating Safe Substitutes of the 33/50 Chemicals, EPA/600/R-94/178, U.S. Environmental Protection Agency, Office of Research and Development, September 1994

3. National Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning - Background Information Document, EPA-453/R-93-054, U.S Environmental Protection Agency,

Office of Air Quality, November 1993.

4. National Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning - Background Information Document, EPA-453/R-93-054, U.S. Environmental Protection Agency, Office of Air Quality, November 1993.

FOR MORE INFORMATION:
Diana Kirk
Risk Reduction Engineering Laboratory
26 W. Martin Luther King Drive, MS-466
Cincinnati, Ohio 45268
(513) 569-7674

RESEARCH SUPPORT TO THE POLLUTION PREVENTION PROGRAM OF THE US POSTAL SERVICE

N. Theresa T. Hoagland
U.S. Environmental Protection Agency
Risk Reduction Engineering Laboratory
Pollution Prevention Research Branch
26 W. Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7783

INTRODUCTION

The USPEA Risk Reduction Engineering Laboratory's (RREL) Pollution Prevention Research Program focuses on the question "How should consumer, government and industrial products and processes be designed, manufactured, used, and/or performed so that their manufacture, use, disposal, or performance will have a minimal effect on the environment." Research projects addressing this issue are divided into five areas: (1) Clean Technology Projects; (2) Clean Products Projects; (3) Longer Term P2 Research; (4) P2 Assessments; and (5) Cooperative P2 Projects with Other Federal Agencies.

Under the general heading of Cooperative P2 Projects with Other Federal Agencies, a specific research program exists at RREL, which is referred to as the WREAFS Program (Waste Reduction Evaluations At Federal Sites). Many of the projects with the Departments of Defense (DOD) and Energy (DOE), are funded under the Strategic Environmental Research and Development Program (SERDP). The primary components of the WREAFS program are: (1) opportunity assessments; (2) research, development and demonstration; and (3) technology transfer.

Most of the WREAFS projects involve Pollution Prevention Opportunity Assessments (PPOA) and have been conducted in conjunction with DOD facilities; however, several "civilian" agencies are now beginning to participate in the program, as well. One major player which is emerging as a leader in addressing P2 on an agency-wide basis is the US Postal Service (USPS). Like most agencies, the USPS' operations entail many industrial-type processes that are common to the private sector industrial complex.

METHODOLOGY

The PPOAs were conducted by an assessment team that was composed of personnel from EPA, USPS, and SAIC, under contract with EPA. The assessments followed the procedures described in the EPA Report, *Facility Pollution Prevention Guide* (EPA/600/R-92/088), which identifies the four major phases of an assessment: (1) Planning and Organization, which includes organization and goal setting; (2) Assessment, which includes a careful review of a facility's operations and waste streams and the identification and screening of potential options to reduce waste; (3) Feasibility Analysis, including an evaluation of the technical and economic feasibility of the options selected and subsequent ranking of options; and (4) Implementation, which involves procurement, installation, implementation, and evaluation.

Many of the pollution prevention opportunities identified during WREAFS projects involve low-cost changes to equipment and procedures that can often be implemented by the facility without extensive engineering evaluations. Other pollution prevention opportunities identified require further study before full implementation can be realized. Typically, opportunities requiring further evaluation are those that have the potential to affect the process and/or require the use of new procedures or equipment. In such cases, it may be necessary to conduct demonstration projects.