1995

Pollution Prevention Implementation Plan for Metal Manufacturers

Iowa Small Business Development Centers

Iowa Waste Reduction Center

IOWA POLLUTION PREVENTION INITIATIVE

Pollution Prevention Implementation Plan

for Metal Manufacturers

SMALL BUSINESS DEVELOPMENT CENTERS - IOWA WASTE REDUCTION CENTER

The Pollution Prevention Implementation Plan for Metal Manufacturers was prepared as part of the Iowa Pollution Prevention Initiative (IPPI) pilot project. IPPIdemonstrated the team approach to small business pollution prevention technical assistance through integration of existing Iowa Small Business Development Center and Iowa Waste Reduction Center services. This cooperative effort was designed to help small businesses learn about and implement pollution prevention through recognition of pollution prevention options, comparison of costs and benefits, and evaluation of financing options.

The Pollution Prevention Implementation Plan (PPIP) for Metal Manufacturers provides:

• An overview of pollution prevention options,
• A review of the costs and benefits associated with these options, and
• Steps for pollution prevention implementation and financing

Use of the PPIP will help a small business select pollution prevention practices that have a high probability of being successful from quality/production, environmental and economic standpoints. While this particular PPIP addresses the metal manufacturing industry, other PPIP's are available for printing and vehicle maintenance facilities.

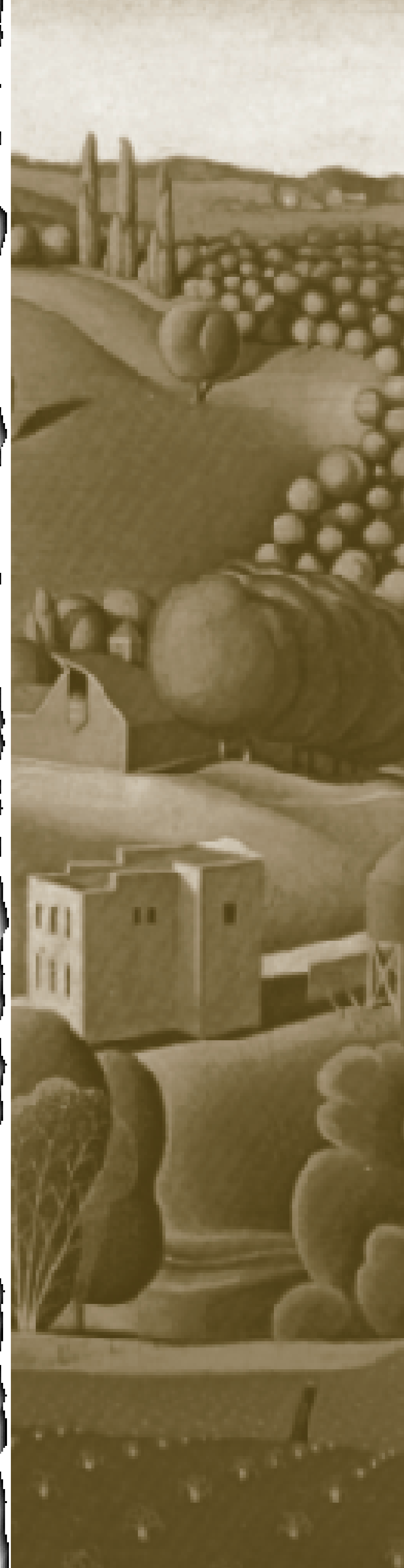
Acknowledgments

Funding for the Iowa Pollution Prevention Initiative (IPPI) was provided by the Environmental Protection Agency and the Small Business Administration as part of the SBDC Multimedia Pollution Prevention Activities.

TABLE OF CONTENTS

Section 1: Introduction

Small Business Development Centers
Iowa Waste Reduction Center



Introduction

Pollution prevention positively affects both the general public and the participating business. Tangible and intangible benefits include environmental protection, resource conservation, material purchase and waste disposal cost savings, and positive public relations. While pollution prevention options are well documented in the media and case studies, implementation at a specific business involves more than simply good intentions. While it is safe to say every business can benefit from pollution prevention, selecting the correct options involves considerable evaluation.

Pollution prevention techniques that work well at one type or size of business may not work well at all businesses. Despite the inherent overall benefits afforded by pollution prevention, barriers to implementation do exist and must be identified to assure success. Barriers to pollution prevention include:

- Limited staff time to properly research and evaluate opportunities
- Quality and availability of necessary data to make accurate evaluations
- Potential influence (positive and negative) on the affected process and/or product quality
- Real or perceived implementation costs
- Opposition to change

Pollution Prevention options should be evaluated in concept for general applicability. Individual options of interest should then be evaluated based on three simple premises:

- Will it reduce waste or prevent pollution?
- Will it work in this particular application (i.e., does an alternative solvent provide adequate cleaning, will personnel use it, etc.)?
- Is there an economic benefit associated with the alternative?

While there are numerous intangible benefits that could be included in this evaluation, for the cost conscience business these criteria essentially dictate the ‘go/no-go’ decision.

Section 2: Painting

Small Business Development Centers
Iowa Waste Reduction Center

PAINTING

COMMONLY OBSERVED PRACTICES

Most metal manufacturing operations involve some type of part or product finishing for rust protection and, in many cases, to offer a product that is aesthetically pleasing. Most commonly, this finish is obtained by coating the product with a petroleum solvent-based, liquid paint. While conventional painting is generally effective in meeting the facility's requirements, it generates significant amounts of hazardous waste and regulated air emissions. Furthermore, conventional spray painting is relatively inefficient in terms of the amount of paint that is actually transferred to the part being finished.

Painting may be the area where pollution prevention efforts are most dramatic and difficult to optimize. Optimal painting involves careful selection of 1) paint/coating products and 2) method of application. Finish quality, drying characteristics, durability and economics must be considered when selecting a coating product. The method of application can be dependent or independent on the type of coating selected and also involves numerous parameters. For example, a liquid coating can be applied with a variety of equipment whereas a powder coat product requires specific application equipment. The selection of a specific coating application method may also affect the type of precleaning required, paint booth design, air permitting requirements for the facility, curing methods and, obviously, costs.

POLLUTION PREVENTION OPTIONS

PAINT TECHNICIAN TRAINING

Regardless of the coating process used, the pollution prevention option that should be implemented first is paint technician training. For coating operations that involve manual spray application, the least expensive way to reduce paint-related emissions, material consumption, and hazardous waste generation is to practice proper spray techniques. Spray technique training can substantially improve transfer efficiency without the purchase of new or special equipment. This pollution prevention option involves adjustment of present equipment to maintain proper settings, painter training to assure proper spray techniques are performed, and a maintenance system to assure maximum equipment efficiency. Optimization of the existing system also creates a baseline from which evaluation of other paint and application processes can be compared.

An operator using proper spray techniques saves the employer money by using less material, covering the piece in fewer strokes, obtaining a higher quality finish with less waste and reducing air emissions. Reduced air emissions saves the employer money by extending the life of paint booth filters. It may also prevent the need to install expensive emission control equipment and reduce compliance requirements under Title V of the Clean Air Act amendments.

Since proper spray technique is such an important tool in pollution prevention, it is recommended that all spray painters undergo formal training. Training should include an explanation of the fundamentals of good technique, what good techniques can accomplish and how the operator can benefit by practicing them.

The basic fundamentals of good spray technique are:

- **Proper Gun Setup**

  Initial gun setup involves using the paint gun manufacturer's suggested air cap/fluid tip combination for the viscosity of the product being sprayed. 'Thicker' product will need a larger orifice. It is also important to adjust the fan pattern so it is compatible with the size and shape of the part being sprayed. This is particularly important for long, thin parts. The longest axis of the spray pattern should be in line with the longest axis of the part being sprayed. Partial trigger application can also reduce waste when painting small parts or edges.

  Air pressure and fluid settings should also be considered. In general, air pressure should be set at the lowest possible setting that allows for adequate atomization. Excessive air pressure can actually cause paint to bounce off the part increasing the amount of overspray. Fluid settings should be as low as possible while maintaining a comfortable gun speed.

- **Spray Distance and Angle**

  The distance between the gun and the part being sprayed should be kept as close as possible to the manufacturer's recommendations at all times. This distance is affected by both the actual distance between the gun tip and the part, and angle of the gun. Gun angle is affected by yaw (wrist moving left or right), pitch (wrist moving up and down) and rotation (wrist moving clockwise or counter clockwise). It is important to keep a locked wrist while painting. A painter's technique can be video taped or observed by a co-worker. If the proper spray distance and/or gun angle are not being maintained, this should be brought to the attention of the painter with instructions for improvement.

- **Lead and Lag Distances and Overlap**

  Lead is the distance between the point where the gun is triggered and the point where the gun pattern hits the part. Lag is the distance between the point where the pattern leaves the part and the point where the gun is untriggered. Both should be kept to a minimum. Each successive paint pass should overlap the previous one by 50%. This will help assure consistent application thickness and minimize paint usage.

Paint/Coating Selection

The first step in choosing alternatives to existing painting practices or setting up new operations involves evaluation and selection of the best paint or coating. Following is a brief description of the advantages and disadvantages of three common paint/coating options that offer significant opportunities for pollution prevention.

- **High Solids Paint**

  High solids paints are solvent-based products with 50% or more solids content. Because of the higher solids content, the desired film thickness can be accomplished with fewer spray applications. Improved abrasion and mar resistance is also expected on the finished part. High solids paints are sensitive to temperature and humidity and may require heating to obtain an acceptable cure time. Part cleanliness also greatly affects the usage of high solids paints.

  Pollution prevention benefits afforded by high solids paints relate mainly to reduced solvent emissions (volatile organic compounds [VOC]); in both the workplace and released to atmosphere through the paint booth exhaust system and during curing. Lower solvent concentration also reduce required air flow rates for curing, thus decreasing makeup air heating costs. Equipment cleaning requirements will be similar to those for conventional, low solids pain

Waterborne Paint

As the name implies, waterborne paint contains water as a solvent, but may also contain 2 to 30% organic solvent. Waterborne paints are sensitive to the cleanliness of the part and can be applied and cured with reduced air flow. Although waterborne paints are compatible with conventional and high volume/low pressure (HVLP) spray gun application equipment, gun modification (i.e. installation of stainless steel or plastic lines, valves, etc.) may be necessary to prevent corrosion.

While VOC's are not totally eliminated, a significant reduction in emissions can be expected. Waterborne paints also reduce or eliminate the need for petroleum-based equipment cleaning solvents. In addition, painting-related wastes such as paint booth exhaust filters and overspray are less likely to be hazardous because of the lower organic solvent content in the paint.

Powder Coatings

Powder coatings are 100% solids in a powder form. Transfer efficiencies can reach 95% to 99% while achieving a durable, corrosion resistance finish. Powder coating is extremely sensitive to part cleanliness making multistage washers a necessary prerequisite to installing this type of system. In addition, powder coating requires specialized application equipment and a heated curing booth.

Powder coatings totally eliminate the generation of VOC's and hazardous equipment cleaning solvents. In addition, overspray and product collected in the paint booth exhaust system can be recovered and reused.

Method of Application Selection

After paint/coating products are evaluated, the best paint or coating application method should be selected. Following is a brief description of the advantages and disadvantages of five common paint/coating application options that afford significant opportunities for pollution prevention.

High-Volume Low-Pressure (HVLP)

HVLP spray guns operate with a high volume of air delivered at 10 psi or less to atomize the paint. This atomization method reduces overspray and, thus, the generation of paint-related wastes. Transfer efficiencies up to 60% are possible with proper training. In addition, less volatile organic compounds (VOC) are released to the work space/atmosphere.

Air-Assisted Airless

Air-assisted airless guns combine conventional atomization with increased (150 to 800 psi) paint fluid pressure. These guns reportedly achieve a paint transfer efficiency of up to 70%. The fluid delivery rate can also be varied based on part size/shape to optimize paint application. Conversion to air-assisted airless guns will likely require painter training and increased maintenance.

- **Electrostatic**

  Electrostatic systems introduce a positive charge to atomized paint at the tip of the spray gun. The part being painted is electrically neutral, causing the charged paint to be attracted to the part. Because of the electrical attraction, electrostatic painting offers a potential transfer efficiency of 68% to 87% with a corresponding reduction in overspray and VOC air emissions. Good edge cover, wraparound, and uniform film thickness are other benefits. Electrostatic painting is more sensitive to the cleanliness of the part than HVLP and convention painting practices. Electrostatic spray guns also tend to be bulky and delicate which may increase maintenance costs.

- **Two Component**

  Two component systems allow mixing of the paint and catalyst at the gun tip. This feature eliminates the need for premixing excess quantities of paint to assure an adequate supply of paint is available and reduces the frequency of equipment cleaning. Both of these factors are directly related to the amount of paint and solvent that is generated as waste. Two component painting systems are compatible with most liquid/catalyst paints and either electrostatic or nonelectrostatic applications. Transfer efficiencies are assumed to be similar to HVLP or electrostatic systems.

- **Powder Coating**

  Due to the nature of powder coating products, special application equipment and curing ovens are necessary. This system offers nearly a 100% transfer efficiency and no solvent usage for clean up.

COSTS/BENEFITS

Selection of a particular paint system (paint and application method) for a specific application depends primarily upon the products to be coated, the coating materials and production requirements. Before selecting a system, a comprehensive economic analysis considering the following items should be performed:

- Cost per volume of the nonvolatile fraction of the paint
- Transfer efficiency versus paint cost
- Relative costs of various coating process equipment
- Energy consumption

Conventional liquid paints are comprised of both volatile and nonvolatile components. When paint is applied to the part, the volatile components evaporate, leaving the nonvolatile components to form the actual finish. In order to evaluate the cost of an applied finish, one must consider: 1) the nonvolatile fraction of the paint versus the product cost and 2) the efficiency of the paint application method (i.e. transfer efficiency).

Cost per Volume of the Nonvolatile Fraction of the Paint

The cost of a paint based on its nonvolatile (solid) fraction can be calculated from product information (generally the product Material Safety Data Sheets [MSDS]). For example, a paint that costs $15.00 per gallon and contains 33% solids actually costs: $15.00 divided by 0.33 or $45.45 per gallon of solids.

If a desired film thickness is known, this cost can be further broken down into a cost per applied surface area using the following equation:

Cost of paint solids per gallon x film thickness in mils x 0.0006233 = paint cost per square foot of applied finish (where 0.0006233 is a unit conversion factor)

Using the paint cost of $45.45 per gallon of solids and a 2 mil (1 mil = 0.001 inch) finished film thickness, the paint cost per square foot of applied finish (assuming a 100% transfer efficiency) would be:

$45.54 x 2 x 0.0006233 = $0.057 per square foot (ideal)

Transfer Efficiency Versus Paint Cost

The above calculation gives the minimum or ideal cost of paint per square foot of applied finish because it assumes that 100% of the paint product adheres to the part being painted. In order to get an actual cost, one must also include transfer efficiency. In most spray painting operations, only a portion of the product reaches the part to be painted. The remainder (overspray) is collected in the paint booth exhaust filters or settles to the floor of the paint area. The amount of paint reaching the product versus the total amount of paint sprayed is referred to as transfer efficiency . A 50% transfer efficiency means half the paint adheres to the product and the other half is wasted. To calculate the actual cost of paint per square foot of applied finish, one must include the estimated transfer efficiency of the paint operation into the above formula as follows:

Ideal paint cost per square foot x 100/TE = Actual paint cost per square foot

where: TE equals transfer efficiency

Using the previous example and a transfer efficiency of 50%, the actual paint cost would be:

$0.057 x 100/50 = $0.114 per square foot (actual)

Relative Costs of Various Coating Process Equipment

Due to the variation of painting requirements present in the broad category of metal manufacturers, providing a realistic cost comparison between one paint application method and another, in a generic form, is nearly impossible. In order to provide some degree of comparative information the following table is offered:

Table 2-1
Painting Alternatives - Cost/Benefit Summary Guide

Method of Application	Capital Cost	Process Complexity	Waste and Emissions	Additional Considerations
Conventional	Low	Low	High	
HVLP	Low	Low	Medium/High	
Air-Assisted Airless	Low	Low	Medium/High	
Electrostatic	Medium	Medium	Medium	Only metal parts may be painted
Two Component	Medium	Medium	Medium	
Powder Coat	High	High	Low	Extensive parts washing and a curing oven are required

Energy Consumption

Energy consumption should also be a consideration when selecting a paint and application method. Energy consuming operations include pretreatment (i.e. part washing), ventilation and make-up air/heat for curing. All three of these factors are directly related to the type of paint and application method selected. For initial comparative purposes, powder coating and water-borne paints may have higher energy requirements due to increased curing demands.

Section 3: Painting Equipment Cleaning

Small Business Development Centers
Iowa Waste Reduction Center

Painting Equipment Cleaning

COMMONLY OBSERVED PRACTICES

All coating practices require some type of equipment cleaning. For spray painting, the most common coating operation, spray guns and accessories must be cleaned between color changes, when orifices clog and, often, at shift changes. Paint guns are generally cleaned using a solvent that is compatible with the product sprayed (i.e., paint thinner). These types of solvents are relatively expensive to purchase and dispose of, and are hazardous to the environment and employee health if handled improperly.

External equipment surfaces are generally cleaned by soaking, wiping or flushing with solvent. If this process is done in an open container, a significant quantity of solvent is lost to evaporation. Internal parts and passageways are commonly cleaned by flushing solvent through the gun and orifice. This practice also results in significant evaporation and loss of usable product.

POLLUTION PREVENTION OPTIONS

The amount of solvent used and generated as a waste because of painting equipment cleaning can be dramatically reduced through simple techniques and the use of specialized equipment. Following is a summary of the most common and effective pollution prevention options.

Settling and Reuse

Waste gun wash solvent/paint mixtures will partially separate in quiescent situations. The solvent rising to the top of a storage container should be of adequate quality to use for initial gun cleaning. A small quantity of new or distilled solvent can then be used for a final rinse. Used solvent can be placed back into the storage container for subsequent settling and reuse. Eventually, sludge will comprise the majority of the container and off-site hazardous waste disposal will be necessary. At this point, the processes can be repeated using a different container. Solvent waste reduction of up to 33% can be accomplished with this simple method. (Note: Facilities classified as Large Quantity Generators (LQG) and Small Quantity Generators (SQG) have maximum hazardous waste storage time limits. Use of this option should consider these regulatory factors).

Automatic Gun Washers

An automatic gun washer operates like a dishwasher. The paint gun is partially disassembled and placed in the unit. Cleaning is accomplished by recirculating solvent sprays. These units reportedly reduce solvent waste by 50 to 75%. VOC emissions can be reduced by up to 20% and a 60% labor time savings can be achieved.

Units range in cost from $600 for small units (gun wash only) to approximately $1500 for industrial type units (gun and paint hose wash). Example gun washer equipment literature is enclosed as Appendix A. Similar units may also be leased through various chemical suppliers and waste management companies at a cost of $165 to $195 per five-gallon waste solvent change out interval.

On-site Distillation

On-site distillation and reuse of gun wash solvents is a common pollution prevention and material conservation practice utilized in numerous manufacturing facilities and automobile body repair shops. Waste solvent is collected and processed through the distillation equipment. Approximately 80% of the used solvent is recovered with basically the same cleaning properties as new product.

The remaining 20% sludge (still bottoms) must be collected for off-site hazardous waste disposal.

To help maintain the cleaning properties of the recycled thinner, certain paint/solvent wastes should be segregated. Waste gun wash solvent and any waste lacquer paint/thinner mixtures may be included for recycling. All waste urethanes, enamels and enamel reducers should be placed in a separate container. Enamel and urethane products will not clean as well as pure lacquer thinner. By segregating the two, the reclaimed solvent will possess cleaning properties like a virgin thinner. This waste management technique has the advantage of reducing the volume of virgin thinner required as well as the amount of waste thinner generated.

On-site distillation equipment comes in a wide range of capacities; 5 gallons per 8 hour shift batch operation to more than 100 gallon per hour flow-through units. Costs for 5 gallon batch units start at approximately $1500 with an average cost of $3000.

COSTS/BENEFITS

Figure 3-1 can be used to calculate the costs/benefits provided by the above pollution prevention options. A company should enter its own data and perform the corresponding calculations. An example situation is included to assist in the calculations.

Figure 3-1
Painting Equipment Cleaning Alternatives
Cost/Benefit Estimate Worksheet

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
	EXISTING CONDITIONS (12 MONTH)		
A	Gallons of gun wash solvent purchased per year	400	
B	Solvent purchase cost per gallon	$7.80	
C	Gallons of gun wash solvent disposed of per year	330	
D	Solvent disposal cost per gallon	$2.45	
E	Annual cost (A x B) + (C x D)	$3,930.00	
	SETTLING AND REUSE		
F	Reduction in waste generation and solvent purchase	33%	
G	Annual cost savings = E x F/100	$1,297.00	
	AUTOMATIC GUN WASHER		
H	Reduction in waste generation and solvent purchase	62.5%	
I	Annual cost savings = E x H/100	$2,456.00	
	Capital cost	$1,500.00	
	ON-SITE DISTILLATION		
J	Reduction in waste generation and solvent purchase	80%	
K	Annual cost savings = E x J/100	$3,144.00	
	Capital cost	$3,000.00	

Figure 3-2 Example Calculation Cost Comparison			
POLLUTION PREVENTION OPTION	ANNUAL COST SAVINGS	CAPITAL COST	PAY BACK (YEARS)
Settling and Reuse	$1,297.00	$0	Immediate
Automatic Gun Washer	$2,456.00	$1,500.00	0.61
On-site Distillation	$3,144.00	$3,000.00	0.95

As shown in Figure 3-2, all three options achieve long term cost savings with equipment payback at less than one year.

Section 4: Parts Washing

Small Business Development Centers
Iowa Waste Reduction Center

PARTS WASHING

COMMONLY OBSERVED PRACTICES

Most metal manufacturing facilities use one or more parts wash basins containing petroleum-based solvents. The frequency the basins are used and the quantity of waste associated with their usage varies greatly from facility to facility. Facilities that use these basins to clean production parts generate significant amounts of parts wash solvent waste while facilities that use them primarily for maintenance related activities generate much smaller quantities.

Parts wash basins are generally serviced on a set time schedule. Servicing is done by facility employees or, most commonly, through a contract with a service provider.

POLLUTION PREVENTION OPTIONS

Many options exist to reduce the toxicity and/or volume of waste generated from parts washing activities. These options range from simple administrative controls to modest process changes.

ADMINISTRATIVE CONTROLS

The first and most easily implemented pollution prevention option involves careful evaluation of existing parts washing solvent quality and scheduled maintenance. Parts washer service intervals are often based on the service company's best estimates, which may be overly conservative; or based on conditions that have changed over time. Basing parts washer service intervals on solvent quality rather than set time schedules is particularly beneficial for facilities that experience seasonal fluctuations in production and/or maintenance activities.

There are no set procedures to establish optimum service intervals. The best method is to rely on the experience of personnel that use the solvent on a daily basis. If two units are used at a facility, dedicate one unit for preliminary cleaning. If additional, higher quality cleaning is desired, the second unit can be used after the preliminary wash. When the operator feels the solvent quality in the preliminary unit is no longer adequate, the second unit can be brought into preliminary use and the dirty unit serviced for reuse as the final wash. By evaluating solvent quality, alternating parts washer servicing between a preliminary and secondary unit, and by servicing the units only when solvent quality dictates, waste solvent generation can be significantly reduced.

If solvent equipment leasing and service companies will not agree to the "as-needed" servicing arrangement, parts wash basins may be purchased and managed in-house. Waste parts wash solvent can be recycled by most hazardous waste management companies. Common parts washer basins cost approximately $600. Common petroleum solvents, in 55-gallon drum quantities, can be purchased at a cost of $2.40 per gallon. Waste solvent recycling services run approximately $2.45 per gallon.

HYBRID PETROLEUM SOLVENT PARTS WASHER UNITS

A second method to reduce petroleum based parts washer solvent waste generation involves the use of 'hybrid' units. These units are equipped with devices that purify the circulating solvent to significantly increase its service life. Benefits associated with the use of hybrid units include:

- Reduced hazardous waste generation and off-site transportation liabilities. This reduced hazardous waste generation may place the facility in a less restrictive regulatory category (i.e. from a SQG to a CESQG).

- Due to continual solvent purification, a consistently cleaner solvent is available.
- One hybrid unit may replace two or more conventional units.

The following purification methods have been identified:

Distillation

Distillation units look like conventional recirculating parts wash basins but are equipped with a small distillation unit. Solvent is continually distilled and returned to the basin. Oil, grease and other impurities are collected as ‘still bottoms’ for subsequent disposal. These units reportedly reduce hazardous waste generation by 90%. The estimated cost for lease and service of a distillation unit is $1200 annually. Example vendor literature for this type of unit is enclosed as Appendix B.

Centrifugal Filtration

Centrifugal filtration units use centrifugal force to separate oil, grease and other impurities from the solvent. The impurities are collected in the unit and removed periodically for disposal. One supplier of this type of equipment indicated a 50% reduction in waste solvent can be obtained as compared to conventional parts washers. The annual service charge for a centrifugal filtration unit was quoted at $798. Example vendor literature for this type of unit is enclosed as Appendix C.

Conventional Filtration

Conventional filtration units have a filter (or set of filters) installed in the solvent circulation piping to remove solvent impurities. Periodic replacement and disposal of the filters are necessary.

Performance data for conventional filtration type units, as provided by the equipment suppliers, are summarized below:

- ✓ Typical solvent life increased from 3 to 10 times (average 6 times).
- ✓ Filter cartridge replacement every 4 to 8 weeks (average 6 weeks).
- ✓ Retail price for the parts washing unit is approximately $700.
- ✓ Replacement filters are $10 each.
- ✓ Solvent purchase cost is approximately $2.40 per gallon.
- ✓ Waste solvent disposal would run $2.45 per gallon.
- ✓ An additional cost for filtration type units would be one-time Toxicity Leaching Characteristic Procedure (TCLP) testing of the waste filters. A $400 laboratory fee should be included in this option’s cost calculation. If testing indicates the filters are hazardous, a relatively small hazardous waste disposal fee (i.e. approximately $2 per filter) should be included in the calculation. If nonhazardous, solid waste landfill costs would be insignificant.

Example vendor literature for these types of units is enclosed as Appendix D.

Biodegradation

These units use a ‘nonhazardous’ solvent that reportedly never requires disposal. Oil and grease accumulating in the unit are degraded by bacteria contained in a replaceable filter. Additional information, from the only identified supplier of this type of unit, is enclosed as Appendix E. An equipment spokesperson provided the following data:

- ✓ A unit cost of $1400
- ✓ Monthly replacement of the $10 bacteria/filter

- ✓ Addition of approximately 5 gallons of solvent every 2 months ($60/five gallons) to make up for evaporation and carry-out.
- ✓ This option would also require the one time TCLP testing ($400) prior to disposal of the waste filters.

Alternative Solvents

D-Limonene

While mineral spirits is a relatively nontoxic solvent, it generally must be managed as a hazardous waste because of ignitability and possibly toxicity if it picks up toxic contaminants from the items being cleaned. Alternative solvents are available that may provide comparable cleaning while generating a nonhazardous waste that will be less costly to dispose of. Two general types of alternatives exist. The first is a citric product (D-limonene) that may be used as a replacement in existing parts washer basins. Common D-limonene solvent blends have flashpoints higher than 140°F so they will not be hazardous because of ignitability (TCLP testing is advised to determine if it is hazardous from toxic metal or organic compound contamination). Nonhazardous, waste D-limonene may be recycled in conjunction with used oil if prior approval from the oil recycler is obtained.

D-limonene can be purchased from most local chemical suppliers at a cost ranging from $15 to $20 per gallon in 55-gallon quantities. As with other alternatives, an initial $400 laboratory cost to characterize the waste as hazardous or nonhazardous should be included in the cost/benefit analysis.

Aqueous Cleaners

Other alternative solvents include aqueous products; specifically neutral and alkaline detergents. These products should be formulated with sequestering agents, surfactants and rust inhibiting additives. Aqueous cleaners work best in pressure spray applications. This requires use of alternative parts washing equipment. Aqueous parts washers resemble dishwashers. Parts are placed in the unit where they are rotated and sprayed with the cleaner. The cleaner is generally heated to facilitate cleaning and reduce drying time. These units cost $3,000 to $4,000. Concentrated aqueous cleaning solution costs approximately $5.50 per gallon in 55-gallon quantities. Example aqueous equipment and solvent vendor information is enclosed as Appendix F.

Facilities plumbed to sanitary sewer systems may be able to discharge aqueous parts washer wastewater to the sewer with prior notification and approval from the city wastewater treatment plant superintendent or city engineer. This method of disposal virtually eliminates off-site waste disposal costs.

Aqueous parts washer wastewater may not be discharged to septic systems or aboveground discharge sources because of regulatory restrictions and potential environmental liabilities. As a result, facilities not located on city sanitary sewer systems must either 1) eliminate this option as an alternative or 2) implement on-site wastewater recycling. On-site wastewater recyclers, designed for this specific application, are available (Appendix F) for approximately $8,000. The recyclers are mobile and can be used to service multiple units. Recycling units will generate a small amount of sludge that will require TCLP testing (an additional $400 cost) and solid/hazardous waste disposal.

COSTS/BENEFITS

The following formulas can be used to calculate the costs/benefits provided by the above pollution prevention options. A company should enter its own data and perform the corresponding calculations.

Existing Conditions

Most manufacturing facilities lease conventional parts washers from a service company. A common monthly lease/service fee for a 30-gallon capacity unit is $100 per month. While the unit has a capacity of 30 gallons, carry-out and evaporation result in the generation of only 15 gallons of waste at the end of the month long service period. This equals an annual solvent usage of 360 gallons and an annual solvent disposal volume of 180 gallons.

Figure 4-1
Parts Washing Alternatives
Cost/Benefit Worksheet
Existing Conditions

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Gallons of parts wash solvent used per year	360	
B	Gallons of parts wash solvent generated as waste per year	180	
C	Parts washer monthly service charge	$100.00	
D	Annual cost = C x 12	$1,200.00	

Hybrid Petroleum Solvent Parts Washer Units

Distillation

The lease/service costs for distillation parts washer equipment is also around $100 per month, however a significant reduction in the amount of solvent used and generated as waste is expected when compared to the existing conditions.

Figure 4-2
Parts Washing Alternatives
Cost/Benefit Worksheet
Distillation Parts Washer

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Gallons of parts wash solvent used per year	180	
B	Gallons of parts wash solvent generated as waste per year	18	
C	Parts washer monthly service charge	$100.00	
D	Annual cost = C x 12	$1,200.00	

Centrifugal Filtration

The lease/service costs for centrifugal filtration parts washer equipment is approximately $266 per four month service interval. Again material usage and waste generation is less tha the existing conditions.

Figure 4-3
Parts Washing Alternatives
Cost/Benefit Worksheet
Centrifugal Filtration Parts Washer

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Gallons of parts wash solvent used per year	225	
B	Gallons of parts wash solvent generated as waste per year	90	
C	Parts washer monthly service charge per 4 month interval	$266.00	
D	Annual cost = C x 3	$798.00	

Conventional Filtration

Figure 4-4
Parts Washing Alternatives
Cost/Benefit Worksheet
Conventional Filtration Parts Washer

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Unit Cost	$700.00	
B	Waste Filter Testing	$400.00	
C	Gallons of parts wash solvent used per year	195	
D	Solvent purchase cost per gallon	$2.40	
E	Gallons of parts wash solvent generated as waste per year	36	
F	Solvent disposal cost per gallon	$2.45	
G	Filter purchase and disposal cost per year	$100.00	
	Annual cost = (C x D) + (E x F) + G	$656.00	
	Capital cost = A + B	$1,100.00	

Biodegradation

Figure 4-5
Parts Washing Alternatives
Cost/Benefit Worksheet
Biodegradation Parts Washer

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Unit Cost	$1,400.00	
B	Waste Testing	$400.00	
C	Gallons of parts wash solvent used per year	40	
D	Solvent purchase cost per gallon	$12.00	
E	Filter purchase and disposal cost per year	$144.00	
	Annual cost = (C x D) + E	$624.00	
	Capital cost = A + B	$1,800.00	

Alternative Solvents

D-limonene

Figure 4-6
Parts Washing Alternatives
Cost/Benefit Worksheet
Alternative Solvents - D-Limonene

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Unit Cost	$600.00	
B	Waste Testing	$400.00	
C	Gallons of parts wash solvent used per year	80	
D	Solvent purchase cost per gallon	$17.50	
E	Gallons of parts wash solvent generated as waste per year	40	
F	Solvent disposal cost per gallon	$0	
	Annual cost = C x D	$1,400.00	
	Capital cost = A + B	$1,000.00	

Aqueous Cleaners

Figure 4-7 Parts Washing Alternatives Cost/Benefit Worksheet Alternative Solvents - Aqueous Cleaner			
ITEM	**VARIABLE**	**EXAMPLE**	**YOUR FACILITY**
A	Unit Cost	$3,500.00	
B	Waste Testing	$400.00	
C	Gallons of parts wash solvent used per year (Concentrate)	55	
D	Cleaner purchase cost per gallon	$5.50	
E F	Gallons of parts wash solvent generated as waste per year (Diluted)	275	
	Solvent disposal cost per gallon	$0	
	Annual cost = C x D	$300.00	
	Capital cost = A + B	$3,900.00	

Figure 4-8 shows a summary of the cost comparisons listed above as compared to existing practices.

Figure 4-8
Cost Comparison - Parts Washing Alternatives

Option	First Year Cost	Subsequent Annual Cost	Payback	Subsequent Annual Savings (Loss)	Estimated Hazardous Waste Reduction
Existing Conditions	$1,200.00	$1,200.00	-	-	-
Distillation	$1,200.00	$1,200.00	0	0	90%
Centrifugal Filtration	$798.00	$798.00	0	$402.00	50%
Conventional Filtration	$1756.00	$656.00	1 year	$544.00	80%
Biodegradation	$2,424.00	$624.00	2 years	$576.00	100%
D-limonene Solvent	$2,400.00	$1,400.00	NA	($200)	100%
Aqueous Cleaner	$4,200.00	$300.00	3 years	$900.00	95%

As can be seen from Figure 4-8, numerous cost effective pollution prevention options are possible based on these example situations. The greatest annual cost savings is obtained using aqueous parts washing methods if one is willing to assume the 3-year payback requirement to recoup the initial purchase and laboratory analysis costs. With the exception of the D-limonene, all other options achieve net annual cost savings with initial purchase cost paybacks of 2 years or less. D-limonene may become economically attractive as well if future product costs decrease.

It is important to note that hybrid (purification) units maintain a consistently cleaner solvent due to continual purification. As a result, one of these units may be able to replace two or more conventional units. If one alternative unit can replace two conventional units, then the cost/benefit for that unit increases twofold.

One should also be cognizant of the hazardous waste reduction potentials of these options. Although pollution prevention benefits were not included in the above calculations, they are nonetheless important and should be considered when making any process change.

Section 5: Cutting Fluids

Small Business Development Centers
Iowa Waste Reduction Center

Cutting Fluids

COMMONLY OBSERVED PRACTICES

The two most common cutting fluids used in the metal manufacturing industry can be broadly categorized as straight or petroleum oils and water-miscible fluids. Water-miscible fluids, including soluble oils, synthetics and semisynthetics, are now used in approximately 80 to 90 percent of all applications. Although cutting, or straight oils, are less popular than they were in the past, they are still the fluid of choice for certain metalworking applications.

Cutting fluid management practices and fluid life vary considerably from facility to facility. In most cases, machine coolant is added to machines in the recommended concentrations but is maintained minimally after this point. The most common reason given for additional coolant attention was odor (rancidity). The response to rancidity was generally the addition of a bactieriacide or dumping and replenishing the coolant with new product. This is a reactive approach that treats symptoms rather than the cause. Premature coolant failure jeopardizes the life of the tool, the quality of the part, and increases raw product usage and waste disposal costs.

Cutting fluids play a significant role in machining operations and impact shop productivity, tool life and quality of work. With time and use, fluid quality degrades and eventually requires disposal once efficiency is lost. Waste management and disposal have become increasingly more complex and expensive. Environmental liability is also a major concern with waste disposal. Many companies are now paying for environmental cleanups or have been fined by regulatory agencies as the result of poor waste disposal practices.

POLLUTION PREVENTION OPTIONS

Fortunately, significant potential exists to extend cutting fluid life through proper fluid selection, maintenance and recycling. A discussion of these topics is presented below.

Product Selection

Choosing the right metalworking fluid can be confusing and time consuming. To select the best fluid for a particular application, advantages and disadvantages of metalworking fluid products should be compared through review of product literature, supplier information, and usage history. Product performance information shared by other facilities is another means of narrowing choices. Ultimately, the best indicator of fluid performance is through actual use in your machining operations.

The following factors should be considered when selecting a fluid:

- Cost and life expectancy;
- Fluid compatibility with work materials and machine components;
- Speed, feed and depth of the cutting operation;
- Type, hardness and microstructure of the metal being machined;
- Ease of fluid maintenance and quality control;
- Ability to separate fluid from the work and cuttings;
- The product's applicable temperature operating range;
- Optimal concentration and pH ranges;
- Storage practices; and
- Ease of fluid recycling or disposal.

One thing that must be remembered when choosing fluids - you generally get what you pay for. Don't choose a fluid just on its initial cost but on the cost per gallon divided by its life expectancy. Although purchase of a premium product is initially more expensive, the long-term cost of the fluid will likely be lower than products of inferior quality.

With significant improvements in fluid formulations, today's fluids are capable of handling a wider variety of machining applications. Machine shops that once required several types of fluids may now find that one or two fluid types meet all needs. Minimizing the number of fluids used in the shop simplifies fluid management. The benefits of a fluid's versatility should be weighed against its performance in a particular metalworking application.

Fluids vary in their suitability for metalworking operations. For example, petroleum based cutting oils are frequently used for drilling and tapping operations because of their excellent lubricity while water-miscible fluids provide the cooling properties required for most turning and grinding operations. Each type of metalworking fluid category, their advantages and disadvantages, and their applications are summarized in the following table.

Cutting Fluid Types - Advantages vs. Disadvantages

STRAIGHT OILS		
	Advantages	**Excellent lubricity; good rust protection; good sump life; easy maintenance; rancid resistant**
	Disadvantages	**Poor heat dissipation; increased risk of fire, smoking and misting; oily film on workpiece; limited to low-speed, severe cutting operations**
SOLUBLE OILS		
	Advantages	**Good lubrication; improved cooling capabilities; good rust protection; general purpose product for light to heavy duty operations**
	Disadvantages	**More susceptible to rust problems, bacterial growth, tramp oil contamination and evaporation losses; increased maintenance costs; may form precipitates on machine; misting; oily film on workpiece**
SYNTHETICS		
	Advantages	**Excellent microbial control and resistance to rancidity; nontoxic; transparent; nonflammable/nonsmoking; good corrosion control; superior cooling qualities; reduced misting/foaming; easily separated from workpiece/chips; good settling/cleaning properties; easy maintenance; long service life; used for a wide range of machining applications**
	Disadvantages	**Reduced lubrication; may cause misting, foaming and dermatitis; may emulsify tramp oil, may form residues; easily contaminated by other machine fluids**
SEMISYNTHETICS		
	Advantages	**Good microbial control and resistance to rancidity; nontoxic; nonflammable/nonsmoking; good corrosion control; good cooling and lubrication; reduced misting/foaming; easily separated from workpiece/chips; good settling/cleaning properties; easy maintenance; long service life; used for a wide range of machining applications**
	Disadvantages	**Water hardness affects stability; may cause misting, foaming and dermatitis; may emulsify tramp oil; may form residues; easily contaminated by other machine fluids**

Fluid Management

Effective programs can keep metalworking fluid as clean as the initial raw product, significantly prolonging its service life. Components of a successful fluid management program include recordkeeping, fluid monitoring and maintenance.

Record Keeping

Record keeping is an important aspect of fluid management which begins with the initial preparation of the fluid. Following its preparation, the pH and concentration of the fluid should be measured and recorded. These initial readings should correspond to the acceptable product quality ranges provided by the fluid supplier. They also provide a baseline from which to evaluate the condition of the fluid over time. Concentration and pH measurements for used fluid are compared to “new fluid” values to assess fluid quality.

A detailed log book documenting fluid usage information should be maintained. Fluid management logs for each machine should include the following information:

- Brief description of the machine and sump/reservoir capacities
- Type of fluid used
- Fluid mixing ratios and initial parameter readings
- Water quality data
- Monitoring data including pH readings, biological monitoring data, fluid concentration measurements and inspection observations
- Adjustments made as part of fluid maintenance
- Fluid recycling and/or disposal frequencies including dates of coolant change out and reason for change out
- Equipment cleaning and maintenance activities, dates and comments
- Quantity of coolant added (both change out and periodic additions)
- Documentation of problems that occur.
- General comments

Fluid usage information should be compiled for the entire facility. This allows tracking the quantity of fluid purchased, recycled and disposed on a yearly basis. It also provides a check on the efficiency of the management program and identifies areas of the program that can be improved.

Fluid Monitoring

Monitoring and maintaining fluid quality are the basic components of fluid management. A fluid must be monitored to anticipate problems. Important aspects of fluid monitoring include system inspections and periodic measurements of fluid parameters such as concentration, biological growth, and pH. Changes from optimal fluid quality must be corrected with appropriate adjustments (such as fluid concentration adjustments, biocide addition, tramp oil and metal cuttings removal, and pH adjustment). It is important to know what changes may take place in your system and why they occur. This allows corrective action measures to bring fluid quality back on-line and prevent fluid quality problems from recurring.

Fluid Preparation

Proper fluid preparation is an important step to extend fluid life, achieve the best fluid performance and use fluid concentrate efficiently. Problems associated with high or low fluid concentrations are avoided. Coolant mixtures should be prepared according to manufacturer’s directions (as obtained through your fluid supplier and/or product information sheets). Specifications regarding the recommended diluent water quality, concentrate to water dilution ratio, and additive requirements should be used. Information on the product's life expectancy and acceptable operating ranges for parameters such as pH, concentration, and contaminant levels should also be available. These ranges provide future benchmarks for coolant adjustment or recycling.

Water Quality

Since soluble fluids may consist of up to 99% water, the quality of the water used to dilute fluid concentrate is an important consideration in fluid preparation. Dissolved minerals and gases, organic matter, microorganisms or combinations of these impurities can lead to problems. The following water quality characteristics should be monitored to achieve the best fluid performance and extend fluid life.

Hardness

Hardness, a measure of the dissolved calcium, magnesium and iron salts in water, has a significant affect on metalworking fluid performance. "Soft" water generally refers to water with a hardness ranging from 0-100 parts-per-million (ppm) while "hard" water contains concentrations of 200 ppm or more. For metalworking fluids, the ideal hardness for makeup water is generally 80-125 ppm. Foaming may become a problem when concentrate is mixed with water with a hardness below this range, particularly in systems where the fluid is subjected to excessive agitation. A hardness above this range may cause dissolved minerals to react with fluid additives, lowering fluid performance. "Hard" water minerals combine with emulsifiers contained in synthetic or semisynthetic concentrates to form scum deposits on sumps, pipes, filters and even the machine. Hard water can also cause the oil to separate out of suspension.

Dissolved Solids

Hardness is not the only water quality parameter of concern. The total dissolved solid (TDS) concentration in water is an important factor in fluid management. Sulfates promote bacterial growth that cause fluids to become rancid. In many areas, drinking water may have sulfate concentrations of 50 to 100 ppm. Chloride salts and sulfates at concentrations above 80 ppm contribute to corrosion. Chloride levels are generally less than 10 ppm in untreated water but are greatly increased by common water softening. Phosphate concentrations above 30 ppm also react with the fluid to stimulate bacterial growth, irritate the skin and cause rancidity.

During normal fluid use, water evaporation increases the concentration of the working fluid. As new water is introduced to replenish system evaporation losses, additional dissolved minerals may also be added. Consequently, the TDS concentration of a fluid builds up over time. The greater the TDS concentration of the make-up water, the faster these concentrations increase in the working fluid.

In order to maintain the proper fluid chemistry, untreated water with an acceptable mineral content should be used for initial fluid makeup. When replenishing evaporation losses, machine operators should add pre-mixed fluid, not just water, to the system. Demineralized or deionized water should be used for the mix to prevent TDS levels from building up in the fluid. Adding fresh fluid to the system ensures that needed additives such as rust inhibitors and emulsifiers are maintained at desired concentrations.

If fluid life is a problem, it is important to have a water analysis completed. Shops served by a public water supply may contact their local water supplier to obtain the needed data. The fluid manufacturer may recommend some form of water treatment based on the water analysis such as deionized water from an in-line tank, or a reverse-osmosis unit. These types of water purification equipment extract ions. Deionizers produce the purest of waters. Distillation units may also be an option.

In some cases, a water softening unit may be added before the water purification system to reduce water hardness. Although water softeners can be used to obtain the correct water hardness, they are not capable of removing the minerals that contribute to metal corrosion and/or salt deposits. A common home-type water softener is not considered adequate for fluid preparation or fluid make-up water treatment.

Fluid Concentration

Monitoring and maintaining proper fluid concentration is essential in assuring product quality, maximizing tool life, and controlling microbial growth rates. High fluid concentrations may result in increased fluid cost through wasted concentrate, reduced heat dissipation, foaming, reduced lubrication and residue formation. Highly concentrated fluid may also stain the workpiece and/or machine tool and increase the toxicity of the fluid, particularly if the fluid becomes super concentrated from water evaporation. This results in increased skin irritation and an undesirable work environment for the machine operator. Dilute concentrations may result in poor lubricity, shorter tool life, increased biological activity, and an increased risk of rust formation on newly machined surfaces.

Evaporation can lead to a 3 to 10 percent water loss from the fluid per day. Water and concentrate are both lost as a result of splashing, misting and dragout. A total daily fluid loss of 5 to 20 percent may occur from the combination of these processes. As a result of these processes, coolant concentration will normally vary. The concentration of metalworking fluid must be monitored regularly to determine if the fluid is too dilute or too rich. Monitoring provides data for calculating the amount of concentrate and water needed to replenish the system and keep the fluid at its recommended operating concentration. Best monitoring frequencies range from daily monitoring for small sumps or stand-alone machines to weekly monitoring for larger systems. These monitoring frequencies are site specific, however, and are best determined through experience.

Fluid concentration may also be controlled through the installation of closed loop and open loop cooling units on machine sumps or central reservoirs. These cooling units reduce evaporation losses by regulating fluid temperature. This helps tighten tolerances, extend tool life by inhibiting microbial activity and increase the fluid's ability to remove heat from the tool/workpiece interface.

Fluid concentration is measured using a refractometer or by chemical titration. Refractometers are inexpensive tools ($200 to $250) capable of measuring fluid concentration. A refractometer is a portable, hand held optical device that reads a fluid's index of refraction. "Index of refraction" is a measurement of how much light is bent as it passes through a liquid. A fluid's index of refraction changes with the density and chemical composition of the fluid. Refractometer readings for a cutting fluid correspond to its concentration (the higher the reading, the greater the fluid concentration). By measuring a cutting fluid's index of refraction, the optimum fluid concentration can be maintained. Refractometers are typically available though coolant suppliers and provide fast, reliable results. Tramp oils, cleaners, hydraulic fluids and other contaminants reduce their accuracy.

Refractometer methods are fast but are less accurate when the fluid is contaminated with tramp oils. To overcome this problem, vendors of fluids have developed titration kits to determine fluid concentration. The titration measures a specific chemical or group of chemicals and is less affected by interferences from tramp oil or water quality. While titration is more accurate than refractometer readings, the procedure varies by coolant, and excess contaminants can affect accuracy.

The titration is done by taking a measured volume of fluid, adding an indicator, and then adding the titrant drop by drop until a color change is noted. The coolant concentration is determined from the number of drops of titrant added.

Microbial Contamination

Microbial contamination is a major cause of fluid spoilage. All water-miscible fluids are susceptible to microbial deterioration that can significantly reduce fluid life. Fluid manufacturers are constantly developing formulations that are more resistant to microbial degradation. This is accomplished by using high quality ingredients and incorporating biocides in the product.

Tramp oil and other contaminants are food for microorganisms and can make a sump an ideal breeding ground for bacteria. Bacteria populations can double as frequently as every 30 minutes. If allowed to multiply, microorganisms will ruin a fluid, causing odor problems and degrading performance. Successful bacterial control is a must.

Bacteria feed on a variety of substances contained in the fluid including the concentrate, tramp oils (including lubricants and hydraulic oils leaked by machinery), minerals in the water and other contaminants. The greater the bacterial growth rate, the faster the fluid becomes rancid. As bacteria multiply, they produce acids which lower the pH of the fluid, causing increased corrosion and reduced lubricity. The acid produced by the bacteria may also dissolve metal chips and fines, possibly causing the material to meet the definition of a hazardous waste. Bacteria may also darken the fluid significantly, resulting in stained parts.

Most bacteria that cause fluid to become rancid are aerobic. That is, they need oxygen rich environments. Bacteria may also be anaerobic (bacteria which grow in oxygen-poor environments). Anaerobic bacteria grow in systems that are inactive for long periods. Inactivity allows tramp oil to rise to the top of the sump, creating an effective barrier to atmospheric oxygen. Consequently, oxygen in the sump becomes low, aerobic bacteria die and anaerobic bacteria begin to increase. Anaerobic bacteria generate hydrogen sulfide, which produces the rotten-egg odor affectionately referred to as “Monday Morning Stink.”

Two common tests for microbial monitoring include plate counts and dip slide tests. Plate counts involve growing a culture using a sample of the fluid. Microorganism colonies that grow on the sample are later counted and identified. Like plate counts, dipslide tests also involve growing cultures using a sample of the fluid. Dipslides provide a more simple, rapid screening method since cultures are grown overnight and a visual approximation is used to assess microbial contamination. When rancidity is a problem, microbial-growth dip slide monitoring provides a chance to add biocide before problems arise. Reliable microbial-growth dip slides are available from fluid suppliers and laboratory-supply houses. Tests cost less than ten dollars each and are useful in setting up biocide-addition programs.

Weekly or biweekly monitoring is typically recommended for detection of microbial contamination, especially during the early stages of developing a fluid management program. With experience, a less frequent monitoring schedule may be suitable.

Biological growth is controlled by a combination of practices. These include water quality control, routine maintenance, biocides and aeration. Many coolant concentrates contain biocides and pH buffers. Therefore, maintaining proper fluid concentration helps control microorganisms.

Microbial contamination is significantly accelerated by poor housekeeping practices. The best method for controlling biological growth is through routine cleaning of machines, coolant lines and sumps/reservoirs. Machines, exhaust blowers, and hydraulic seals should also be maintained to prevent oil leaks from contaminating the fluid.

Accumulations of chips and fines in a sump also promote bacterial and fungal growth. These particulates increase the available surface area for microbial attachment and prevent biocides from effectively reaching the fluid trapped in these fines. Particulates in the bottom of a sump become septic or rancid if not periodically removed.

Even if the majority of the fluid is free of bacteria, the sludge in the bottom will continue to harbor bacteria and create a septic condition. This can dissolve metals, possibly increasing the toxicity of the fluid to a level at which disposal through a local wastewater plant is no longer permitted.

The addition of biocides inhibits biological degradation of the fluid by controlling bacteria and fungi. Relying strictly on biocides for microbial control is discouraged since these chemicals are expensive and can create hazards for the operator’s skin.

Due to the variety of bacteria which may be present in a fluid, use of a single biocide may control certain bacterial species while allowing others to proliferate. Random use of various types of biocides may prove to be more effective. Less frequent doses with higher concentrations of biocide are also more effective than low-level, frequent doses.

Selection of an effective biocide should be based on laboratory tests and actual “real life” performance. Biocides that reduce microorganisms present in the fluid and do not interfere with fluid performance should be selected.

Aeration can be used in conjunction with biocide additives to control anaerobic microbial growth in systems during periods of inactivity. Aeration oxygenates the fluid producing an atmosphere hostile to the odor producing anaerobic bacteria. A small pump can bubble air into machine sumps either continuously or periodically to agitate stagnant areas within the sump.

pH is the measurement of hydrogen ion concentration. A pH of 7 is considered neutral. Higher pH values represent alkaline solutions while pH values below 7 represent acidic solutions. Ideally, the pH for water-miscible metalworking fluids should be kept in the limited range of 8.6 to 9.0. This slightly alkaline range optimizes the cleaning ability of the fluid while preventing corrosion, minimizing the potential for operator dermatitis and controlling biological growth. If the pH of fluid in a sump drops below 8.5, the coolant loses efficiency, can attack ferrous metals (rusting), and biological activity will significantly increase. A pH greater than 9.0 may also cause metal corrosion.

Regular monitoring of a fluid’s pH is a simple means of anticipating problems. Coolant pH should be measured and recorded daily after the machine is placed in operation. Steady pH readings give an indication of consistent fluid quality. Swings in pH outside the acceptable range indicate a need for machine cleaning, concentration adjustment or the addition of biocide. Each action taken to adjust the pH to the desired operating range should be documented in the machine log book and evaluated for effectiveness. Any rapid change in pH should be investigated and action taken to prevent damage to the coolant.

The pH of a fluid usually remains constant because of buffers contained in the fluid concentrate. Water evaporation will cause the fluid pH to change after initial mixing. Improper control of microbial growth will also alter the pH of the fluid. By-products of microorganisms produce offensive odors and lower coolant pH. As the fluid becomes rancid or septic, the fluid becomes more acidic. Sudden downshifts in pH usually indicate increased biological activity or a sudden change in coolant concentration due to contamination. If coolant concentration and pH both jump downward, the sump has been contaminated. If coolant concentration remains fairly constant while pH decreases, biological activity has probably increased significantly.

The pH of a metalworking fluid is readily determined using litmus paper (available through your metalworking fluid supplier) or a handheld pH meter. Litmus paper provides a quick, low cost means of estimating fluid pH. Its accuracy is limited to plus or minus one full pH unit and is not particularly effective in predicting biocide failure.

pH meters are more expensive but provide more accurate readings. Depending on the degree of accuracy and other desired options, pH meter kits may be purchased at a cost ranging from as little as $50 to several hundred dollars. Low to medium cost pH meters are accurate to plus or minus 0.2 pH units, an accuracy sufficient for monitoring biological degradation. Although high-cost meters are accurate to hundredths of a pH unit, this degree of accuracy is of little benefit with regard to fluid management.

System Maintenance

Fluid contaminants must be controlled in order to obtain optimum fluid performance and life. These contaminants can be kept to a minimum with regular system inspections, maintenance and housekeeping practices.

System Inspection

Brief inspections of the fluid and system cleanliness are an important aspect in monitoring fluid quality and avoiding premature fluid failure. Operators and maintenance personnel should be aware of signs which indicate a need for fluid maintenance or recycling. Such observations include excessive tramp oil accumulation, buildup of metal cuttings within the sump, foaming problems and leaky machinery. Machines must also be inspected for stagnant areas, dirt accumulations and bacterial slime accumulations. Observations regarding fluid quality should also be documented in the machine log book. Difficulties in observing and cleaning problem areas often justifies equipment modifications to eliminate the hard to reach or stagnant locations. Retrofitting machines with external sumps often improves accessibility, facilitating routine particulate and tramp oil removal.

Routine Maintenance Practices

Maintaining clean machines, coolant lines and sumps is an integral part of fluid management. Clean machines use metalworking fluids more economically and extend fluid life. Any dirt and oil allowed to remain in the system simply recirculates, resulting in plugged coolant lines, unsightly machine buildup and bacteria breeding sites.

Particulate Removal

Excessive chip accumulation reduces sump volume, depletes coolant ingredients and provides an environment for bacterial growth. Excessive solids buildup can also cause the temperature of the fluid to increase. Machine turnings should be removed as often as possible. Mobile sump cleaners, such as ‘sump suckers’ or high quality drum vacs, are useful for this purpose.

Tramp Oil Control

Tramp oils such as hydraulic oil, lubricating oil or residual oil film from the workpiece are a major cause of premature fluid failure. These oils provide a source of food for bacteria, interfere with the cooling capability of the fluid and contribute to the formation of oil mist and smoke in the workplace. Tramp oils also interfere with fluid filtration and form residues on machining equipment. Tramp oil contamination must be controlled through preventive maintenance and removal.

Ultimately, the best method for control of tramp oil is to prevent it from contaminating the fluid in the first place. Routine preventive maintenance should be performed on machine systems to prevent oil leaks from contaminating the fluid. Some facilities have reportedly substituted undiluted, petroleum based fluid concentrate for gear box oil lubricants, machine way oils and hydraulic oils. Instead of becoming contaminated with leaking oil, the fluid is actually enriched by the concentrate. This should only be done if machines are properly prepared for using a fluid concentrate substitute to ensure this practice does not harm the machine's operation or performance. Machining equipment is also available which has been designed to require less hydraulic oil in its operation, or direct lubricating and hydraulic oil leakage away from the machine sump.

Even with the best preventive maintenance programs, some tramp oil contamination is inevitable and will require removal. Depending on its water miscibility, tramp oil will either "float out" when the fluid is allowed to sit for a period of time or be emulsified by the fluid. Free floating tramp oil should be removed on a regular basis (either continuously or periodically) as a part of fluid maintenance. An oil skimmer, coalescers or oil-absorbent pads can remove floating oils. A centrifuge is needed to remove emulsified tramp oils.

Tramp oil separation and removal can also be improved by purchasing fluids that resist tramp oil emulsification or by using hydraulic and lubricating oils that won't readily emulsify with the fluid. Use of high quality lubricants with ingredients that won't be a food source for bacteria is another alternative.

General Housekeeping

Cutting fluid contaminants such as lubricating oils, greases and metal particulates are an expected part of machining operations. Many of the contaminants that cause fluids to be disposed of prematurely consist of foreign materials such as floor sweepings, cleaners, solvents, dirt, waste oils, tobacco, and food wastes. These contaminants have obvious detrimental effects on coolant quality and should be eliminated by improved housekeeping and revised shop practices. Facility personnel should learn not to dispose of these materials in machine coolant basins.

Annual Cleanout

Machine systems must be thoroughly cleaned out at least once a year in order to keep biological growth in check and maintain proper system operation. During clean-out, each machine should be thoroughly cleaned and disinfected. Simple flushing of cleaning solution through the system does not provide adequate cleaning. To clean a coolant system properly, biocide should be added to the dirty fluid and allowed to circulate before pumping out the reservoir. All chips, swarf and visible deposits should then be removed.

Although accessibility is often an inherent problem due to a machine's design, extra effort should be made to thoroughly clean all hidden areas. If these difficult-to-reach areas are not addressed, they simply become a source of bacteria that rapidly attack the fluid used to refill the sump after cleaning.

Following cleanout of the sump/reservoir, the system should be charged with water (preferably hot water) and mixed with a machine cleaner. This mixture should then be circulated through the system for several hours in order to loosen and remove any hardened deposits, oily films or gummy residues. The cleaner must be:

- Compatible with the metalworking fluid (in case some cleaner remains in the system after rinsing);
- Low foaming to prevent pump cavitation; and
- Resistant to short-term rusting between cleanout and recharge.

Coolant chemical suppliers often provide instructions for equipment cleaning including information on safe, effective and compatible cleaning materials.

While the cleaning solution is circulating, leaking equipment should be repaired and the outside of the machine cleaned. If possible, troublesome areas should be steam cleaned. Finally, once the machine has been thoroughly cleaned and inspected, any residual cleaning solution must be rinsed from the equipment. Fresh water should be circulated through the system at least twice to rinse off any remaining cleaner. To protect against flash rusting, a small amount of coolant concentrate (0.5 - 1%) should be added to the rinse water. After completely draining the rinse solution, the system can be charged with fresh fluid. The fluid should then be circulated for at least 15 minutes prior to production.

The cleanout procedures described above are provided as general guidance. Each individual facility should develop a cleanout schedule and system suitable for their own operation.

The following is an example of a coolant-change practice found to be most efficient for extending fluid life at one small machine shop.

- Skim all tramp oil from coolant surface.
- Pump coolant from sump.
- Remove sump-access covers.
- Vacuum chips from sump.
- Clean and vacuum sump (repeat until clean).
- Replace sump-access covers.
- Replace original coolant.

The change practice was performed every 2-3 months and required an average of 5 hours to accomplish on a cast sump of 20-100 gallons. Sumps made of sheet metal take less time because corners are generally rounded and more easily cleaned. These system maintenance practices, when combined with improved, ongoing fluid maintenance, can greatly extend fluid life.

Maintenance of Straight Oils

Straight oils are generally easier to maintain than water-based fluids. In fact, straight oils may be the most environmental friendly fluid for certain applications (e.g. honing) due to their extraordinary stability, recyclability and long life. Straight oil maintenance consists of keeping the fluid free of contaminants (such as water or waste oils generated in other areas of the shop), adequate particulate removal through filtration and the addition of antioxidants. The presence of water promotes microbial growth while waste oil contamination dilutes the ingredients added to straight oil for enhanced lubricity and wettability. Waste oil contamination also increases the viscosity of the straight oil, lowering its filterability.

Straight oils that are kept contaminant free and adequately filtered may still require replacement as oxidation increases viscosity, making particulate filtration more difficult. As a result, additives referred to as antioxidants may need to be used to prevent oxidation from occurring.

Summary of Recommended Best Practices for Fluid Maintenance

- **Routinely inspect the fluid and system for cleanliness**
- **Perform regular maintenance on machines and sumps through;**
  - ✓ **Particulate removal;**
  - ✓ **Tramp oil control;**
- **General housekeeping**
- **Annual cleanout of machine systems**
- **Prevent foaming conditions from occurring**

Fluid Recycling

Despite all efforts to extend fluid life, fluid quality will eventually reach a point where routine maintenance is no longer effective. At this stage, the fluid either needs to be recycled or disposed.

The key to effective recycling is knowing when to recycle. Fluid should be recycled well before it becomes significantly degraded. Fluids with excessive bacteria counts or tramp oil concentrations cannot be restored. This is why monitoring microbial activity, concentration, pH and contamination levels are such critical aspects of fluid management.

If the fluid exhibits any of the following characteristics, it should not be recycled. Instead, the fluid should be disposed and the machine thoroughly cleaned before recharging with fresh fluid.

- If the pH is less than 8.0. (Normal pH range is 8.5 to 9.4.)
- If the fluid concentration is less than 2.0%. (Normal is 3.0% to 12.0%.)
- If the fluid appearance is dark gray to black. (Normal is milky white.)
- If the fluid odor is strongly rancid or sour. (Normal is a mild chemical odor.)

Recycling Equipment

A wide variety of recycling equipment is available for contaminant removal and most recycling equipment is generally easy to operate and maintain. The choice of recycling equipment will depend on the needs, objectives and financial resources of the shop. Cutting fluid may be recycled using a variety of equipment including filters, centrifuges, skimmers, flotation and magnetic separators.

Skimmers

Skimmers are specifically designed to remove tramp oils that float to the surface of cutting fluid after it has been allowed to sit still for a period of time. Skimming is most effective when tramp oils have a low water miscibility and the cutting fluids used by the shop reject tramp oil emulsification. Since oil has an affinity for plastic, most skimmers consist of plastic belts or disks that are partially submerged in the fluid. Tramp oil adheres to the skimmer as it passes through the fluid. The tramp oil is then scraped from the skimmer with a blade and collected for recycling or disposal.

For small sumps, oil absorbent fabrics or pillows (treated to repel water and absorb hydrocarbons) may suffice for tramp oil removal. The fabric can be drawn across the sump pit for tramp oil removal or pillows may be allowed to float in the sump to absorb oils. The disadvantage of using absorbents is the subsequent need for disposal.

Coalescers

Coalescers are often used in conjunction with skimmers to enhance tramp oil removal. Coalescers are porous-media separators which use oleophilic (oil attracting) media beds (typically constructed out of polypropylene) to attract oil in preference to water. These media beds often consist of inclined corrugated plates or vertical tubes. As cutting fluid is passed through the coalescer unit at a low, nonturbulent flow rate, dispersed tramp oil droplets attach to the media and coalesce to form larger and larger droplets. Eventually these droplets reach a size at which they rise to the top of the coalescing unit for removal with a skimmer. Coalescer units have no moving parts, are generally self cleaning and may be purchased for $1,000 to $5,000.

Like skimmers, coalescers are ineffective for removing emulsified tramp oils. They may also accumulate fine particulate matter during their operation. If these units are not cleaned periodically, the dirty media will provide a breeding ground for microorganisms.

Separation Equipment

Separation equipment includes settling tanks, magnetic separators, hydrocyclones and centrifuges. The primary function of this equipment is particulate removal. Settling tanks and centrifuges may also be used for tramp oil removal.

The simplest separation system consists of settling tanks. Settling tanks use baffles and weirs designed to promote settling of heavy particulates to the bottom of the tank while allowing tramp oil and light particulates to float to the surface of the fluid. Settling tanks are equipped with skimmers to remove the floating oil and light particulates. Chips and other particles that settle to the bottom are removed using baskets or automatic chip conveyors.

Magnetic separation tanks use cylindrical magnets to remove ferrous particulates. Contaminated fluid flows over the slowly rotating magnetic cylinders that extract the ferrous particulates from the fluid. The ferrous particles are then scraped from the magnetic cylinder into a tote bin for disposal. Nonferrous metals that pass by the magnetic cylinder are removed with another separation process, typically settling.

Hydrocyclones and centrifuges create artificial gravity for contaminant separation. Density differences between the cutting fluid and contaminants cause their separation. In a hydrocyclone, cutting fluid rapidly enters a cone-like vessel, producing a vortex that forces denser solids down and out. The disadvantage of hydrocyclones is that they tend to emulsify tramp oils.

Centrifuges use a spinning bowl to develop the centrifugal force needed for contaminant removal, exerting a force up to 6,000 times gravity (6,000 Gs) on the cutting fluid. However, unlike hydrocyclones, some centrifuge units can remove free, dispersed and emulsified tramp oil. High speed centrifuges also offer the extra benefit of bacterial removal. Removal of emulsified tramp oils requires a centrifugal force of 4,000 to 6,000 Gs. These units often use several coalescing disks to aid tramp oil separation. The disadvantage of centrifuges is the intensive maintenance required for the system and cost. In addition, under certain conditions, centrifuges used for removal of emulsified tramp oils may also separate fluid concentrate from the working solution. Your fluid supplier should be consulted beforehand to ensure centrifuging will not have a detrimental impact on fluid quality.

Filtration Equipment

Filtration involves passing cutting fluid through a permeable material for particulate removal. Filters may be permanent or disposable and are rated on an absolute or nominal scale. The absolute rating of a filter refers to smallest size particle that will be removed during filtration while nominal ratings refer to the average particle size that will remain in the fluid after filtration. Filters are typically made from materials such as wedge wire, microscreens, paper, cloth and manmade fibers such as nylon, polypropylene or polyester. In some applications it may be necessary to use a series of progressively finer filters in order to achieve the desired level of particulate removal.

Filtration systems used for recycling cutting fluid include vacuum, pressure and gravity filtration. Vacuum filtration pulls cutting fluid through the filter for particulate removal while pressure filtration uses a pump to force the fluid through the filter. The filtered fluid then enters the reservoir for redistribution. As chips and other contaminants build a cake on the filter media, resistance to flow increases. At a preset limit, the filter medium (usually rolled paper and wedge wire filters) indexes to expose a clean surface.

Gravity filtration systems involve cutting fluid flowing onto a blanket of filter media suspended over a reservoir tank. Particulates are then removed as the fluid passes through the filter into the reservoir for redistribution.

Flotation

Flotation is a process in which cutting fluid is aerated to achieve contaminant separation. During aeration, oil and particulate matter adhere to the air bubbles and are carried to the surface where they are mechanically skimmed off. This contaminant removal process is typically used after larger and heavier particulates have already been removed by settling.

Recycling System Selection

A wide variety of recycling systems are available for purchase. Such systems incorporate the above recycling equipment in their designs in order to remove contaminants such as tramp oil, particulates and bacteria. They are also capable of readjusting the fluid's concentration before it is returned to the individual machine. The following factors should be considered when selecting a recycling system in order to ensure it meets the needs of the shop:

- The volume of fluid which will require recycling (e.g. the number and volume of sumps);
- Particulate and tramp oil removal requirements;
- Type of material machined at the shop and hours of operation;
- Type of metalworking operations performed at the shop;
- Types of cutting fluids used by the shop and their optimal concentrations;
- What additives will be needed.

Recycling systems consist of both batch and continuous in-line systems. For small shops, the most effective method to recycle fluid for individual machines is the use of a batch-treatment system. Batch-treatment systems are portable or nonportable fluid recycling units. Fluid from individual machine sumps is treated in batches for contaminant removal. A recycle system for a small shop can cost from $7,500 to over $15,000 depending on the equipment options selected.

Typically, contaminated fluid is removed from the machine sump using a mobile sump cleaner (i.e. a sump sucker or high quality drum vac) and placed in the batch-treatment recycling unit for contaminant removal. To keep fluid clean, batch treatment must be done on a frequent basis. Many shops find that batch treatment must be done two to three times as often as the fluid's life expectancy. Thus, if a fluid lasts three months before it needs disposal, it will need to be batch treated monthly. If the fluid only lasts two or three weeks, it will need to be batch treated weekly.

Recycling Schedules

How often a fluid must be recycled depends on the following conditions:

- Fluid Type
- Water Quality
- Fluid Contamination
- Machine Usage
- Machine Filtration
- Fluid Control
- Fluid Age

A fluid that is stable and resists biological contamination will be able to withstand repeated recycling and will require less recycling. Poor water quality (water that is too hard or too soft) will cause excess dissolved minerals to accumulate in the fluid and may require more frequent recycling.

The level of productivity of a shop will also affect the frequency of recycling. Large shops that operate at maximum capacity around the clock will need to recycle fluids more frequently than smaller shops whose work schedule is less demanding. It is generally recommended that coolants be recycled every two or three weeks on average to keep coolants fresh and usable for extended periods of time. Some manufactures of recycling equipment recommend a 30 day recycling schedule for each machine.

COST/BENEFITS

An ideal machine coolant management program involves both proper management of the coolant in the machine sump and on-site recycling. The Figures 5-1 and 5-2 can be used to calculate the costs/benefits provided by a comprehensive coolant management program. A company should enter its own data and perform the corresponding calculations.

Figure 5-1
Machine Coolant Management Alternatives
Cost/Benefit Worksheet
Existing Conditions

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Number of machine sumps	20	
B	Average sump capacity in gallons	100	
C	Facility coolant capacity in gallons = A x B	2000	
D	Coolant cost per gallon (Concentrate)	$10.00	
E	Dilution ratio (Concentrate to Water)	1 to 20	
F	Cost of coolant in the sump per gallon = D x E	$0.50	
G	Sump change outs per year	4	
H	Daily coolant makeup requirements (10%) in gallons per day	200	
I	Annual coolant usage in gallons = (C x G) + (H x 260 days)	60,000	
J	Annual coolant purchase cost = I x F	$30,000	
K	Annual amount of coolant generated as waste in gallons	8,000	
L	Coolant disposal costs per gallon	$0.60	
M	Annual coolant disposal cost = L x M	$4,800.00	
	Total annual coolant management costs = J + N	$34,800.00	

Figure 5-2
Machine Coolant Management Alternatives
Cost/Benefit Worksheet
Coolant Management and On-Site Recycling

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Coolant recycling equipment cost	$50,000	
B	Number of machine sumps	20	
C	Average sump capacity in gallons	100	
D	Facility coolant capacity in gallons = B x C	2000	
E	Coolant cost per gallon (Concentrate)	$10.00	
F	Dilution ratio (Concentrate to Water)	1 to 20	
G	Cost of coolant in the sump per gallon = D x E	$0.50	
H	Sump change outs per year	12	
I	Daily coolant makeup requirements (5%) in gallons per day[a]	100	
J	Annual coolant usage in gallons = D + (I x 260 days)	28,000	
K	Annual coolant purchase cost = G x J	$14,000	
L	Annual amount of coolant generated as waste in gallons	0	
M	Coolant disposal costs per gallon	$0.60	
N	Annual coolant disposal cost = L x M	$0	
	Total annual coolant management costs = J + N	$14,000.00	

[a] Less makeup coolant is required due to proper maintenance of coolant concentration and sump cleaning (i.e. No shock treatments are necessary for pH or biocide control)

As calculated above, annual coolant purchase and disposal costs were $34,800 per year. By installing a $50,000 recycling system and maintaining the coolant properly in the sump, coolant disposal was eliminated and significantly less new product was used. These reductions brought the annual coolant purchase/disposal cost to $14,000 per year or a $20,800 annual savings. Based on this situation, a payback on the recycling equipment can obtained in less than 2.5 years.

Section 6: Financing Options

Small Business Development Centers
Iowa Waste Reduction Center

Pollution Prevention Implementation Plan for Metal Manufacturers

Painting Systems

Most metal manufacturing operations have some type of painting system for rust protection and/or finishing purposes. The selection of a specific coating application method affects the costs of the overall system a firm needs to purchase. Whether a firm chooses high solids paints, waterborne paints or powder coatings, it may require external financing to purchase the necessary paint booth and related items. There are also costs associated with the method of application that the firm selects. The costs for conventional, high-volume low-pressure (HVLP), and air-assisted airless application methods are relatively low, but electrostatic and two component systems will often require outside financing. Powder coating systems are the most expensive application methods on the market and may also require outside financing if selected for implementation.

Painting Equipment Cleaning

The three most common pollution prevention options for painting equipment cleaning are settling and reuse, automatic gun washers, and on-site distillation. Automatic gun washers cost approximately $1,500 and on-site distillation can cost a minimum of $3,000. These will generally be financed internally from operations as the paybacks are under a year, but they can be added to your financing package if your firm is changing its painting and application procedures.

Parts Washing

Most metal manufacturers use parts wash basins containing petroleum-based solvents. Common parts washer basins cost $600 but for less than $1,500 a firm can reduce petroleum-based parts washer solvent waste generation by purchasing a "hybrid" unit. These units purify the circulating solvent and reduce hazardous waste generation and off-site transportation liabilities. Another option is the purchase of an aqueous cleaner that can cost from $3,000 to $4,000. However, if you are not located on city sanitary sewer systems, you will need to spend another $8,000 for an on-site wastewater recycler. Most parts washers will be financed internally but if you do opt for an aqueous cleaner the Small Business Administration's (SBA) low doc program might fit your needs.

Coolant Recycling Equipment

External financing will be needed to install a coolant recycling system as it will generally cost at least $7,500 for a small shop and up to $50,000 for larger shops to purchase and install. Very few firms have sufficient cash flow to internally finance this type of project. By carefully preparing a cost/benefit worksheet as shown in Figures 5-1 and 5-2, a firm can show its commercial lender the value of the capital investment. These types of projects qualify for either SBA "low doc" or 7(a) financing.

FINANCING NEEDS

The first step is to review the firm's monthly cash flow from operations statements. The least expensive way to finance less expensive pollution prevention technologies is to internally finance the capital outlays. However, this may not always be possible for metal manufacturers when purchasing coolant recycling equipment or new painting systems. Therefore, many firms will turn to their financial institution for financing these more expensive projects. Pollution prevention initiatives that do not show quick paybacks, such as coolant recycling equipment replacement projects, may meet with some resistance from the lender. That is where the SBA's financial assistance program can be very useful to the business.

The largest financial assistance program is the SBA. The SBA has several programs that your firm may find useful in financing pollution prevention and/or reduction capital projects. The most common and largest program is the 7(a) loan guaranty program. The 7(a) program allows the SBA to reduce risk to lenders by guaranteeing the major portion of loans made to small businesses.

The eligibility requirements and credit criteria of this program are very broad in order to accommodate a wide range of financing needs. When you have put together the list of equipment that you need to purchase you will fill out an application for a loan with a lending institution. The lender will review the application and decide if it merits a loan on its own or if it requires additional support. Many firms will have little difficulty in obtaining the needed financing for their smaller projects, however, a firm with a significant level of debt already on their balance sheet may need the SBA loan guarantee before the financial institution will extend further credit.

The SBA can guarantee as much as 80 percent on loans of up to $100,000 which will be sufficient for most pollution prevention projects. If the loan is more than $100,000, the guarantee drops to 75 percent up to a maximum guaranty of $750,000 (75 percent of a $1,000,000 loan).

There are no balloon payments, prepayment penalties, application fees or points permitted with 7(a) loans. Repayment plans may be tailored to each individual business.

Most pollution prevention purchases could be financed over a period of 5 to 7 years. Both fixed and variable interest rates are available. Rates are pegged at no more than 2.25 percent over the lowest prime rate as published in the Wall Street Journal on the day the application is received by the SBA. (Loans under $50,000 may have slightly higher rates).

The SBA charges the lender a nominal fee to provide a guaranty and the lender usually passes this charge on to the borrower. The fee is based on the maturity of the loan and the dollar amount that the SBA guarantees. On any loan with a maturity of one year or less, the fee is 0.25 percent of the guaranteed portion of the loan. On loans with maturities of more than one year, where the portion that the SBA guarantees are $80,000 or less, the guaranty fee is 2 percent of the guaranteed portion. The SBA will require that you pledge sufficient assets to adequately secure the loan.

Most pollution prevention projects will typically be less than $100,000 so the Low Documentation Loan (LowDoc) program may be the best alternative to obtain reasonable financing with a minimal amount of paperwork. For firms with established relationships with lenders and those meeting the lender's requirements for credit, LowDoc is a simple one page SBA application form with a rapid turnaround time. Like the 7(a) program, the SBA will guarantee up to 80 percent of the loan amount.

Most lending institution will require a projected cash flow statement, projected income statement and projected balance sheet. Examples are available from your local SBDC office.

Section 7: Appendices

Small Business Development Centers
Iowa Waste Reduction Center