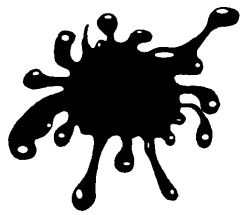
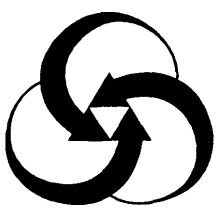
Shop Guide to Reduce the Waste of Metalworking Fluids



A Competitive Advantage Manual for the Metal Fabricating and Machining Industry

Prepared by:



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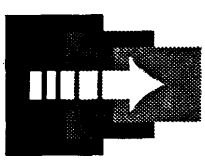

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The Institute of Advanced Manufacturing Sciences (IAMS) is a not-for-profit organization whose mission is to improve the competitiveness of industry through technology transfer, training, and applied research. The Institute's specialized areas of expertise include: pollution prevention, machining and machine tool technology, and manufacturing productivity. Courses offered at their Cincinnati, Ohio training facility include: *Practical Machining Principles for Shop Application, Grinding Principles and Practice, Centerless Grinding, and Pollution Prevention seminars.*

The Waste Reduction and Technology Transfer Foundation (WRATT) is a not-for-profit organization funded by public and private sources dedicated to reducing the cost of industrial waste and protecting the-environment. WRATT conducts confidential, free, voluntary, nonregulatory assessments for business and industry and conducts programs to educate the public, business, and industry representatives in reducing discharges to the environment, usually resulting in substantial cost savings. Retired engineers and scientists manage the programs.

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INTRODUCTION

Much progress has been made in recent years in improving metalworking and fabrication processes as regulations regarding the discharges into the environment have become more stringent. This industry needs to continue to meet new standards which further decrease the amount and type of wastes it may discharge. Metalworking fluids and lubricants used by metalworking and fabrication companies often represent the majority of waste discharges. Therefore, waste minimization of process metalworking fluids and lubricants has proven to be an effective method of meeting discharge limitations. Furthermore, since metalworking fluids and lubricants used in manufacturing are major overhead costs, many companies find they benefit from the guidelines in this manual in the following ways:

- Cost reduction by reducing waste volume
- Decrease waste disposal costs and liability by recycling and reuse of metalworking fluids
- Reduce downtime and improve productivity
- Improve quality and reduce costs of the products they manufacture

This manual will prove useful for companies involved in cutting, metal removal and forming which may include:

Broaching	Turning	Milling
Threading	Tapping	Drilling
Forming	Stamping	Drawing
Honing		

This manual includes several excellent methods which have proven successful in many metalworking companies. However, like most things in life, there are no free lunches being offered here. Effective waste minimization requires an investment of time and hard work. There is no magic wand or new technology that makes the selection and maintenance of metalworking fluids and lubricants easy, simple and free. Each company is different in its particular needs and what works best for one may not be the best for another. Taking advantage of their own expertise and knowledge of local conditions, operators of each facility must determine whether a particular technology can be implemented economically. Most importantly, for a successful plan to be implemented, ***all*** personnel including owners, upper management, engineers, shop foremen, machine operators, etc. must buy in and become part of the team.

Metalworking and fabrication companies of all sizes are making significant reductions in their operating costs and mandated environmental waste handling concerns by investing in an effective, organized Waste Reduction Program. These programs involve more than simple waste recycling; they cannot be bought off the shelf, ready-to-use from any vendor. Often, a Waste Reduction Program becomes part of a company's overall Total Quality and Continuous Improvement efforts, improving and maintaining its competitive position in the marketplace.

REGULATORY BACKGROUND

The purpose of this manual is to provide practical ideas for reducing metalworking fluids and lubricant wastes. Compliance with the many environmental laws and regulations that govern waste treatment and disposal is beyond the scope of this manual. However, in waste reduction efforts, it is important to at least be aware of the regulatory issues involved in disposing of the wastes. This regulatory framework is one important reason for working on the *front end* of the operation to reduce the amount of waste sent to disposal.

The major environmental issue in disposing of metalworking fluids and lubricants is whether or not the wastes are *hazardous.* Hazardous wastes are specifically listed and closely regulated under RCRA (the Resource Conservation and Recovery Act). A detailed set of regulations require generators to register with the EPA, comply with labeling and containment requirements, and maintain records to document the origin, handling, and ultimate disposition of all hazardous wastes. Disposal of hazardous waste is very expensive, and, if the regulations are violated, there can be severe fines and even criminal penalties.

There are many varieties of metalworking fluids and lubricants used in metal fabrication. Initially it is necessary to determine whether the product itself is classified as a hazardous waste. In some cases this information can be found on the Material Safety Data Sheets (MSDS) that the process fluid vendor is required to provide. However, do not assume that ingredients in Section 2, “Principle Hazardous Components“ of the MSDS automatically imply that the fluid is classified as a hazardous waste. Rather, the RCRA regulations, which are included in Section 7 of the MSDS, state the appropriate method of disposal for a given product. If the product itself is hazardous from a waste disposal standpoint (RCRA), consider asking the vendor about nonhazardous alternatives.

Metalworking fluids may also become hazardous during use because they ‘pick up’ other waste materials. Therefore, the chemical components of the wastes reflect not only the *original makeup* of the process fluid, but also the operation and conditions of their use. In fact, many metalworking fluid wastes contain higher percentages of lubricating oils and suspended solids (dirt), and metal fines than they do metalworking fluid. If working with metals other than carbon steel, there is a possibility that *heavy metals* (such as cadmium, copper, chromium, lead, mercury, nickel, silver, zinc) in the,fluid waste will result in it being classified as hazardous waste. To find out whether the specific waste is hazardous, a sample must be sent to an EPA certified lab for analysis using the TCLP (Toxicity Charateristic Leaching Procedure) test method.

Even after all tramp oil, chips and fines have been removed, consult the local wastewater authority before disposing of metalworking fluid waste in the municipal sewer treatment system. Significant surcharges could result if discharge limits are violated and if waste is disposed of without proper authority.

NOTE: Other regulatory issues, such as oil mist standards and metal products and machinery (MP&M) standards, while also important, are beyond the scope of this manual.

While the rules and regulations for managing hazardous waste are complex, help is available. For more information, call:

- The state hazardous waste agency
- The EPA regional office
- The RCRA/Superfund Hotline - l-800-424-9346
- EPA's Small Business Ombudsman Hotline - l-800-368-5888
- A particular business' national trade association or its local chapter
- Refer to the EPA's "Understanding the Small Quantity Generator Hazardous Waste Rules: A Handbook for Small Business", document #530-SW-86-019
- ILMA's "Waste Minimization and Wastewater Treatment of Metalworking Fluids"

A primary objective of fluid management is to keep the fluid from becoming a hazardous waste!

WASTE REDUCTION TECHNIQUES FOR METALWORKING FLUIDS

No matter what part of a company's operating budget metalworking fluids represent, their effect on overall costs and productivity can be huge. A good fluid management program extends the useful life of metalworking fluids and has both economic and environmental advantages:

- Improves quality and repeatability
- Decreases costs of disposal for spent fluids
- Decreases purchase costs of fluids
- Less downtime for machine cleanouts and recharges
- Cleaner work environment and improved health conditions

This section of the manual focuses on:

- selecting the appropriate fluid
- keeping it alive as long as possible through proper application and maintenance
- the 3 R's: reduce, reuse and recycle

Functions of Metalworking Fluids

Metalworking fluids are applied to the workpiece, cutting tool, or grinding wheel to facilitate the cutting operation. A metalworking fluid is used:

- to lubricate the tool-workpiece interface
  - reduces the amount of heat generated
  - reduces tool wear
  - improves surface finish
- to keep the tool temperature down to prevent premature wear and damage
- to keep the workpiece temperature down to prevent warpage or inaccurate machining dimensions
- to provide a good finish on the workpiece
- to wash away chips
- to inhibit corrosion or surface oxidation

Although metalworking fluids are often called "coolants", many applications rely more on the fluid's lubricity than cooling properties.

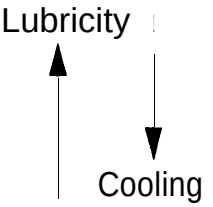
Types of Metalworking Fluids

There are four basic types of metalworking fluids as summarized in the Table 1 below:

TABLE 1

Types of Metalworking Fluids

Type	% Petroleum Oil in concentrate
• Non-dilutable straight oils	100%
• Water soluble oils	50-90%
• Semi-synthetic fluids	2-50%
• Synthetic fluids	0%



Some products contain EP (Extreme pressure) additives. EP formulations contain chlorinated, sulfurized, or phosphorus-type extreme pressure ingredients. High performance polymer-based EP additives are also entering the market. The impact a given fluid has on the waste stream will depend on its formulation, dilution factor and the waste stream limitations.

Selecting the Correct Fluid for the Application

Operational requirements are dictated for the most part by the material to be machined, the process to be used, the tool material, the quality reauirements and the amount of machining required. Other items, such as type of filtration, water quality and chemical restrictions, may also influence the selection of a fluid. Some materials may not require any metalworking fluid. Some alloys may require only a little tapping fluid when threaded or tapped. In certain cases, water alone can be used as a coolant and finish. In most cases, however, use of a metalworking fluid will deliver higher production rates and extend tool life.

TIP - It is important to carefully select the metalworking fluid most suitable for the particular application to maximize its performance and fluid life. Fluid selection should be done from plant-wide perspective to find the best products and minimize the number of different fluids in use. The broad applications of some high quality fluids sometimes make it possible to employ only one type in an entire plant with different concentrations appropriate to the specific application. This will simplify operations, minimize contamination, and maximize purchasing power.

To make informed choices of fluids, it is important to consider not only the fluids' performance characteristics, but other factors, such as:

- fluid life
- waste treatability
- cost of disposal
- resistance to microbial attack
- corrosion protection provided
- type of residues left on the machine tools and workpieces
- foaming characteristics
- part requirements (tolerance, finish, rust protection)
- machine requirements (lubrication, seals, paint, cleanliness, visibility of work area)

*TIP - Metalworking fluids should **never** be chosen based on cost alone. The lower cost of a given fluid might be quickly negated by lost productivity, inferior product quality, shorter tool life, increased downtime, and higher cost of disposing of greater volumes of waste fluids.*

A vendor can be a great help in selecting the right fluid for a particular application. Some companies have found it helpful to have the same vendor provide the fluid, the equipment, and a fluid management program. This allows the vendor to develop a better understanding of the entire process.

Gases can sometimes be used in place of metalworking fluids, because they provide chip control and limited cooling with no workpiece contamination. Air is the most frequently used gas, both in dry cutting or with other fluids. Nitrogen and carbon dioxide are occasionally used as well, but their cost is higher and gases do not provide lubrication. However, their lack of disposal considerations could make them an effective alternative for some operations.

Starting a Fluid Maintenance Program

Implementing a metalworking fluid maintenance program will extend fluid life, cut costs and reduce the downtime associated with fluid replacement, equipment cleanout and waste disposal. Ways to check fluids are listed in Table 2:

TABLE 2

Fluid Check List

Daily Checks	Weekly Checks	Random Checks - as needed
• water level (make-up)	• biological growth	• rust
• tramp oil	• dirt load	• foam
• concentration of fluid		• filterability
• total oil		• settling/surface tension

The next several sections of the manual provide suggestions for establishing a fluid maintenance program.

Maintaining the Correct Concentration

Without sacrificing machining performance, select the lowest cost concentration of fluid to water. Why use a 5 parts of water to one part product (5: 1) concentration, when a 20: 1 may give a similar surface finish quality, tool life, and machining efficiency? Concentration or performance ranges are established by the metalworking fluid manufacturer. Keeping this in mind, determine the best concentration for the application and stay with it.

***TIP** - Keeping the chemistry of the metal working&id at a consistent level will increase its useful life. Fluid monitoring can be accomplished by using a Daily Log Sheet. Log sheets are generally available from the metal working fluid vendor. See the back of the manual for a typical example.*

There are generally two methods used for monitoring fluid concentrations:

- by titration, which uses chemical reagents. Titration kits are available from lubricant vendors. Titration is the most accurate method of measuring concentration.
- by refraction, using a refractometer which can be purchased from most lubricant vendors.

A simple eductor-type proportioning device, as shown in ***Figure 1, mixes*** water with the metalworking fluid, providing consistent concentrations during system makeup.

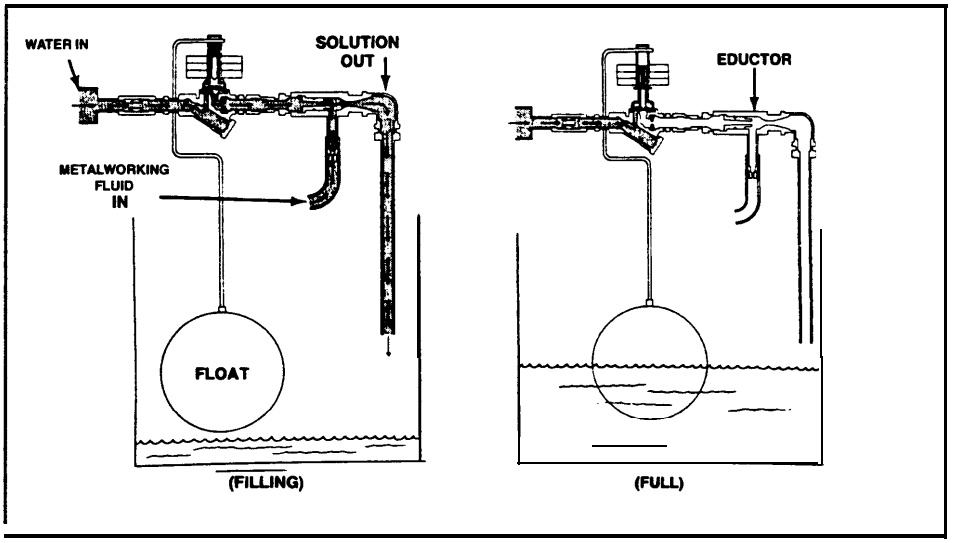


Figure 1. Liquid Proportioner.

Illustration provided courtesy of DuBois Chemicals, Inc., Cincinnati, OH

As water flows through the eductor, detergent is sucked into the stream in a ratio according to the orifice installed. When the level in the reservoir nears full, the float rises and shuts off the water supply. When the level drops, the float falls and the solution is replenished.

Some companies have bought positive-displacement proportioning pumps to maintain very accurate proportions of metalworking fluid concentration.

The next section discusses the quality of water used to make-up dilutions of metalworking solutions.

Using Deionized Water

The higher the mineral content ("hardness") of the makeup water, the more likely stability problems will occur with soluble oils and semi-synthetic products. The level of hardness is dependent on the amount of calcium and magnesium ions dissolved within the water. When using city water or well water to replenish water in a metalworking fluid, the dissolved solids do **not** evaporate and they build up over time. This buildup results in changes in fluid alkalinity and leads to problems of corrosion, bacteria growth and residues. *Therefore, when mixing water to maintain the correct concentration level, use* ***deionized*** *water to lower the level of minerals added to the system if the hardness of city or well water is too high.*

To develop an appropriate water treatment method, start with a raw water analysis. If the plant is served by a public water supply, the local vendor of water can provide the needed data. The fluid manufacturer may then recommend some form of water treatment based on the water analysis.

Recommendations could include the use of:

- Deionizer (DI) from an inline ion exchange system
- A reverse osmosis (RO) unit. (reverse osmosis may be a problem with high sulfate waters)

TIP *- Under no circumstances should waterfrom a common home type water softener be used to treat make-up water for metalworking fluids because of potentially high levels of salt loading. In most cases, add concentrate to water, not water to concentrate.*

In the next section the removal of contaminants such as tramp oil from the metalworking fluid is reviewed.

Keeping Tramp Oil and Trash Out

Waste oils, which come from the machine or surfaces of the raw materials, are picked up by the metalworking fluid and are referred to as "tramp oils". Tramp oil sources are: hydraulic fluid, way oils, lubrication oils, tapping oils, gear box oils, etc. These oils seal off the surface of the sump from the air, speed up the degradation of the metalworking fluids and promote microbial growth. This microbial growth (better known as "Monday morning odor") leads to rancidity problems which require metalworking fluids to be disposed of prematurely.

The best way to reduce tramp oil is by regular inspection and replacement of gaskets, wipers and seals and skimmers. Some companies use concentrated metal working fluid in the gear box and as a tapping fluid so as to avoid the contamination problems of tramp oil. Tramp oil is relatively easy to control using inexpensive skimmers (see page 16 of this manual). If leakage cannot be prevented, check with the fluid vendor to make sure the machine lubricants are compatible with the metalworking fluids. Certain lubricant and hydraulic additives may react and destroy some metalworking fluids.

As ***Figure 2*** illustrates, dirty coolant (test tube A), can be separated into tramp oil and solids (test tube B). Test tube C contains cleaned coolant ready for reuse, while test tube D contains recovered tramp oil.

An irritating problem in many shops is the contamination of fluids with trash such as cigarette butts, tobacco juice, food, food wrappers, etc. Simple good habits will help reduce this problem. Explain to the operators that they are simply feeding and encouraging "Monday morning odor," which can also aggravate health problems like skin rashes.

TIP - *Covering the sumps with screens or solid covers will reduce ongoing contamination problems.*

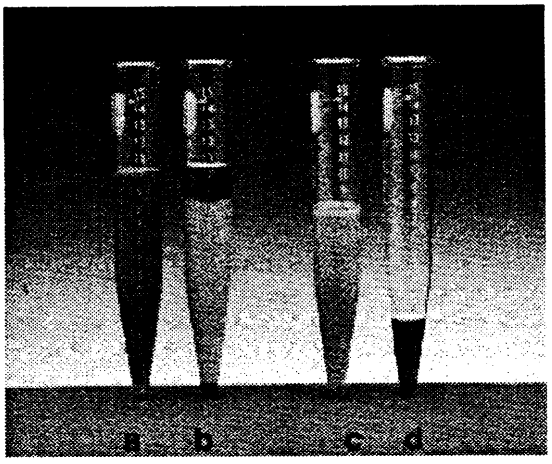


Figure 2. Used Cutting Fluid Recycled by a High-Speed Disc Centrifuge

Adding Biocides

The use of biocides greatly reduces microbial growth, which will:

- Prevent corrosion and odors
- Extend fluid life
- Reduce down time caused by clogged or plugged lines or filters

Do not add bleach to reduce bacteria levels since bleach will degrade and cause excessive levels of chloride salt to build up in the metalworking fluid solution.

Because many types of biocides exist, vendor assistance should be used in their application. Some fluids contain biocides in their formulations. Health and safety problems may be caused from *over-dosing* a metalworking fluid with a biocide. More is not necessarily *better*. Biocides must be approved by the EPA and have usage instructions on the product label. Biocides should only be used after sources of contamination have been identified and minimized. Also, care and caution should be exercised when handling biocides.

TIP - *To measure microbial growth, reliable microbial growth* ***dip slides*** *are available. Tests are inexpensive and are useful in setting up biocide addition programs. When rancidity has been a problem, microbial growth monitoring provides a chance to add biocide before problems arise. Dip slides are available from fluid vendors and from laboratory supply houses.*

As ***Figure 3*** illustrates, microbiological dip slides give a clear indication of the level of bacteria contamination of a given fluid.

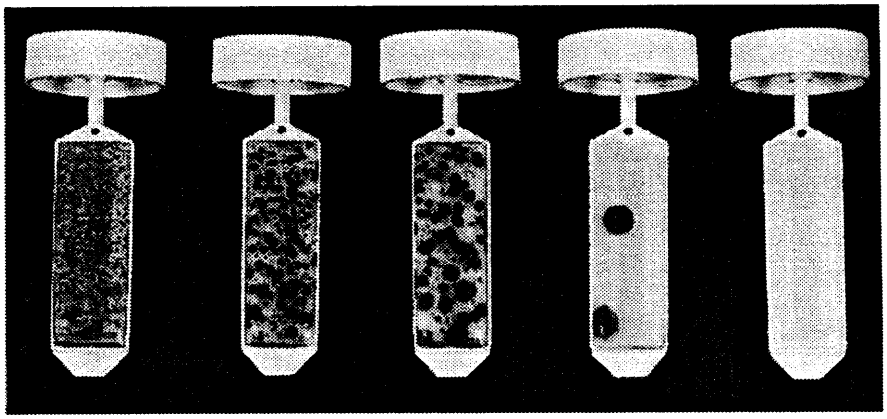


Figure 3. Bacteria Growth Dip Slides.

Photograph courtesy of DuBois Chemicals, Inc., Cincinnati, OH

The large quantity of bacteria colonies *(Slide #I)* indicate very contaminated fluid, while undetectable growth indicates very clean fluid (Slide #5).

Fluid Maintenance Systems

On a broad basis, pH, a measure of a solution's alkalinity or acidity, is another indicator of bacterial growth. Most fluids have a pH between 8.0 and 9.0. Generally, as bacteria activity increases, the fluid's pH decreases (becomes more acidic). pH testing strips are available from fluid vendors and from laboratory supply houses. pH drops are a good "early warning sign" of bacterial growth.

The usable life of the metalworking fluid can be extended by filtering out contaminants and reusing (recycling) the cleaned metalworking fluid. Fluid maintenance can be done either on-line or by a batch process. For larger machines or small groups of machines, a large settling tank, skimmer, and/or filter can be added in the return lines to continuously clean the fluid. For smaller sumps, it is generally more cost effective to have a small, stand-alone system, that may also included coalescer, hydrocyclone or other technologies. A double tank cart is used to bring cleaned fluid to the tooling machine and to take the dirty fluid from the tooling equipment to the recycling process system.

Figure 4 illustrates the division of equipment used to remove particles from metalworking fluids.

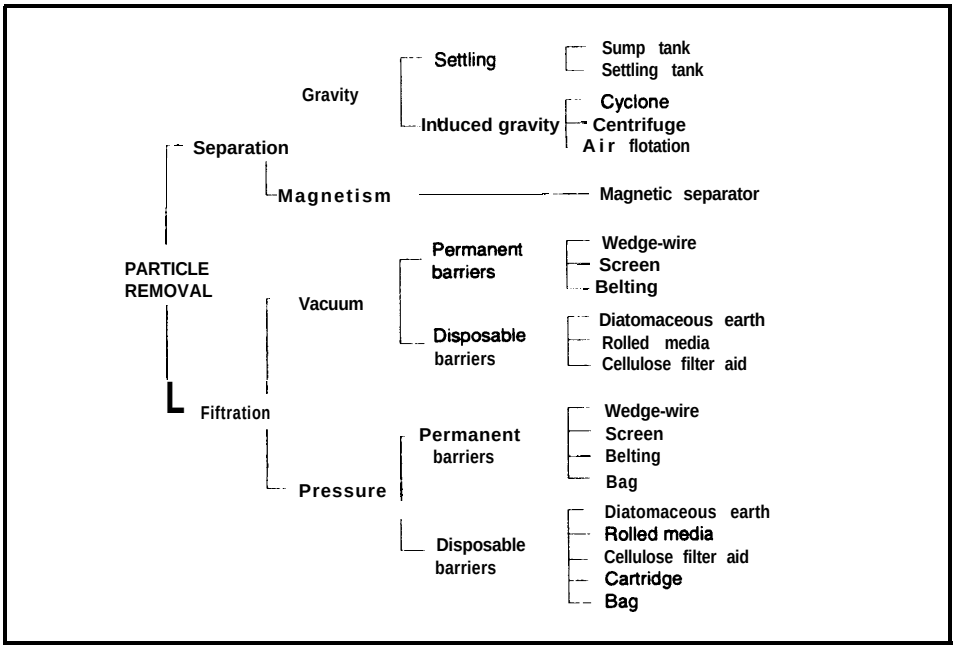
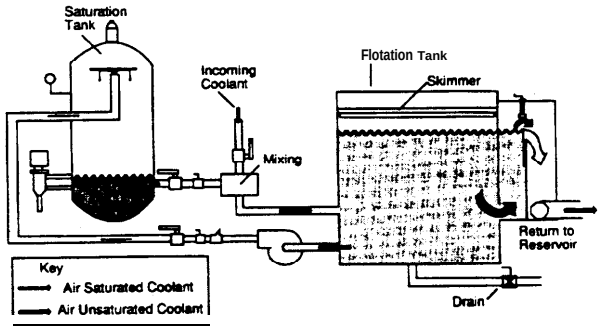


Figure 4.

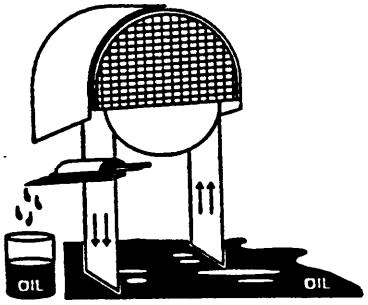
Fluid filtration and mechanical treatment methods are listed in Table 3 below:

TABLE 3

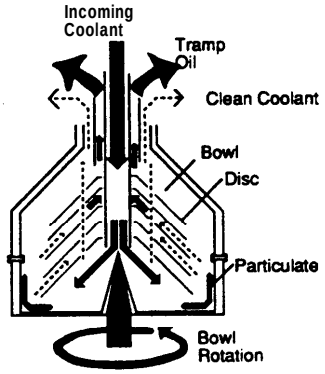
Method	Description
Air floatation unit	A device that uses aeration to float the solids and tramp oil the surface of the fluid where they are skimmed away.



Belt skimmer	A skimmer belt attracts tramp oil and scraps it into oil container.



Centrifuge	A rotating bowl that uses centrifugal forces to separate solids and tramp oils.

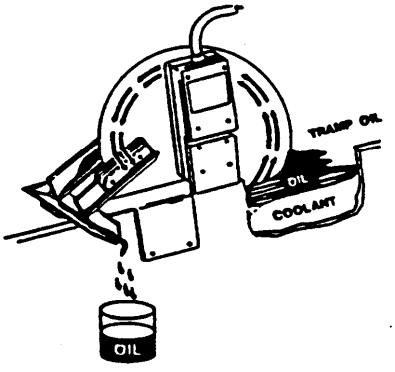


Chemical Precipitation Chemical treatment products are added to waste solutions to neutralize dirt, oil and dissolved metals, allowing the resulting sludge to be skimmed off or 'dropped' to the bottom of a vessel.

Cloth Filter The fluid drains through cloth filter media to remove solid materials.

Coalescer Tank Plastic media that attracts oil to promote formation of oil 'floats' that can be skimmed Off.

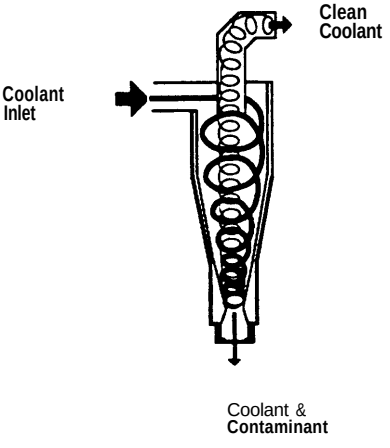
Disc skimmer Skimmer disc attracts tramp oil and scrapes it into an oil container.



Drag tank A tank with an automatic drag bar or rake device to remove metal shavings and other settled solids.

Evaporation Waste solution is boiled, causing the water to be vaporized and exhausted, the free oils to be removed through an overflow weir, and solids to be settled and removed through a bottom port.

Hydrocyclone A cyclonic device that separates solids from the fluid.

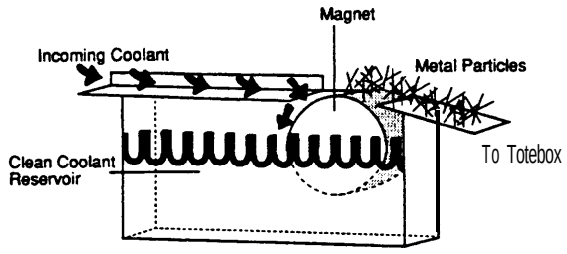


Ion Exchange

Ion exchange resin beads remove dissolved metals from waste stream. Resin tanks are shipped back to manufacturer for reconditioning or reconditioned in-house.

Magnetic separator

Used to collect ferrous metal shavings.



Pasteurization

The fluid is heated to improve separation of solids, reduce biological activity, lower centrifuge maintenance, reduce tramp oil layer and eliminate ‘rotten egg odor’.

Pressure filter

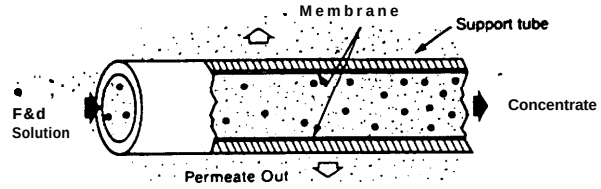
Fluid is pushed under pressure through a canister or bag filter media.

Settling tank

A tank containing baffles and weirs to assist in the settling of solids.

Ultrafiltration (UF)

Fluid is pressurized and passed through cylindrical tubes containing a semi-permeable membrane, with ‘cleaned’ fluid (called “permeate”) passing through membrane, while dirty fluid is concentrated, recirculated and eventually pumped out for off-site disposal.



Vacuum filter

Fluid is pulled by vacuum through a roll or cylinder media.

The economics of fluid maintenance systems need to be carefully evaluated based on specific, individual situations. Outlined below are a two case studies:

Case Study A 1993 US EPA report [EPA/600/SR-93/114] reviewed a mobile recycling unit where the customer was charged a fixed fee for the service. The unit used a combination of filtration, pasteurization, and centrifugation. The economic evaluation compared the costs for recycling versus disposal costs. Recycling costs included the onsite service charge for the customer and tramp oil disposal cost. Disposal costs included spent fluid disposal cost and hazard waste analysis cost. The annual savings for a typical small user, who recycled 1,250 gal/year of metal working fluid, was approximately $1,600 if the fluid was nonhazardous, and $7,800 if the spent fluid was hazardous.

Case Study An article in *Modern Application News (MAN),* July 1995, reported that an aerospace fastener manufacturer in Southern California has implemented a waste reduction strategy that will save them an expected minimum of $18,000 annually. The company uses an oil management service that decreases disposal and liability, enhances production quality and decreases overall costs. "On-site filtration equipment, blending tanks, and pumps purify the used straight oils, and customized reformulation with necessary additives adjusts viscosity and chemical characteristics. The company has reduced annual waste oil disposal from 10,000 gallons to 1,000 gallons, and expects to recoup the initial capital investment for filtration equipment, blending tanks and pumps completely within two years.

Using a Centralized System

Whenever several machines use the same type metalworking fluid, the economics of a central replenishment and recirculating system should be investigated. The use of a central system assists in starting a fluid management program. A central system allows for convenient, proper monitoring of concentrations and microbial growth. Central systems can also make it economically feasible to install filtration equipment that removes tramp oils and other contaminants.

Figure 5 provides an example of the process flow in an integrated coolant recovery system.

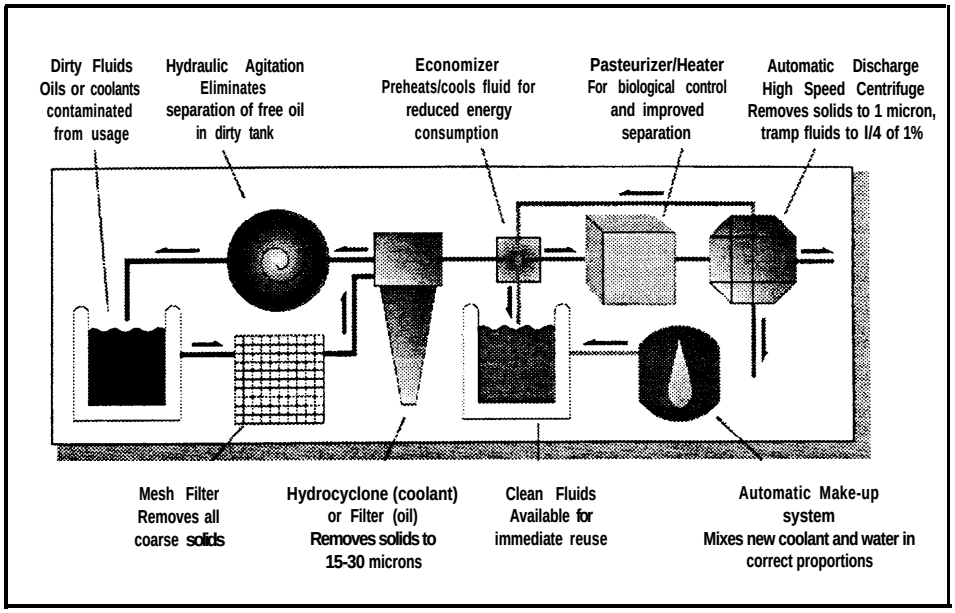


Figure 5. Process Flow Diagram of an Integrated Coolant Recovery System.

Provided courtesy of Sanborn Technologies.

Cleaning and Sanitizing the System

It is important to flush the system when changing fluids, preferably with a cleaning solution recommended by the fluid vendor. Bacteria can breed in the nooks and crannies of most machines and fluid systems. If these bugs are not removed, they will immediately begin to contaminate the new fluid and significantly reduce its life.

To combat rancidity, it may be necessary to clean and sanitize the system. This generally requires several steps and the use of a cleaner and special sanitizer. Because special cleaners and sanitizers are used for this process, vendor assistance should be used in their application. Outlined in the next section are procedures used for cleaning and sanitizing machine tools.

Cleaning Procedure for Machine Tools:

(Provided courtesy of DuBois Chemicals, Inc.)

The following procedure outlines tactics for combating rancidity:

1. Drain the machine.
2. Remove all chips, mud, debris, etc.
3. Hose down the sump with fresh water to loosen any additional dirt.
4. Fill the system with a solvent-emulsified detergent. A dilution of 1: 15 to 1:25 is typically in the proper range. Some machines require a stronger solution if they are extremely dirty. Check with the metalworking fluid vendor for choosing correct product and concentration.
5. Circulate for 2 hours or more. Use common sense. If the sump is completely visible and clean, less time may suffice. While the cleaner circulates, clean the sump covers, outside of machine and any areas that need cleaning.
6. Drain the cleaning solution.
7. Remove additional chips, debris, and dirt loosened by the solvent-emulsified detergent. A second cleaning may be necessary if the sump is extremely dirty. Again, use common sense.
8. Rinse thoroughly with fresh water.
9. Drain rinse water, remove additional chips, debris, and dirt loosened by rinse.
10. Rinse thoroughly again. This will eliminate any possible foam from residual cleaner.
11. Drain machine.
12. Remove any loose dirt and debris:
13. Check machine. Be sure a good job has been done. Also, examine themachine for oil leaks which contribute to tramp oil. This is also an excellent time to make any repairs that may be needed.
14. Charge machine with proper metalworking fluid. Titrate and maintain recommended concentration.
15. OPTIONAL: If microbial problems have been severe and typical cleaning maintenance is not resulting in satisfactory tank life, a Sump Sanitizing Procedure is outlined below. It should be followed after Step 13 of Normal Cleaning Procedures.

Sanitizing Procedures:

Purpose: To reduce microbial populations after normal cleanout procedures.

1. Follow the MSDS and label precautions for all products - rubber gloves, eye protection, etc. Avoid inhalation of **fumes** and maintain good ventilation.

2. Circulate the appropriate vendor qualified chlorine-based cleaner/sanitizer at 2 to 4 oz./gal. in tap water throughout the system for 30 minutes.
3. Hand clean nozzles, pans, machine exterior, and holding tank above coolant line with the same cleaner/sanitizer mix.
4. Drain the sanitizer mix.
5. Flush all lines, machine exteriors, and other surfaces thoroughly with tap water to remove all residual cleaner/sanitizer.
6. Flush coolant lines with tap water until 1 ppm or less or residual chlorine is left. Use a chlorine swimming pool kit or use common sense to decide how much rinsing is needed to remove residual.
7. Recharge system with fresh coolant.

OTHER FLUIDS AND LUBRICANTS

Other fluids and lubricants are used in the metal fabrication process and offer additional ways in which waste reduction can be achieved. This section discusses waste reduction techniques for forming and drawing lubricants, hydraulic fluids, and other equipment lubricants.

Forming and Drawing Lubricants

This section is devoted to dealing with some of the types of forming or drawing metals. These include:

- Punch presses
- Forming presses
- Progressive dies
- Deep drawing of sheet steel
- Hi-speed dies
- Low volume production dies
- Wire drawing

Lubricants may be either a wet or dry base material. Wet based materials would include:

- Petroleum oil based products
- Synthetic based material
- Water based material
- Soap based products, especially for wire drawing

Dry based materials include:

- Soap based material
- Synthetic materials

All of these lubrication systems require the use of one or more of the materials noted above with the metal being formed or drawn. The amount of material to be added is a direct function of the type and extent of the metal forming/drawing. In most cases, this lubricant must be removed prior to following operations, such as plating or painting.

Waste Reduction Techniques for Forming and Drawing Lubricants

No Additional Material – Talk with the vendor of the stock material to determine if the lubricant used on the stock will be supplied consistently. Then decide if there is sufficient lubricity to permit proper forming or drawing in the operation.

> ***TIP - Look at the total cost of the operation, taking into account the wear of the tooling and the appearance of*** *the* ***finished product (no unsightly scratches) when deciding if using the sheet steel on an "as received" basis is advantageous.***

Change from a Wet Material to a Dry Compound – Using a dry compound may avoid contaminating the wet solvent or the wet transfer agent. Further, it may eliminate one additional material that must be reclaimed at a later point in the operation.

Use ***a Precoated or Primed Material –*** A material precoated with lubricant may not require any additional lubrication, eliminating the need to be removed prior to the coating of the stamped product.

> ***TIP - Anytime that the use of a material that is not an integral part of*** the ***final product can be avoided, a reduction of cost and waste is achieved.***

Lubrication Required to Produce Product to Specification – If additional lubrication is necessary, there are several actions that can be used to minimize the use of that lubricant.

- Determine the ***least*** amount of lubrication that is needed to assure proper functioning of the forming equipment and the proper location for the application of the lubricant.
- Ultrafiltration of oily wastes can remove soluble oils and other impurities, concentrating the contaminants for easier disposal. In one case an ultrafiltration system reduced hazardous waste generation by 90%.
- Proper storage and inventory control reduce spoilage and obsolescence.
- Encourage the recycling of metalworking fluids by the manufacturer and by contract sources. Selection of lubricants that will enhance this process will further reduce waste and costs. This process includes reuse of the lubricant once it had been recycled/reprocessed.

Each and every operation must be carefully reviewed so that the best one may be selected. There is no substitute for careful analysis and a ***new approach*** to the problem of waste reduction. There is no one best solution that will fit every situation, since each situation is unique. The challenge of improving an operation in a cost effective manner can result in a very satisfying conclusion.

Case Study

Ad eburring job shop received, from the customer, workpieces coated with a viscous stamping oil. About 9,000 pounds of parts were deburred per day. Between 20 to 60 pounds (2 to 7 gallons) of oil coated parts. The oil was being removed in the tumbling process, but was causing violations of the oil and grease limits on sewer discharges. The company installed a table with a screen bottom to drain the parts prior to tumbling and collected the oil and returned it to the customer.

Hydraulic Fluids

The nature of a hydraulic system (closed and under pressure) eliminates many of the types of contamination found in other types of lubrication systems. Because the system is closed and under a positive pressure, the only normal contamination comes from a deterioration of the hydraulic mechanisms (seals, pistons and pumps).

Normally, the choice of hydraulic fluids is rather limited, especially in comparison to normal lubricants and metalworking fluids. Thus the analysis of a hydraulic system is much simplified, but this does not mean that considerable savings are not available to the operation.

- Use the appropriate grade of hydraulic fluid in the system. Check with the equipment system manufacturer and the hydraulic fluid vendor to verify the right fluid is being used. A poorer grade of fluid could result in higher wear which could quickly contaminate the hydraulic fluid as well as cause abnormally high wear on system components. Likewise, a higher grade could result in greater expense with no value added.
- Additive packages found in many hydraulic oils are very detrimental to metalworking and metalforming fluids, especially zinc dithiophosphates (ZDTP) .
- The next step is to be certain that the cleanliness of the fluid is monitored on a regular basis, using appropriate filters to keep the fluid as clean as possible.
- Finally, replace the fluid on a regular schedule.

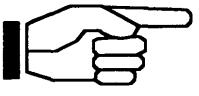
Reclamation and Reuse of Hydraulic Oil – Using filtration, thin film evaporation, distillation and oil-water separation, it is possible to recover hydraulic oil for reuse. Major causes of hydraulic oil loss are breaks in the hydraulic hoses and an occasional problem with the oil/water tube heat exchangers. In the past these oils were collected and placed in landfills, but with new technology another alternative is available.

Case Study

A medium sized company in Snow Hill, North Carolina has 30 hydraulic presses. The hydraulic oil recovery system recovers 10 gallons of hydraulic oil per hour at a cost of $0.40 per gallon - making it possible to reuse all of the hydraulic oil. Prior to installation, the company used 8,000 gallons of oil per year at a cost of $24,000. With the recovery unit they recover all 8,000 gallons. Considering the savings for purchase of new oil, the previous cost of disposal and the cost of operation, this company has saved approximately $3 1,000 per year.

Equipment Lubricants

In contrast to the previous section on hydraulic oils, equipment lubricants (including the semi-solid greases) are an extremely diverse group and cover a wide range. Additionally, because the systems are generally open, the lubricants are easily contaminated.



***TIP** - Because of the diversity, it is crucial to follow the suggestions of the machine builder when selecting machine/equipment lubricants. However, this is only a starting point. With a solid machine maintenance system in place, and with careful and detailed records, the cost benefits of selected lubricants can be maximized. Remember, it is not just the cost of the lubricant that must be considered - all related costs must be considered as well. These costs include the cost of the lubricant, the cost of changing or adding lubricants, the machine wear characteristics, and downtime of production.*

Reduction of Use – The easiest step to reduce unnecessary lubricant use and the subsequent disposal of used products, is to accurately determine the minimum amount of lubrication that will satisfy equipment need. This will be determined by using equipment manufacturer recommendations and both careful review of maintenance records. Also, careful control of inventory can be a substantial benefit, assuring that lubricants are not subject to deterioration or obsolescence.

Substitution – Make sure that substitute lubricants (other than those specified for the original equipment) are really an advantage. Check with the equipment manufacturer to verify that the substitute lubricant is suitable for use in the particular equipment application. For example, synthetic lubricants may last longer and therefore eliminate some costs of maintaining the equipment, including maintenance down time and frequency of service.

TIP - The initial cost of a lubricant, while potentially higher, may result in an over all cost savings once all factors are considered.

Reclaiming Waste Lubricants – There are two primary ways to reclaim used or waste lubricants:

- reclamation at the use site
- use of reclamation services

The decision depends on the needs and cost factors. In general, if the volume of used lubricants is relatively small, the capital expense of putting in a reclamation system may be prohibitive.

However, if the volume of used lubricants is large, installing a reclaim system is likely to be cost justified, with substantial savings. By keeping control of the used/waste lubricants one assures that the reclaimed material will be put back into service with the specified characteristics required for the particular machinery.

Case Study

The Semiconductor Industry Association reported that in one company 90% of waste oil was reclaimed for reuse by means of a distillation and filtration system. The system draws oil by vacuum from waste oil tanks, through a prefilter, an adjustable flow control valve, and through an electric heater into a vaporizer. The moisture and dissolved gases are drawn off in the form of a vapor. The vapor is condensed and collected for disposal. The purified oil is pumped through a polishing filter and collected for reuse. Although capital cost was $20,500, the system reduced virgin oil requirements, reduced waste oil disposal volume, making the project cost justifiable.

Case Study

A firm in New Jersey reported similar results by filtering and recirculating lubricating oils. The contamination within their system was reduced by using more corrosion resistant materials and improved equipment sealing systems. While the results were not reported in detail, the study indicated that the manufacturer had been generating 110 gallons per month prior to the program initiation. For more detail, contact Richard Gimello or Susan Boyle at the New Jersey Hazardous Waste Facilities Siting Commission. 28 West State Street. Trenton, New Jersey 08606.

METAL CHIPS AND SWARF

Depending on the quantity of metal chips generated in the production process, it may be practical to recover chips and earn a profit by selling them to a scrap metal dealer. The financial decision to keep the chips separated from each other and swarf should depend, in part, on the advice of scrap metal dealers.

If the quantity produced warrants and is otherwise economically feasible, chips should be separated into the following groups:

- boring chips of cast iron
- short drillings or turnings of steel
- long turnings of steel

If interested in starting a chip recovery program, contact "Scrap Metal Dealers" in the local yellow pages.

Swarf is defined as "metal fines and grinding wheel particles generated during grinding". As mentioned in the Regulatory section of this manual, the disposal of fluids and swarf must be done according to local regulations.

Depending on the value and quantity of metal fines, there may be a cost benefit to recovering metal fines from swarf by using ceramic filters to separate out the larger metal particles.

The next section discusses ways in which a Waste Reduction Team can be developed.

WASTE REDUCTION IMPLEMENTATION

The methods suggested in the previous sections should spark some ideas of cost-effective waste reduction techniques that can be used in many shop operations. Outlined below are two ways in which a company can implement a waste reduction plan.

Setting Up a Waste Reduction Team

Consider setting up a Waste Reduction Team at each facility to identify, plan, and implement a waste reduction strategy. Draw on other resources within the company to assess all aspects of the program:

- Include personnel from production, maintenance, engineering, purchasing, and accounting
- Identify waste sources and their associated overall cost
- Give this *manual* to each team member to help spark ideas
- Review the following areas:
  1. General housekeeping
  2. Water condition
  3. Emulsion stability
  4. Tool/wheel life
  5. Rancidity
  6. Tramp Oil
  7. Oxidation
  8. Contamination
  9. Foam and
  10. Misting
- Gather information from vendors and other resources (listed in the "***Where To Go To Learn More"*** and ***"Metalworking Fluid and Filtration Buyer's Guide"*** of this manual)
- Evaluate the performance, economics and quality impact of all alternatives
- Implement improvements that make the most sense for a given operation
- Measure and report the cost savings to the team and management
- Motivate the team and foster continuous improvement
- Make corrections to the process as necessary

A plant *Self Assessment Survey* is included in the next section as a suggested starting point. The first task of the fluids committee is to gather and record operation data for production and metalworking fluids. Completing the assessment survey is a time consuming task. By adding their input and recording factual data, each team member will assist the others to understand what goes into the program to achieve and maintain high production output and minimize rework, scrap and coolant waste.

The data gathered and recorded will aid in identifying the real cost for purchasing, storing, using, and recycling metalworking fluids.

Waste Minimization of Metalworking Fluids *Self Assessment Survey*

The following worksheets are designed to help assess a company's current waste reduction program and to generate ideas to establish a waste reduction program. Once the questions from WORKSHEET 1 have been completed, a company can then decide if further measures are practical or necessary. If "No" is checked for any questions, investigate that part of the operation to see if any changes are justified.

For a simple cost comparison between not recycling and recycling, fill out WORKSHEET 2.

NOTE: If neccessary, a more detailed Self Assessment Survey(form TW-I 0) is available from the Institute of Advanced Manufacturing Sciences.

Date: Shop: Prepared By: WORKSHEET 1

QUESTIONS:	❑ Check Yes Or No
Has the fluid selection process been reviewed and has the correct fluid been selected for each metalworking operation?	☐ Yes ☐ No
Has a fluid maintenance program started?	☐ Yes ☐ No
Is deionized water used for system makeup?	☐ Yes ☐ No
Is a method used to keep tramp and trash out of the fluid?	☐ Yes ☐ No
Are biocides and other additives used to extend fluid life?	☐ Yes ☐ No
Are all fluids filtered and reused?	☐ Yes ☐ No
Have meetings with the fluid supplier been recent to review the fluids program and to see if new technology exists that might further extend the life of the fluid or cause the fluid to have lower environmental impact?	☐ Yes ☐ No
If a central fluid handling system does not exist, does it make sense to consider installing one?	☐ Yes ☐ No
Is each piece of equipment thoroughly cleaned and sanitized on a regular basis?	☐ Yes ☐ No
Have the forming and drawing lubricants operations been reviewed to find ways to reduce waste?	☐ Yes ☐ No
Is a hydraulics fluid recycling program in place?	☐ Yes ☐ No
Is a program in place to deal with the waste generated from metal swarf and chips?	☐ Yes ☐ No
Has a waste reduction team been established?	☐ Yes ☐ No
If "Yes" was answered for the question above, who are the members and what are their positions with the company?	☐ Yes ☐ No
Have you considered waste reduction consultants for help on the tougher waste reduction processes?	☐ Yes ☐ No
Are good housekeeping procedures for each piece of metalworking equipment in place?	☐ Yes ☐ No
Has a waste reduction audit been previously conducted?	☐ Yes ☐ No
Have other losses from not recycling been considered, such as increased downtime, decreased performance, increased material reject and scrap, equipment damage, etc.?	☐ Yes ☐ No

Additional Comments:

Date: Shop: Prepared By: WORKSHEET 2

TABLE I -Purchase Costs of New Fluids

Fill in the data below: *Calculations:*

Column Number:	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Fluid Type or Name	Application	Gallons Fluid Used/ Year	Price/ Gal.	Dilution Ratio	Water Used/ Gal. Fluid	Water Cost/Gal.	Annual Water Usage	Annual Cost of Water	Annual Cost of Fluid	Total Cost/Year
							= Column B x Column E	= Column G x Column F	= Column B x Column C	= Column I + Column H
1										
2										
3										
4										
SUB-TOTAL:										

TABLE II -Disposal Costs of Waste Fluids

Fill in the data below: *Calculations:*

Column Number:	*A*	*B*	*C*	*D*	*E*
Waste Fluid Type	Source	Disposal or Treatment Method	Amount Disposed in Gal./Year	Disposal or Treatment Cost/Gal.	Annual Disposal or Treatment Cost
					= Column C x Column D
4					
SUB-TOTAL:					

Total Current Cost Metalworking Fluids (Add SUB-TOTALS from Tables I & II above):

This information is valuable in analyzing the current fluids program and comparing it to a program that includes methods for increasing the life of fluids and reducing the associated wastes. For example, some companies have seen reductions in costs of Up to 80% by implementing the techniques in this manual. **For further information** consult with the appropriate vendor (a Buyer's Guide is listed in the back section of this manual).

RESOURCES: WHERE TO GO TO LEARN MORE

State Pollution Prevention Offices - Most states provide non-regulatory pollution prevention technical assistance for industry. Call the National Pollution Prevention Roundtable (202-466-7272) to learn about a particular state's options.

The U.S. Environmental Protection Agency (EPA) - provides free technical information on a variety of pollution prevention topics and cleaner technologies.. For a publications list contact: CERI Publications Unit, US EPA, (513-569-7562). A wealth of information is available from Enviro$ense, EPA's environmental information system. Enviro$ense can be found via the World Wide Web (Internet) at http:// wastenot.inel.gov/envirosense

The Independent Lubricant Manufacturers Association (ILMA) - is a trade association that provides information on metalworking fluids and lubricants. (703-836-8503) ILMA has published an excellent collection of articles titled, *Waste Minimization and Wastewater Treatment of Metalworking Fluids, 1990.*

Institute of Advanced Manufacturing Sciences (IAMS) - provides both waste reduction technical assistance and expertise in machining and machine tool technology. Related courses are offered regularly at their training facility in Cincinnati: *Practical Machining Principles for Shop Application, Grinding Principles and Practice, and Center-less Grinding Principles. IAMS* also has published the *Machining Data Handbook, 3rd Edition (1980),* (call 800-345-4482). Internet home page: *http:// www. iams. org*

Waste Reduction Resource Center (WRRC) - provides multimedia waste reduction information supported by reports, contact lists, referrals, case summaries, seminar support, on-site technical assistance, vendor files and a video library. Provides support in FL, GA, KY, MI, NC, SC, TN, DE, DC, MD, PA, VA, and WV.

Waste Reduction and Technology Transfer (WRATT) Foundation - provides free, confidential, voluntary, non-regulatory assessments for business and industry and conducts training programs on waste minimization call: (205) 386-3869.

Metalworking Fluids, Jerry P. Byers, Marcel Dekker, Inc., New York, NY (1994).

Machine Coolant Waste Reduction by Optimizing Coolant Life, J. Pallansch, U.S. EPA, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH (1989).

Example of Daily Log Sheet

Metalworking Fluids Log Sheet & Service Report

(Provided courtesy of DuBois Chemicals, Inc.)

ACCOUNTNAME _____ ACCOUNT NO. _____

ADDRESS _____ PHONE NO. _____ SALES REP. _____

CITY /STATE/ZIP _____ CONTACT NAME(S) _____ RECAP NO. _____

PRODUCT _____ RECOMMENDED pH _____ RECOMMENDED CONCENTRATION _____

TIME		OPERATION				TOOL CONTROL		METALWORKING FLUIDS CONTROL						MACHINE / SYSTEM CLEANED	COMMENTS/RECOMMENDATIONS	INVENTORY	
DATE	HOUR	MACHINE LOCATION	OPERATION TYPE	METAL TYPE	MICRO FINISH	TOOL MATERIAL	#PARTS PER TOOL CHNG.	PRODUCTS IN USE NAME	PRODUCTS IN USE TYPE	pH ACTUAL	TITRATION DROPS ACTUAL	REFRACT READING ACTUAL	CONCEN-TRATION ACTUAL	DATE		ACTUAL	

PRICE PER GALLON ÷ CONCENTRATION = USE COST PER GALLON
COST TO CHARGE MACHINE = COST X VOLUME OF SUMP
VOLUME OF SUMP IN GALLONS = LENGTH X WIDTH X DEPTH (OR HEIGHT OF FLUID) (CUBIC FEET) X 7.48
VOLUME OF SUMP IN GALLONS = LENGTH X WIDTH X DEPTH (OR HEIGHT OF FLUID) (CUBIC INCHES) ÷ 231

GLOSSARY OF TERMS

Additive	Sulfur, chlorine, and other materials added to cutting fluids to improve lubricity, stabilize oil emulsions, and prevent chipwelding under high heat and pressure.
Anaerobic Organism	An organism that lives in the absence of oxygen.
Bacteriocides	Materials added to cutting fluid to inhibit bacterial growth.
B iocide	An EPA registered product added to metalworking to inhibit the growth of bacteria, fungi, and molds.
BOD	Biochemical oxygen demand of water; a measure of the oxygen required by bacteria for oxidation of the soluble organic matter under controlled test conditions.
Boundary Additives	Sulfur, chlorine, phosphorus, and other compounds. When added to cutting fluids, they fill in surface irregularities at the tool/workpiece interface, creating a lubricating film.
Coagulation	The neutralization of the charges of colloidal matter.
Coalescence	The gathering together of coagulated colloidal liquid particles in to a single continuous phase.
COD	Chemical oxygen demand; a measure of organic matter and other reducing substances in water.
Concentrate	Agents and additives that, when added to water, create a cutting fluid.
Coolant	Fluid that reduces temperature buildup at the tool/workpiece interface during machining
Cutting Fluid	Liquid used to improve workpiece machinability, enhance tool life, flush out chips and machining debris, and cool the workpiece and tool. Three basic types are: straight oils: soluble oils, which emulsify in water; and synthetic fluids, which are water-based chemical solutions having no oil. Each category often exhibits some properties of the other.
Deionization	Removal of ions from a water-based solution.
Eductor	A simple chemical/water proportioning device that operates based on a pressure drop across an orifice.
Electrolyte	A substance that dissociates into two or more ions when it dissolves in water.
Emulsion	Suspension of one liquid in another, such as oil in water.
EP (extreme pressure) Additives	Cutting-fluid additives (chlorine, sulfur, or phosphorus compounds) that chemically react with the workpiece material to minimize chipwelding; good for high-speed machining.

Film Strength	Relative ability of a fluid to form a film between workpiece and tool, under the influence of temperature and pressure, to prevent metal-to-metal contact.
Filtrate	The liquid remaining after removal of solids as a cake in a filter.
Filtration	The process of separating solids from a liquid by means of a porous substance through which only the liquid passes.
Flocculation	The process of gathering coagulated particles into settleable flocs
Flood Application	Fluid applied in volume by means of a recirculating system comprised of a reservoir, filter, chip-removal components, pump hoses, and positionable application nozzles, along with movable splash shields, valves for adjusting flow, and other controls. Normally permits the highest metal-removal rates possible with fluids. It requires careful setup and adjustment, as the stream and attendant splashing may obscure the cut point from the operator's view.
Flushing Hose	Hand-operated hose and nozzle added to machine's cutting-fluid application system to permit manual flushing of table and workpiece areas.
Fungicide	Material added to chemical or soluble-oil cutting fluids to inhibit the growth of fungi and bacteria.
Hazardous	A chemical that has a negative affect on the environment or poses a threat to human health.
ILMA	Independent Lubricant Manufacturers Association.
Ion Exchange	A process by which certain ions of given charge are absorbed from solution within an ion-permeable absorbent, being replaced in the solution by other ions of similar charge from the absorbent.
Lubricant	Substance that reduces friction between moving machine parts. Can be liquid (hydrocarbon oil), solid (grease), or gaseous (air). Important characteristics are to prevent metal-to-metal contact between moving surfaces, be a cooling medium, and protect surfaces from rust and corrosion.
Lubricity	Measure of the relative efficiency with which a cutting fluid or lubricant reduces friction between surfaces.
Membrane	A barrier, usually thin, that permits the passage only of particles up to a certain size.
Miscible	Ability of a liquid to mix with another liquid.
Mist Application	Atomized fluid generally applied when a clear view of the cut point is needed, as in contour bandsawing or manual milling. The airborne mist can be directed precisely to the point of cut, sometimes reaching areas flood-applied coolant will not penetrate. The water evaporates on contact, providing further cooling and leaves oils and additives on the work.

Mixture Ratio	Ratio of water to concentrate in certain cutting fluids (i.e., 5: 1).
Monday Morning Odors	Odors caused from the build up of hydrogen sulfide gas due to growth of anaerobic bacteria.
MSDS	Material Safety Data Sheet required by OSHA for all industrial chemicals.
NPDES Permit	The National Pollution Discharge Elimination System permit required by and issued by EPA.
OSHA	Occupational Safety and Health Administration. Regulates health and safety standards in the work place.
Pasteurization	A process for killing pathogenic organisms by heat applied for a critical period of time.
PH	A means of expressing hydrogen ion concentration in terms of the powers of 10; the negative logarithm of the hydrogen ion concentration.
Polar Additives	Animal, vegetable, or synthetic oils that, when added to a mineral oil, improve its ability to penetrate the work/tool interface.
Pollutant	A contaminant at a concentration high enough to endanger the environment or public health.
POTW	Publicly Owned Treatment Works for sewage treatment.
Precipitate	An insoluble reaction product in an aqueous chemical reaction, usually a crystalline compound that grows in size to become settleable.
Rag	Debris that accumulates at an oil-water interface.
Rancidity	Bacterial and fungal growths in water-miscible fluids that cause unpleasant odors, (“Monday morning odors”) stained workpieces and diminished fluid life.
RCRA	Resource Conservation and Recovery Act. Regulates the generation, transportation, treatment, storage and disposal of hazardous solid waste.
Refractometer	An optional instrument that measures the refractive index of a metalworking fluid used to determine concentration.
Reverse Osmosis	A process that reverses (by the application of pressure) the flow of water in the natural process of osmosis so that it passes from the more concentrated to the more dilute solution.
Sanitizer	An EPA registered compound used to reduce microbial growth.
SARA	Super-fund Amendments and Reauthorization Act. Contains the Emergency Planning and Community Right-to-Know Act.
Sedimentation	Gravitational settling of solid particles in a liquid system.
Semi-synthetic Cutting Fluid	Water-based chemical solution that contains some oil.
Separation	Removes the particles from the fluid using a characteristic of the materials, i.e. density or magnetism. Separators randomly remove particles. A certain size of particle removal cannot be guaranteed.

Shop Air	Pressurized air system that cools the workpiece and tool when machining dry. Also refers to central pneumatic system.
Soluble-Oil Cutting Fluid	Fluid in which oil is suspended in water. Since water is a superior heat-removal agent, these fluids are primarily used when lubrication is desirable, but cooling is the key consideration. The ratio of oils and other additives to water varies with the application. For milling, the ratio of water to oil/additives runs 20: 1 to 25: 1. For sawing and other work, where a more confined tool/chip/workpiece condition is normal, a 1O:l ratio is used to improve lubricity. Additives include emulsifying agents that help keep the oil in suspension and substances that promote wetting, enhance lubricity, prevent chipwelding and inhibit rusting. Also known as emulsified oil.
Straight Oil	Cutting fluid that contains no water. Produced from mineral, vegetable, marine, or petroleum oils, or combinations of those oils.
Surfactant	A surface active agent; usually an organic compound whose molecules contain a hydrophilic (having an affinity for water) group at one end and a lipophilic (having an affmity for oil) group at the other (a detergent).
Swarf	Metal fines and grinding wheel particles generated during grinding.
Synthetic Cutting Fluid	Water-based solution that contains no oil. Normally contains additives that improve lubricity and prevent corrosion, rancidity, etc.
TCLP	Toxicity Characteristic Leaching Procedure test method used by labs to determine if waste is classified as hazardous.
Titration	Testing method that uses reagents to determine concentrations of metalworking fluids and other chemical solutions.
Tramp Oil	Oil that is present in a metalworking fluid and is not from the product concentrate. The usual sources are machine tool lubrication systems and leaks.
Ultrafiltration	A physical molecular separation process which operates at moderate pressure (30psi) through a semi-permeable membrane.
Viscosity	Measure of a fluid’s tendency to flow; varies with temperature.
Waste	An unwanted by-product of a manufacturing process.

METALWORKING FLUID AND FILTRATION EQUIPMENT BUYER'S GUIDE

This is an alphabetical guide of vendors for Metalworking Fluids, Filtration Equipment and other support materials used in the metalworking industry. Included is a list of each company's name, address, phone, fax, contacts, and product offering. The majority of this list was provided by Modern Application News (MAN) (May, 1995 issue), a monthly magazine that specializes in the metalworking industry. This list is not comprehensive and represents some of the available vendors and the products and services they offer.

Company Name	Address/ Phone/Fax	Management/Contacts	Products
3-D INTERNATIONAL, INC.	PO Box 201133 Bloomington, MN 55420 Tel 612/888-4520 Fax 612/888-4520	Del Radeztsky, President/CEO; Frank Sniderich, Marketing Director; Denis Dudrey, Vice President/Corp. Technology	Three-bowl (liq/solids) centrifuge filtration systems; Liquid/liquid centrifuge systems for tramp oil removal
AETNA MFG. CO.	4622 68th Avenue Kenosha, WI 53144 Tel 414/654-1170 Fax 414/654-1788	Terry Peterson, Vice President/Sales; Jay Krafft, Vice President/Manufacturing	Mistic Mist spray lube systems; Mistic Mist concentrate--coolant; Mistic 2000--lube dispenses; Mistic 2000--lubricants
AMERATRON PRODUCTS INC.	PO Box 659 Suffrern, NY 10901 Tel 914/357-3279 Fax 914/357-8833	Mindy Pirro, President; Tony Pirro, Vice President	Clear mint plus coolant (synthetic); Tap mint coolant (synthetic); Buff-o-mint (synthetic grinding coolant); XL-63 sump cleaner
AMERICAN SAW & MFG. COMPANY	301 Chestnut Street E. Longmeadow, MA 01028-0504 Tel 413/525-9605	Jim Kacalekas, Product Manager; Joe Jankowski, Fluids Manager; Ann Rooke, Communications Coordinator	Band-Ade sawing fluid; Lenox lube; Lenox machine cleaner; The Micronizer applicator
AML INDUSTRIES, INC.	3500 Davisville Road Hatboro, PA 19040 Tel 215/674-2424 Fax 215/674-3252	Aaron Lavin, President	Industrial centrifuges; Oil/water separator; Liquid/solid separator
ARMSTRONG-BLUM MANUFACTURING	1441 Business Center Drive Mt. Prospect, IL 60056 Tel 708/803-4000 Fax 708/803-4019	Thomas Tritschler, Sales/Marketing Director	ECO-DROP 2000 micro-dispensing system and lubricant
BARNANT COMPANY	28W092 Commercial Avenue Barrington, IL 60010 Tel 708/381-7050 Fax 708/381-7053	G. Sezemsky, President; Mark Stolman, Sales/Marketing Director; G. Keats, Engineering Director	Masterflex drives, pump heads; Temperature meters, probes; pH meters, Gilmont flowmeters
BARNES INTERNATIONAL, INC.	814 Chestnut Street Rockford, IL 61105-1203 Tel 815/964-8661 Fax 815/964-5074	Ron Cosler, Vice President/General Manager; Terry Connel, Vice President/Sales, Filtration Systems Div.; Tom Lenhart, Vice President/Engineering	Honing Systems;Filtration systems; Modular robotic systems
BARRETT CENTRIFUGALS INC.	PO Box 15059 Worcester, MA 01615 Tel 508/755-4306, 800/228-6442 Fax 508/753-4805	Steve Ayres, President; Steve Foskett, Sales Manager; Neil Billings, Vice President/Engineering	Oil extractors; Liquid/solid filters; Liquid/liquid filters; Sludge dewatering centrifuge
BIJUR LUBRICATING CORP.	50 Kocher Drive Bennington, VT 05201-1994 Tel 802/447-2174 Fax 802/447-1365	Darold Myers, Sales Manager; Peter Sweeney, Marketing Manager; Herb Taylor, Chief Engineer	Suremetic grease systems; Versamatic oil systems; Airmatic oil systems; Air/oil injector systems
BLASER SWISSLUBE INC.	Westgate Industrial Park Goshen, NY 10924 Tel 914/294-3200 Fax 914/294-3102	Ulrich Krahenbuhl, Executive Vice President/General Manager; Hans Schneider, Vice President/National Sales Manager	Blaser metalworking fluids
BOWDEN INDUSTRIES	1004 Oster Drive Huntsville, AL 35816 Tel 205/533-3700 Fax 205/539-7917	Don Bowden, President; Michael Hunt,Sales/Marketing; Bruce Roth, Engineering	Parts washing systems; Oil de-emulsifiers; Detergents; Baskets
CASTROL INDUSTRIAL	1001 W. 31st Street Downers Grove, IL 60515 Tel 708/241-4000 Fax 708/241-1977	Don Dorsey, Vice President/General Manager; Jim Besecker, Vice President/Sales; Jan Ciccarelli, Marketing; Dennis Zintak, Engineering Manager	Syntilo; Clearedge; Ilocut; Honilo
CHEMICAL TECHNOLOGIES, INC.	1610 Clara Street Jackson, MI 49203 Tel 517/782-8262, 800/688-8262 Fax 517/782-2448	Larry Schramm, President; Doug Van Arsdelen, General Manager; Dan Karagozian, Regional Sales Manager; Jim Cramer, Vice President/Technical Director	Coolants; Cleaners; Drawing & stamping compounds; Corrosion preventives; Die cast lubricants
CINCINNATI MILACRON - PRODUCTS DIVISION	P.O.Box 9013 Cincinnati, OH 45209 Tel 513/841-8121 Fax 513/841-7178	Jeff Welday, Marketing Manager	Coolants; Cutting and Grinding Fluids, forming fluids, protecting fluids; fluid management equipment, oil skimmers; proportioners; refractometers; recycling systems, ultrafiltration
CLARMATIC INDUSTRIES, INC.	PO Box 780 Pemberville, OH 43450 Tel 800/521-5246 Fax 419/287-4104	Robert Fox, President; Sandra Mahlman, Marketing; Merlin Hoodlebrink Sales Engineer	Gravity filters; Vacuum media filters; Wedgewire drum filters; Micro plus filters

METALWORKING FLUID AND FILTRATION EQUIPMENT BUYER'S GUIDE

Company Name	Address/ Phone/Fax	Management/Contacts	Products
CLC LUBRICANTS CO.	100 S. Old Kirk Road, PO Box 764 Geneva, IL 60134-0764 Tel 800/543-0505 Fax 708/232-7015	Joseph O'Brien, Jr.	Coolants, Lubricants; Cutting oils; Quench oils
COOK'S INDUSTRIAL LUBRICANTS	5 N. Stiles Street Linden, NJ 07036 Tel 908/862-2500 Fax 908/862-6885	Tony Soriano, President; Dick Cariss, Sales Manager; Axel Farhi, Manager/Product Development	Cutting oils and coolants; Stamping and drawing oils and fluids; Industrial lubricants; Cleaners
COOLJET SYSTEMS, Div. of MKT Innovations	2900-A Saturn Street Brea, CA 92621 Tel 714/577-9262 Fax 714/577-9271	Mike Kenney, President; Dave Whitaker, Sales Engineer; Frank Kenney, Systems Engineer	High-pressure coolant pumping systems (up to 1500 psi), valves, filtration, nozzles, etc.
CORTEC CORPORATION	4119 White Bear Parkway St. Paul, MN 55110 Tel 612/429-1100 Fax 612/429-1122	Boris Miksic, President; Barry O'Brien, Marketing Specialist; Gene Spancre, Technical Advisor	VCI-369; VCI-373; VCI-376; VCI-386
CRESCENT OIL COMPANY	PO Box 1266 Indianapolis, IN 46206 Tel 317/634-1415 Fax 317/630-5184	John Burns III, President; Glen Mayfield, Vice President/Fluid Management; Ted Lapworth, Vice President/Technical	Coolants; Industrial lubricants; Cutting oils; Rust preventives
D.A. STUART COMPANY	7575 Plaza Court Willowbrook, IL 60521 Tel 708/655-4595 Fax 708/655-1088	Jim Castle, President; Jim Morcrum, Group Vice President	Coolants; Cleaners; Specialty hydraulic fluids; Rollings oils
DUBOIS CHEMICALS, INC.	255 E. 5th St, Suite 1200 Cincinnati, OH 45202 Tel 513/762-6000 Fax 513/762-6601	Kim Markert, Product Manager; Chuck Soule, Director of Marketing	Metalworking fluids, coolants; lubricants, greases; protecting fluids; sanitizers, cleaners; metal finishing compounds; wastewater treatment chemicals
EDJETECH SERVICES	22036 Fairgrounds Road Wellington, OH 44090 Tel 800/242-0525 Fax 216/647-2400	Edward Heidenreich, President; Jack Kosmider, Sales Engineer; Joe Insana, Production Manager	Tramp oil separation systems; Coolant recovery systems; Ultrafiltration systems; Reverse osmosis systems
THE ELCO CORPORATION	1000 Belt Line Street Cleveland, OH 44109-2800 Tel 216/749-2605 Fax 216/749-7462	Robert Wyuill, General Manager; Tony Cristiano, Sales Manager	Anti-wear additives; Corrosion inhibitors; Chlorinated paraffin replacements; Friction modifiers
ELDORADO TOOL & MANUFACTURING CORPORATION	336 Boston Post Road Milford, CT 06460 Tel 203/878-1711 Fax 203/878-6156	Kenneth King, Marketing Director	High-pressure coolant systems; Gundrills; Gundrilling machines
ENCYCLON INC.	6705 14th Avenue Kenosha, WI 53143 Tel 414/654-0032 Fax 414/657-7435	Don Becker, President; Mark LaMere, Engineering	Cyclonic filtration systems; Disc-type oil skimmers; Drop-in refrigeration; UV ozone generators
GLOBAL DIVERSIFIED PRODUCTS	11401 16th Court North St. Petersburg, FL 33716 Tel 813/579-0011 Fax 813/579-4211	Russell Morris, Executive Vice President; Kamal Junesa, Vice President	Aqueous cleaners & degreasers; Aqueous metalworking coolants
GRAYMILLS CORPORATION	3705 N. Lincoln Avenue Chicago, IL 60613 Tel 312/477-4100 Fax 312/477-4133	Gerald Shields, President; Keith Vohwinkel, Market Manager; Craig Shields, Engineering Manager	Coolant pumps, and pump and tank systems; High-pressure coolant pumps and filtration; Aqueous parts cleaners; Solvent parts cleaners
GRUNDFOS PUMPS CORPORATION	2555 Clovis Avenue Clovis, CA 93612 Tel 209/292-8000 Fax 800/347-1357	Len Petersen, Product Manager/Commercial-Industrial; Cynthia Hamilton, Marketing Specialist; Charles Sarabian, Product Engineer	Coolant pumps (machine tool); Condensate pumps (boiler); EDM pumps; Industrial parts washers, pumps
GUARDSMAN PRODUCTS, INC.	411 N. Darling Fremont, MI 49412 Tel 800/374-7543 Fax 616/924-2085	Craig Connors, Sales/Marketing; Andy Whitlock, Engineering	Dri Slide multi-purpose lubricant; Dri Slide chain lube 1000; Dri Slide heavy-duty multi-purpose grease (HDMP) -- hi-temp; Dri Slide limited slip additive
HANGSTERFER'S LABORATORIES, INC.	Ogden Road Mantua, NJ 08051 Tel 609/468-0216 Fax 609/468-0200	Edward Jones, President; James Wert, Vice President/Sales & Marketing; Larry Jankowski, Chief Chemist	Water soluble oils; Straight cutting oils; Metalforming compounds; Rust inhibitors
HARRY MILLER CORPORATION	4309 N. Lawrence Street Philadelphia, PA 19140 Tel 215/324-4000 Fax 215/324-1258	Ron Joniec, General Manager; Bruce Entwisle, Sales/Marketing; Nick Ariano, Technical Director	Hamikut 1837; Hamikleer 1883-4; Kleerkut 1900; Hamikleer 2030-HDL-2
HARVARD CORPORATION	PO Box 108 Evansville, WI 53536 Tel 608/882-6330 Fax 608/882-5127	Edd Gryder, Vice President/General Manager; Dennis Morgam, Design Engineer	Filters; Filtration systems; Environmental products; Fluid waste stream reduction equipment
THE HILLIARD CORPORATION	100 West Fourth Street Elmira, NY 14902 Tel 607/733-7121 Fax 607/737-1108	Gene Ebbrecht, Vice President; Gary Smith, Sales Manager; Howard Reed, Engineering Product Manager	Filters; Coalescers; Filtration systems; Valves
HIRSCHMANN ENGINEERING USA, INC.	503 W. Golf Road Arlington Heights, IL 60005 Tel 708/437-9677 Fax 708/437-9705	Peter Knowles, President/CEO	IONOPLUS synthetic EDM fluid; Rotorol Bio 60005 synthetic grinding fluid; Hirschmann wire EDM tooling; Hirschmann sinking EDM tooing

METALWORKING FLUID AND FILTRATION EQUIPMENT BUYER'S GUIDE

Company Name	Address/ Phone/Fax	Management/Contacts	Products
INDUSTRIAL FILTERS COMPANY	9 Industrial Road Fairfield, NJ 07004 Tel 201/575-0533 Fax 201/575-9238	David Donker, President; Steven Donker, Sales Marketing; Matthew Kudia, Engineering	Deep bed filters; Roltray filters; Clear-fast filters; Skim-matic oil wheel
INDUSTRIAL PRODUCTS GROUP, Div. of Spartan Chemical Co., Inc.	110 N. Westwood Avenue Toledo, OH 43607 Tel 419/531-5551 Fax 419/536-8423	Skip Wolford, Industrial Products Group Manager; Thomas Hause, Engineering	The Cleaner; The Cutter; The Cooler; The Grinder
INTERNATIONAL LUBRICANTS, INC.	7930 Occidental South Seattle, WA 98108 Tel 206/762-5343 Fax 206/762-7989	Frank Erickson, President; David Folkins, Sales/Marketing; William Mammel, Engineering	Lubegard heavy-duty cutting oil; Lubegard Bio-T cutting oil; Lubegard forming paste; Lubegard dry-film lubricant
IRMCO METALSTAMPING PROGRAMS	2117 Greenleaf Street Evanston, IL 60202 Tel 708/864-0255 Fax 708/864-0012	Bradley Jeffery, Executive Vice President	Non-oil metal-stamping lubricants; Process consulting
ITW FLUID PRODUCTS GROUP	4366 Shackleford Road Norcross, GA 30093 Tel 800/952-8757 Fax 800/952-5823	Steve Henn, General Manager; Bob Wylie, Marketing Manager	Rustlick--WS-5050, WS600A, SN-100A, SS-400A; Acculube--LB-2000, LB-3000, LB-5000, LB-6000
JOKISCH/INTERCON ENT. INC.	1122 Fir Avenue, Unit C2 Blaine, WA 98230 Tel 604/946-6066 Fax 604/946-5340	Alfred Schenk, President; David Dunbar, Sales/Marketing	Universal water-soluble coolant concentrate; Exclusive grinding fluids; Tapping/cutting fluids; Tapping/cutting paste
KOCH MEMBRANE SYSTEMS, INC.	455 East Eisenhower Parkway, Suite 150 Ann Arbor, MI 48108 Tel 313/761-3836	Gerard Gach, Regional Sales Manager	Ultrafiltration
KANO LABORATORIES	1000 S. Thompson Lane Nashville, TN 37211 Tel 615/833-4101 Fax 615/833-5790	Peter Zimmerman, President	Kroil; Aerokroil; Penephite; Weatherpruf
KOOLANT KOOLERS	2625 Emeral Drive Kalamazoo, MI 49001 Tel 616/349-6800 Fax 616/349-8951	Dan Bowman, General Manager; Tom Barr, Marketing Manager; Doug Mathews, Chief Engineer	Industrial water chillers and liquid coolers; Heat exchangers
LAMSON OIL COMPANY	PO Box 5303 Rockford, IL 61125 Tel 815/226-8090 Fax 815/226-9250	Greg Lamantia, Sales Representative	LamSyn 4250 stamping compounds
LANDA, INC.	13705 N.E. Airport Way Portland, OR 97230-1048 Tel 800/547-8672 Fax 800/535-9164	Larry Linton, President/CEO; Tom Tunnell, Vice President/Sales; Paul Linton, Vice President/Engineering	Spray jet parts washers; Water Blaze wastewater evaporators
LOCKWOOD PRODUCTS, INC.	5615 SW Willow Lane Lake Oswego, OR 97035 Tel 800/423-1625, 503/635-8113 Fax 503/635-2844	Rick Holmboe, President; Cindy Lozeau, Sales Manager	Loc-line adjustable hose, quick-set shields, valves and manifolds
LPS LABORATORY INC.	4647 Hugh Howell Road Tucker, GA 30084 Tel 404/934-7800	Jim Allen, President; Jim Kulbeda, Marketing Director; John Roudebush, Research & Development Director	LPS 1 greaseless lubricant; LPS 2 industrial-strength lubricant; Magnum Teflon lubricant; LST penetrant
METALLOID CORPORATION	500 Jackson Street, PO Box 737 Huntington, IN 46750 Tel 219/356-3200 Fax 219/356-3201	Robert McKay, President; William Fair, Sales Manager; Robert Kowalski, Director/Technical Operations	METSOL--water-soluble metalworking fluids; METDRAW--drawing & forming fluids; METCHEM--synthetic-based metalworking fluids; METGRIND--grinding fluids
MISTIC METAL MOVER	Rural Route 2 Princeton, IL 63156 Tel 815/875-1371 Fax 815/872-0915	Kent Thomspon, Jr., President	Mistic Metal Mover II; Alumicut
MOBIL OIL CORPORATION	3225 Gallows Road, 6W-421 Fairfax, VA 22037 Tel 703/849-3708 Fax 703/849-6636	Kevin Sullivan, Industrial Marketing Manager; Jim Wilt, Marketing Manager; Carl Gerster, Product Manager	Mobilmet metalworking fluids; Mobil Vactra way oils; Mobilmet aqua RHO--bioresistant, emulsifiable metalworking fluid; Mobil DTE hydraulic oils
MONLAN CORPORATION	2015 Schippers Kalamazoo, MI 49001 Tel 616/382-6349 Fax 616/382-0018	Roger Beckers, President; David Willson, Sales Manager; Don Inman, Project Engineer	Coolant filtration; Coolant recycling equipment
MONROE FLUID TECHNOLOGY	36 Draffin Road, PO Box 810 Hilton, NY 14468 Tel 716/392-3434 Fax 716/392-2691	James Silloway, President; Mary Silloway, Executive Vice President/Sales & Marketing; Alan Christodaro, Vice President/Manufacturing	Metalworking fluids, Industrial cleaners; Rust preventatives; Sawing fluids
MUSCLE PRODUCTS CORPORATION	112 Fennel Drive Butler, PA 16001 Tel 412/283-0567 Fax 412/283-8310	Richard Fennell, CEO; Jay Fennel, President; George Fennel, Executive Vice President/Engineering	Power-Cut PC-10; SY-10 synthetic cutting fluid additive; CO-10 soluble cutting oil
MUSKEGON TOOL INDUSTRIES	1000 E. Barney Street Muskegon, MI 49444 Tel 616/722-1161 Fax 616/722-7122	Thomas Wheeler, President; Deborah Patten, Vice President/Sales & Marketing; Kelly Pickett, Engineering Manager	ChilCut cold air unit

METALWORKING FLUID AND FILTRATION EQUIPMENT BUYER'S GUIDE

Company Name	Address/ Phone/Fax	Management/Contacts	Products
NICO COMPANY	W7754 Deep Pond Road Whitewater, WI 53190 Tel 414/473-6885 Fax 414/473-6886	L. G. Burkwest, President; Eileen Burkwest, Treasurer/Sales Manager; Tim Burkwest, Secretary/Production Manager	Nico super spout -- "a coolant nozzle for industrial grinding"
PARKER HANNIFIN CORPORATION	30240 Lakeland Boulevard Wickliffe, OH 44092 Tel 216/943-5700 Fax 216/943-3129	Lonnie Gallup, General Manager; Fred Dikeman, General Marketing Manager; Chuck Fullmer, Product Sales Manager; Louis Morevias, Chief Engineer	Hydraulic hoses & fittings; Pneumatic hoses & fittings; Assembly equipment; Hose adapters & swivels
POLYTECH FILTRATION SYSTEMS, INC.	490 Boston Post Road Sudbury, MA 01776-3301 Tel 508/443-4901 Fax 508/443-1723	Erik Andresen, President; Finn Andresen, Sales Manager	Vacuum filters; Gravity bed filters; Hydrocyclone; Conveyor dragout; Centrifuge, bag & cartridge filters
RE-LI-ON CORPORATION	PO Box 352647 Toledo, OH 43635 Tel 419/841-4380 Fax 419/841-1909	Richard Imes, President; Maureen Haneghan, Vice President	Re-Li-On cutting and tapping fluid
REMCOR PRODUCTS COMPANY	500 Regency Drive Glendale Heights, IL 60139-2268 Tel 708/980-6900	Edward Wajda, General Manager; Carl Moose, National Sales Manager; Steve Zoz/Steve Strepka, Staff Engineers	Chillers; Coolers; Heat exchangers
REYNOLDS MACHINE & TOOL CORPORATION	2033 N. 17th Avenue Melrose Park, IL 60160 Tel 800/323-7133 Fax 800/820-0723	Jim Reynolds, President; Bob Garro, Marketing Manager	ITW fluid product group; Hangsterfers chemical; LPS chemical; Monroe chemical
SANBORN TECHNOLOGIES	7 Industrial Parkway Medway, MA 02053-1796 Tel 800/343-3381 Fax 508/384-5346	Ellen Friedman, Manager	Integrated coolant recovery systems including filtration, high speed centrifugation, pasteurization
SLICK 50 INDUSTRIAL	1187 Brittmoore Road Houston, TX 77043 Tel 713/932-9954 Fax 713/935-4392	Bill Cornelson, Vice President/Sales; Mark Carroll, Vice President/Marketing; Anne Searle, Product Manager	Lube; Air tool; Gear box treatment; Grease
TAPMATIC CORPORATION	802 Clearwater Loop Post Falls, ID 83854 Tel 208/773-8048 Fax 208/773-3021	Mark Johnson, President; David Ridenour, Sales Manager; Kirk Marceau, Vice President/Manufacturing	Tapping attachments; Cutting fluids
TEXACO LUBRICANTS COMPANY	1111 Bagby Houston, TX 77002 Tel 800/782-7852, 713/752-3097 Fax 713/752-4706	Paul Wicker, Manager/Technology; Larry Cekella, Manager/Total Fluid Management; Fred Alverson, Group Leader	Cleartex CF and HD CF chlorine-free cutting oils; Long-life coolant/anti-freeze
TRICO MANUFACTURING CORPORATION	1235 Hickory Street Pewaukee, WI 53072-3999 Tel 414/691-9336 Fax 414/691-2576	Bob Jung, President; Mark Glasser, Sales Director; Brad Rake, Engineering Director	Lubricant systems; Mist coolant systems; Coolants; Lubricants
TRIPLE R AMERICA COMPANY, LTD.	201 Spinnaker Way, #4 Concord, ON L4K 4C6 Tel 905/660-1911 Fax 905/660-1261	David Murrary	Oil cleaning systems; Oil/water separators; Variable speed motor controllers
TWIN SPECIALTIES CORPORATION	15 E. Ridge Pike Conshohocken, PA 19428 Tel 610/834-7900 Fax 610/834-7903	Michael Petrosky, Vice President	Cutting and grinding fluids; Drawing and stamping compounds; Water-soluble cleaners and degreasers; Rust preventives
UNI-MIST, INC.	4134 36th Street SE Grand Rapids, MI 49512 Tel 616/949-0853 Fax 616/949-9503	Wally Boelkins, President; Bryson Hoff, Marketing Manager; Larry Tilma, General Manager	Precise spray application systems; Roller lubrication systems for metalforming; Precise lubrication systems
UNIVERSAL OIL, INC.	265 Jefferson Avenue Cleveland, OH 44113 Tel 216/771-4300 Fax 216/771-1845	Bob Mendelsohn, President; Tim Mendelsohn, Vice President; Alan Barbish, Product Manager	Unicut--metalworking oils; Universal RP--metal coatings; Spartan--solubles, synthetic, semi-synthetic
VALENITE, INC.	31700 Research Park Drive PO Box 9636 Madison Heights, MI 48071-9636 Tel 810/589-6267	Daniel Barron, Valcool Business Manager; Michelle Gruda, Media Services Manager	Valcool cutting fluid; Inserts, wear parts
VOKES -- NORTH AMERICA	200 West Shore Boulevard Newark, NY 14513 Tel 315/331-9105 Fax 315/331-4750	F.E. Tarala, President; T.D. Kinton, Vice President/Sales & Marketing; D. Cullen, Engineering Manager	Lube/fuel oil filters; ASME filter housing; Duplex filter systems; Oil mist coalescers
WINFIELD BROOKS CO., INC.	70 Conn Street Woburn, MA 01801 Tel 617/933-5300 Fax 617/932-9239	Hubert Perry, Jr., Vice President; Dana Perry, Assistant Sales Manager; Mark Parker, Research Chemist	Tapfree, Tapfree2; Alumtap; Clean Tap
WYNN OIL COMPANY	1050 West Fifth Street Azusa, CA 91702 Tel 818/334-0231 Fax 818/334-1456	Gerry Miles, Sales Director; Joe DeBlasi, National Sales Manager; Walter Marquez, Research & Development	Metalworking cutting fluids; Protective coatings; Industrial lubricants; Tapping compound

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