APPENDIX A: CASE STUDIES

CASE STUDY A – FLUID MANAGEMENT AT A FULL SERVICE MACHINE SHOP

Background Information

A full service machine shop located in eastern Iowa performs metalworking operations on a variety of metals including aluminum, brass, steel, stainless steel and cast iron. The facility employs 22 people, operates 35 to 40 machines (both CNC and manual) and runs one shift Monday through Friday. Being located in a rural setting, the facility lies beyond municipal sanitary sewer system connections. Consequently, few options exist for disposing of spent metalworking fluid. At considerable expense (estimated to be approximately $1,500 to $2,000 per month), spent cutting fluid had to be disposed as a hazardous waste through a permitted hazardous waste management company.

Due to the regulatory burden and expense associated with disposal of spent cutting fluid as a hazardous waste, the shop eventually purchased a batch recycling system for $8500 and a sump sucker for approximately $3750. A fluid management program, tailored to suit the shop's needs, was also developed and implemented at the facility.

Fluid Monitoring and Maintenance

One semisynthetic fluid is presently used for practically all metalworking operations performed at the facility. Water used for preparing the fluid and replenishing evaporation losses is treated only by an industrial water softener. Due to the success of the program, no additional water treatment was deemed necessary by management personnel.

During early stages of developing the fluid management program, samples of the fluid were periodically submitted to a laboratory to monitor biological contamination. Fluid concentration and pH were also monitored using a refractometer and pH meter. Biological and pH monitoring eventually ceased after it became apparent that the management program resulted in a dramatic decrease in biologic contamination and consistent fluid pH. Monitoring at the facility now consists of using a refractometer for concentration control and fluid inspections by machine shop personnel. Machine operators are also responsible for thoroughly cleaning out the machines each month.

Recycling

Fluid from each machine sump is recycled at least weekly, and often twice a week. When metalworking operations involve metals that readily degrade fluid quality (such as cast iron), fluid recycling is performed on a daily basis. One employee is responsible for fluid recycling and fluid management record keeping.

The fluid recycling procedure used by the facility begins by removing cutting fluid from the machine sump with a sump sucker. After the fluid is pumped out, the sump is immediately recharged with recycled fluid. Fluid to be recycled is then transferred from the sump sucker into a batch treatment recycling unit for tramp oil removal, particulate filtration, biocide addition and concentration adjustment.

The recycling unit consists of several compartments including an initial skimmer tank; a filtration bag; a coalescer compartment equipped with a series of weirs; an oil skimmer and aerator; and a polishing tank for biocide and concentration adjustment. Fluid first passes through the initial skimmer tank where a skimmer pump removes any free floating tramp oil. Fluid from the skimmer tank is then pumped through a 100 micron cloth filter bag (for particulate removal) into the coalescer tank where a set of weirs force the fluid to pass through coalescing media for removal of dispersed tramp oil. Tramp oil surfacing to the top of the coalescer compartment is then removed with a disk oil skimmer. The coalescer compartment is also equipped with an aerator to prevent anaerobic bacteria from degrading the fluid while in the recycling unit. Finally, fluid then enters the polishing compartment where biocide and concentration adjustments are made. When cutting fluid in a sump needs recycling, fluid from the polishing compartment is pumped into a mobile container and used to recharge the machine sump being serviced.

In addition to recycling cutting fluid, all tramp oil recovered by the facility is provided to a used oil marketer and metal cuttings are provided to a scrap metal dealer for recycling.

Results

Since acquiring the recycling unit and establishing the fluid management program approximately three years ago, the facility has realized the following benefits:

- ✔ No waste cutting fluid has been generated at the facility since implementing the fluid management program. This has eliminated the regulatory burden and expense associated with off-site disposal of spent cutting fluid as a hazardous waste.
- ✔ Facility purchases of fluid concentrate dropped from approximately 250 - 300 gallons per year to only 100 gallons per year.
- ✔ A noticeable improvement in the employee work environment has occurred at the facility. Since establishing the program, no incidents of dermatitis have been experienced by employees.
- ✔ Consistent product quality and production tolerances have been realized by the facility. The facility has also experienced fewer problems in achieving low machining tolerances.

Based on these benefits and the costs associated with implementing a fluid management program, machine shop management personnel estimate the program paid for itself within two years.

CASE STUDY B – FLUID MANAGEMENT AT A SMALL MANUFACTURING FACILITY

Background Information

In 1990, a small manufacturing facility located in central Iowa purchased recycling equipment to prolong the life and improve the quality of the semisynthetic fluid used for its machining operations. Fluid quality problems experienced in the shop included employee dermatitis, a haze in the machining area from fluid smoking and short fluid life. Failed metalworking fluid was also hauled away as hazardous waste at a disposal cost of $75 per drum. Just prior to 1990, the total sump capacity for the facility was approximately 150 gallons and approximately 1,300 gallons of coolant were used annually. In 1994 the number of machines used by the facility doubled, increasing the total sump capacity to 300 gallons. The facility now operates six chip-making machines (including five CNC lathes and one CNC mill) for its cast iron and mild steel metal-working operations.

Fluid and Waste Management

At a cost of approximately $42,000, fluid recycling equipment was purchased and installed at the facility. A fluid management program was also started for the machine shop. A designated coolant technician is now responsible for pumping out machine sumps, operating the coolant recycling unit and monitoring/adjusting coolant concentration at the recycling unit with a refractometer. Deionized water is used for preparing the fluid and replenishing evaporation losses.

Once a month, coolant from each machine sump is pumped out for recycling using a sump sucker. The fluid is then transferred into the settling tank of the coolant recycling unit for particulate removal. The settling tank is also equipped with a belt skimmer to remove any free-floating tramp oil. After twelve hours in the settling tank, the coolant is drawn through a centrifuge where any residual tramp oil is removed for transfer into a 55-gallon drum. Finally, the coolant enters the bottom chamber of the recycling unit where the fluid concentration is automatically adjusted. No biocide adjustments are performed on the recycled fluid and no other monitoring is performed at the facility. If a problem is experienced with fluid quality, a sample is collected and submitted to the fluid supplier for analysis.

At their discretion, machine operators are responsible for adding make-up coolant or deionized water at the machine sump. Tramp oil recovered by the facility is provided to a used oil marketer and metal cuttings are provided to a scrap metal dealer for recycling.

Developing fluid in a lathe machine

Results

The facility has realized the following benefits since acquiring the recycling equipment and establishing the fluid management program:

- ✔ Fluid life has been prolonged at the facility and very little, if any, requires disposal. The facility also tested the fluid and obtained permission from local wastewater treatment authorities to discharge small amounts of cutting fluid to the sanitary sewer system when necessary.

- ✔ Although the total sump capacity for the facility doubled since installing the recycling equipment, the facility's annual fluid consumption has increased by only 200 gallons (a 15 percent increase in fluid consumption with a 100 percent increase in sump capacity).
- ✔ Management personnel estimate the recycling system paid for itself within two years.
- ✔ No more cases of dermatitis have been reported by employees and the haze in the machining area has been eliminated.

Areas for Improvement

Although the fluid management practices already performed at the facility have significantly reduced consumption rates and virtually eliminated the need to dispose of fluid, management personnel plan to keep refining the program. Management identified the following as areas for improvement:

- ✔ Although machines are thoroughly cleaned out once a year, management intends to increase this cleanout frequency to at least twice a year in an effort to reduce the frequency at which fluid is currently recycled.
- ✔ The facility intends to fabricate external sumps for its machines. The internal sumps on the machines are very inaccessible, requiring significant amounts of downtime for cleaning. Use of external sumps will better accommodate more frequent cleanout schedules and reduce the amount of downtime required for cleaning.
- ✔ Management will continually work with employees in an effort to maintain employee support for the fluid management program.

CASE STUDY C – FLUID MANAGEMENT AT A MANUFACTURING FACILITY

Background Information

In 1986, management personnel at a manufacturing facility in Central Iowa began to review and revise their machining operations in an effort to improve efficiency, reduce waste and reduce costs. At that time, the facility used nine different coolants, had several hand chip-making operations, employees often reported cases of dermatitis, and a heavy haze existed throughout the shop. The facility also disposed of approximately 775 gallons of coolant every three months as hazardous waste. Hand operations were subsequently changed to automated lines and the number of metalworking fluids used by the facility was reduced to two semisynthetic coolants and one straight oil. Management personnel and the facility's fluid supplier also performed a detailed analysis identifying the benefits and cost savings associated with establishing a fluid management and recycling program for the facility. In 1990, a fluid management and recycling program was implemented.

Currently, the facility employs 130 people (100 machinists/assemblers and 30 management personnel) and operates 63 chip-making machines with individual sumps. Sump capacities range from 20 to 1,300 gallons and the total sump capacity for the facility is approximately 4,100 gallons.

Fluid and Waste Management Practices

Administrative Support and Employee Participation - Following the decision to establish a fluid management program, management personnel ensured the support, equipment and resources were made available to develop and sustain an effective program. A coolant technician position was created specifically for the purpose of maintaining the program.

Coolant is viewed as a machine tool and the responsibilities of the coolant technician are considered of equal importance to that of the machine operator. In order to gain employee support for the program, a teamwork atmosphere is encouraged and employees regularly attend fluid management seminars conducted by the coolant manufacturer.

Fluid Monitoring, Maintenance and Recycling - All machines are now on a monthly cleanout schedule which is maintained by the facility's dedicated coolant technician. Other responsibilities of the coolant technician include keeping a daily service log and monitoring for bacterial growth, water hardness, and pH on a daily basis. Each machine operator has a refractometer at the machine and is responsible for checking coolant concentration. Deionized water and coolant makeup lines are piped to each work station so that machine operators can readily replace evaporation/splash losses and adjust fluid concentration at the sump.

Each month, the coolant in each sump is vacuumed out with a sump sucker. After they are pumped out, machines are thoroughly washed out, rinsed with clean water and recharged with fresh coolant. Coolant recovered from machine sumps is transferred to the settling tank of the coolant recycling system. Particulates in the coolant are allowed to settle out for approximately 12 hours while free floating tramp oil is skimmed off of the top with a belt skimmer. The coolant is then drawn through a centrifuge where any residual tramp oil is transferred to a holding barrel. Finally, the coolant is transferred to the bottom chamber where its concentration is automatically adjusted.

During the facility's 1995 shutdown, coolant from the facility's machine sumps was completely replaced with new coolant - the first time in five years! It is now anticipated that the coolant will only need to be completely changed out every 3 to 5 years. The fluid recycling and management program also eliminates the need to dispose of the spent coolant as hazardous waste. To dispose of the fluid, the oil is separated out of the coolant and provided to a used oil marketer for recycling or energy recovery. The remaining water phase is then acceptable for discharge to the municipal sanitary sewer system.

In addition to recycling the semisynthetic coolant, the facility also filters and reuses the straight oil used for the facility's automatic screw machines. Straight oil is reused for approximately 3 years before being provided to a recycler.

EQUIPMENT MODIFICATIONS. In addition to purchasing the coolant recycling system and providing coolant and deionized water lines to each work station, the following equipment modifications were made at the facility to prevent fluid from spoiling:

- ✔ Most of the machines have been modified so that the sumps are external and there are no hard to reach areas where coolant can become trapped and promote bacterial growth.
- ✔ Some of the older machines have also been equipped with skimmers for removing tramp oil right at the machine sump.
- ✔ The facility's 1,300 gallon sump was equipped with its own filtering system and centrifuge for particulate and tramp oil removal.

CUTTINGS AND TRAMP OIL. Metal chips generated by the facility are either spun dry using a centrifuge or the fluid is allowed to drain off through the use of magnetic chip conveyors. Chips are then collected and provided to a scrap metal dealer. Fluid from grinding operations is passed through a vacuum filtration system for particulate removal. Fines collected from this operation are landfilled. Any tramp oil recovered at the facility is provided to a used oil marketer.

Results

The facility has realized the following benefits since acquiring the recycling equipment and establishing the fluid management program:

- ✔ Not one documented case of dermatitis has been reported since 1990 and the haze that once existed in the shop has been completely eliminated.
- ✔ No hazardous waste is generated from the facility's chip-making operations.
- ✔ Costs for purchasing and installing the recycling system was recovered in approximately 6 to 8 months.