United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/S2-90/033 Sept. 1990

EPA

Project Summary

Machine Coolant Waste Reduction by Optimizing Coolant Life

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Machine shops use coolants to improve the life and function of machine tools. With use, these coolants become contaminated with oils, and this contamination can lead to growth of anaerobic bacteria and shortened coolant life. This project investigated methods to extend coolant life through improved coolant maintenance; the goal was to reduce the volume of coolant waste.

Skimmers to remove oil from the surface of coolants were cost-effective. Practices for changing the coolant were documented and modified for improved coolant life. A specific coolant with wide applicability and tolerance was tested and found to have a life of at least 7 mo when using the documented procedures.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Machine shops use coolants to transfer the heat generated during the machining process away from cutting tools and parts being produced. The coolant is collected in and recirculated from a sump. During use, the coolant collects oil from the machining process. This oil, called tramp oil, contributes to the growth of anaerobic bacteria that produce hydrogen sulfide gas, shorten coolant life, and eventually force disposal of the coolant as waste.

Coolant sumps contain from 20 to 100 gal each, and depending on maintenance practices, the coolant may require monthly or even weekly replacement. Even a small shop will have several machine tools, and large shops can have 100 and more. The exact management scheme for this waste coolant is determined by the type of coolant, level of contamination, presence of regulated materials (metals, organic solvents) and availability of treatment. Disposal costs vary from $20 to $200 per 55-gal drum depending on management required.

Washington Scientific Industries (WSI) is a machine shop that uses a wide variety of tools to make parts from materials such as steel, aluminum, copper, and stainless steel. The machines are medium-sized and similar to those used in many machine shops. The volume of waste coolant generated by WSI is affected by business activity, but averages 120 55-gal drums per yr with a management cost of $150 per drum.

This project was designed to study the following:

- a specific water-soluble coolant (Blasocut 2000 Universal*) used

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

with a variety of machines, tools, and materials;
- coolant maintenance practices associated with three types of machines;
- observable health effects when using and handling recycled coolants;
- handling practices for chips and waste coolant;
- chip/coolant separation; and
- oil/water separation

The goal was to identify factors and techniques that contribute to the extension of coolant life and to document procedures and effects of the entire coolant life cycle. This information should be useful for decision making in other shops attempting to reduce the volume of waste coolant generated.

Procedures

The coolant selected by the company, Blasocut 2000, is a mineral oil based, water-soluble, metal-working fluid. Its use is intended for all chip-forming operations except grinding and all materials except magnesium. The concentration is made up of 60% refined mineral oils, to which emulsifiers and corrosion inhibitors are added. No biocides are present in the concentrate, and none are needed to maintain the solution. Company literature indicates that use of this coolant does not adversely affect worker health and that the coolant is recycled extensively in other applications.

Machines chosen for the project are 1 to 4 yr old and used for jobs with long (2 to 4 wk) production runs. Operators, material, and process were held constant during the project as much as possible. Standard industrial engineering practices were used to determine direct and indirect labor required for coolant change practices, coolant maintenance, waste handling, and waste containment.

Sampling was done to establish baselines for new coolant, way oil, coolant dilution water, air quality, and health effects. Ongoing sampling and analysis were also performed to monitor recycled coolant quality, air quality, and health effects. All sampling and analysis were performed by an independent consulting laboratory.

After several months of characterization, various coolant maintenance practices were evaluated: disk and belt skimmers for removing tramp oil, a centrifuge for removing tramp oil, and coolant change and sump cleaning practices. Sump modifications were required to mount equipment on the control group of machines, and additional equipment such as timers and coolant circulating pumps were also evaluated.

Chip handling practices from generation to storage before salvage were evaluated to address the problems of inefficient handling, poor salvage quality, and escape of coolant and oil draining from chips in storage. Time-and-motion studies were used to develop an efficient system for moving chips from the machine tools where they are generated to a waste management building specifically designed to capture and store draining coolant and oil and to protect chips while in storage.

Results and Discussion

Coolant Changing Procedure

The following changing procedure was established as the most efficient for extending coolant life.

1) skim all tramp oil from coolant surface
2) pump coolant from sump
3) vacuum chips from sump
4) remove sump access covers
5) vacuum chips from sump
6) steam clean and vacuum sump (repeat until clean)
7) replace sump access covers
8) replace coolant

This new practice takes about 5 hr and 12 min to do on a cast sump. Sumps made of sheet metal take several hours less because corners are more easily cleaned. This new coolant changing procedure, when combined with improved ongoing coolant maintenance, holds promise for extending coolant life.

Coolant Maintenance

Both belt and disc-type skimmers effectively reduced coolant oil and grease concentrations. This increases aerobic activity in the coolant and contributes to longer coolant life. When a centrifuge was evaluated for cleaning the coolant in the sumps of 25 machines not in the study group, it was not cost-effective, at least as a mobile unit.

Coolant

Blasocut 2000, even after being recycled for 7 mo, met or exceeded metal removal rates for aluminum, steel, copper, and stainless steel. The use of recycled coolant also did not appear to be associated with any increase in dermatitis on operators' hands. Laboratory research showed that when the recycled coolant must be disposed of, oil and water can be separated by acidifying the coolant and allowing the oil fraction to separate. Elevated levels of 2.5 to 3.5 mg/L copper and 8 to 10 mg/L zinc were found in the water fraction of the coolant left after this separation.

Conclusions and Recommendations

The life of machine tool coolant can be significantly extended, and the volume of waste coolant generated can be reduced. Using a coolant and way oil with wide applicability and suitability for recycling is important. Key factors seem to be tolerance of hard water, resistance to anaerobic bacteria growth, and stability over a range of concentrations.

Simple skimming of tramp oil using any of several different methods was cost effective and reduced oil and grease concentrations significantly. This extended coolant life to at least 7 mo; previously, used coolant may have been changed after 1 wk.

Although using this single coolant meets 90% of WSI s requirements, many machine shops will balk at switching to a different coolant. Therefore, further research is needed on the coolant maintenance and changing procedures documented in this project and on their effect on the life of a variety of coolants. Research is also needed on alternative cooling methods and schemes for preventing contamination of coolant by way and hydraulic oil.

This study was conducted through the Minnesota Technical Assistance Program and the Minnesota Waste Management Board. The full report was submitted in partial fulfillment of Cooperative Agreement No. CR 813437-01 under the sponsorship of the U.S. Environmental Protection Agency.

☆U. S. GOVERNMENT PRINTING OFFICE: 1990/748-012/2009

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The complete report, entitled "Machine Coolant Waste Reduction by Optimizing Coolant Life," (Order No. PB 90-257 783/AS; Cost: $17.00, subject to change) will be available only from:
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