

Soy Metalworking Fluid



Company C

“We use about half the amount of coolant since switching to soy.”

**NORTHEAST IOWA MACHINE
SHOP OWNER**

New Environmental Technology for Small Business (NETSB) Project Summary

NETSB, a program developed by the Iowa Waste Reduction Center (IWRC) at the University of Northern Iowa, strives to increase the use of new environmental pollution prevention technology by small business, resulting in measurable environmental and economic benefits.

When choosing which technologies to test, the IWRC recognized three key areas of consideration: environmental criteria, economic measures and small business use feasibility. The equipment should have a positive impact on the environment, such as pollution prevention or energy savings. The technology should be evaluated considering capital costs, operational costs and return on investment. And finally, the equipment should be applicable in a small business environment.

In 2006-2007, the IWRC placed several types of potential pollution prevention technologies at small businesses throughout Iowa including: soy-based metal working fluids, RASERS heat reclamation equipment, and Zerowaste wastewater treatment systems.

Small Business Placement Description

A Computer Numerical Control (CNC) machine shop located in northeast Iowa replaced their petroleum-based metalworking fluid with a soy alternative product in July 2006. The soy product is a water-soluble coolant with the usual mix ratio of 5% coolant to 95% water. The shop's twenty-four (24) machine stations operate using water-soluble coolant as the preferred metalworking fluid. Each of the machining stations has a standalone reservoir of coolant. The shop also began using soy way lube and soy cleaner.

Due to the superior lubricity and durability of the soy coolant half as much metalworking product is now being used in the shop at the same production level. As with many job shops, it was difficult to quantify any increase in tool life but intuitively it seemed that soy coolant reduced wear and tear on the tools as well as the machines.

The shop had a coolant reclamation system to reduce the amount of waste generated and to maximize the utility of the coolant product. Used coolant is removed from the machine station sump by a vacuum and delivered to the recycling system. The quiescent environment of the recycling system allows tramp oils to rise to the top to be skimmed. A chip hopper also removes any excess grind. The used coolant is then refreshed with new product and placed back into production.

Technology Description

The pollution prevention benefits of **soy metalworking fluids** come from the superior performance of the soy product as compared to petroleum-based metalworking fluids. Increased lubricity and longer life of the soy product leads to less product use and less wear on tools.

The product placed was Environmental Lubricants Manufacturing, Inc. (ELM) SoyEasy Cool XXL Plus which is a water-soluble metal working fluid concentrate. When mixed with water, the SoyEasy forms a stable emulsion that provides cooling, lubricity, and rust protection for use in a wide variety of machining applications. Formulated with ELM's exclusive OptiBase™ North American grown natural seed oils and select additives, it surpasses the lubricity and performance of conventional mineral oil based metalworking fluids.¹

The use of soy oil for metalworking began as an alternative to conventional products (petroleum-based, synthetics and semi-synthetics). Soy, like many other ag-based oils, exhibits superior lubricity in many industrial applications. Additionally, many companies are interested in the biodegradable products, especially those developed from renewable resources that help agribusiness. Specifically soy coolants have these advantages over conventional products:

- 1) produce less mist for reduced inhalation problems

- 2) contains no chlorine or sulfur
- 3) reduces or eliminates dermatitis issues
- 4) reduces retooling costs
- 5) increases productivity (or feed) rates

Machining is a part of the manufacturing of most metal products. Machining involves using a power-driven machine tool, such as a CNC machine, to shape metal parts.

Metalworking fluids are used to lubricate the machining process and deter metal fines from re-attaching to the part.

Metalworking fluids basically come in two types: water-soluble coolant and neat (straight) oil. Coolant use is the most common metalworking fluid (MWF) used in the industry. Coolants are generally 5% cutting fluid and 95% water. Coolant is used in processes that require a bath of product to continually remove shaving or grind away from the part being machined.

Machining operations require the use of machining tools to refine the shape of the work piece by removing small amounts of material from it. Machining processes use various products in the processes such as cutting fluids, lubricants, hydraulic fluids, cooling or quench oils, and possibly cleaning solutions.

Machining involves high-pressure, metal on metal moving contacts between tool and work piece. To reduce the heat and friction caused by these operations, metal working fluids (MWFs) are circulated over the work surfaces. These fluids are used to:

- Control and reduce the temperature of tools and work surfaces;
- Reduce friction and vibration by acting as a lubricant;
- Wash away chips and metal debris;
- Improve the quality of the machined surface; and
- Inhibit corrosion and rust on newly exposed surfaces.



Environmental, Health, and Regulatory Background

The health and safety benefits of soy MWFs include reduced dermatitis issues and reduced misting for inhalation problems. Less misting also creates a safer work environment by reducing slippery floors and work surfaces.

Coolant or water-soluble oil is mixed with water to form metalworking fluid, generally emulsified oil and 95% water mixture.

Coolants improve cooling capabilities. Petroleum-based coolant may contain sulfur or chlorine to enhance wetting. The presence of water makes coolants more susceptible to rust problems, bacterial growth causing rancidity, tramp oil contamination and evaporative losses.¹ Misting of soluble oils may create a dirty and unsafe work environment through slippery surfaces and inhalation hazards. Petroleum coolants can cause irritant dermatitis when the strong alkaline solution (due to additives) removes protective oils and damages the natural skin barrier. The resulting decrease in water content in the skin is exhibited as dermatitis. Allergic dermatitis is also possible due to petroleum products additives.²

Soybean oil has a high molecular weight as compared to petroleum oil and a high flashpoint too. These properties help soy oil bond well with metals creating an effective friction reducer (lubricant) and reduce heating to minimize smoking and misting problems by not burning off at high temperature points such as the tool-to-part contact point. Soy oil use also reduces dermatitis issue due to the soy oil's compatibility with the natural skin oils and the lack of harsh chemical additives.

The reduced wear on tools and machinery is an environmental benefit by enhancing the longevity of these durable goods.

The environmental benefits of soy include being biodegradable products that come from a renewable resource as well as the many environmental problems surrounding

petroleum mining, transportation, use, and disposal.

Outcomes

POLLUTANT REDUCTION OUTCOMES

Every industrial process has inputs and outputs. Material that is not incorporated into the finished product eventually becomes waste. Implementing pollution prevention can increase industrial efficiency and potentially decrease costs.

Non-hazardous material reduced in pounds per year: 800 pounds per year

The shop used half as much soy product therefore reduced the non-hazardous material usage from 1600 pounds per year (200 gallons) of petroleum-based metalworking fluid to 800 pounds per year (100 gallons) of soy-based product.

Solid waste reduced in pounds per year: 3,740 pounds per year

Used oil generated as non-hazardous waste (solid waste) was also reduced by half. The 7,480 pounds per year (935 gallons) previously recycled was reduced to 3,740 pounds per year.

Water Use gallons per year reduced: 1900 gallons per year

Reducing the coolant usage by half also reduced the water usage for mixing metalworking fluid by half.

ECONOMIC OUTCOMES

Increased product life is the most significant economic benefit of this pollution prevention application.

The cost of fluid divided by its life expectancy is the best calculation of the true cost of metalworking fluids. Although petroleum products may cost less per gallon than soy products, the increased lubricity and durability of the product greatly enhance the economic benefit of using soy metalworking fluid.

Cost of 200 gallons Petroleum MWF annually at \$12 per gallon	\$2,400.00
Disposal	\$523.60
Annual cost of petroleum	\$2,923.60
Cost of 100 gallons Soy MWF annually at \$18.68 per gallon	\$1,868.00
Disposal	\$250.00
Annual cost of soy	\$2,118.00
Saved annually by using Soy MWF	\$805.60

REGULATORY COMPLIANCE OUTCOMES

Exposure to air, heat, moisture, light and metal shavings (which act as catalysts in the breakdown of the lubricant) cause MWFs to become spent and must be replaced. Bacterial growth may cause contamination and lead to fluid degradation too.

Spent metalworking coolant (including aqueous-based products) can be regulated as used oil if the disposal method includes waste coolant being processed for energy recovery. 40CFR279, the Used Oil Management Standards, imposes management requirements affecting the storage, transportation, burning, processing and re-processing of used oil.

Using less soy MWF generated less used oil in this application.

ACRONYMS USED IN THE CASE STUDY

CFR	Code of Federal Regulations
CNC	Computer Numerical Control
ELM	Environmental Lubricant Manufacturing, Inc.
IWRC	Iowa Waste Reduction Center
MWF	Metal Working Fluid
SIC	Standard Industrial Classification

References

- ¹ http://www.elmusa.com/products/data_sheets/pdf/soyeasy_cool_XXL_Plus.pdf located on the manufacturer's website at <http://www.elmusa.com/index.html>. For the Material Safety Data Sheet see http://www.elmusa.com/products/MSDS/pdf/soyeasy_cool_XXL_plus_msds.pdf.
- ² Cutting Fluid Management for Small Machining Operations: A Practical Pollution Prevention Guide, 3rd Edition. Iowa Waste Reduction Center, 2003. <http://www.iwrc.org/downloads/pdf/cuttingFluid03.pdf>.
- ³ "Prevention of Skin Problems when Working with Metal Working Fluids" Technical Report 55-7-2001, July 2001. Washington State Department of Labor and Industry. http://www.lni.wa.gov/Safety/Research/Dermatitis/files/mwf_skin.pdf