Pollution Prevention
For
Machining, Cleaning, Degreasing, Finishing Operations for Metal Products

Small communities are facing many issues in maintaining permit compliance and the operational capabilities of their Publicly Owned Treatment Works (POTW) due in part to the age of the plants and infrastructure, volume, growth, pollutant loadings and ever tighter wastewater discharge regulations. Most communities have some manufacturing, fabrication or service industries that accomplish machining, cleaning, degreasing or finishing of metal products that create wastewater discharges which can be problematic.

Best Management Practices which incorporate Prevent Pollution

This fact sheet provides basic pollution prevention information common to several industrial processes which may generate waste water. Selected “Best References” materials will follow in each section but we encourage the reader to contact your state TAP program to get additional technical information, case studies, vendors, cost calculations and other information that will help implement pollution prevention ideas.

Metal Machining Operations

Machining includes any operations that saw, cut, drill, punch, press or shape metal using a machine that requires a liquid for cooling or cutting at the point of operation on the machine. Historically shops used several different petroleum based liquids for that purpose. In recent years most shops have moved to using synthetic, semi-synthetic and other water soluble machining and cutting fluids. In many cases the coolants can be discharged legally to the sewer. However the first step of a shop intending to discharge wastewater should be to gain approval from the local POTW.

The following best management practices are commonly found in machine shops that are practicing good waste minimization and pollution prevention strategies.

• Minimize the number of fluid types used in the shop to allow better recycling
• Implement good operator training programs with emphasis on the environment
• The use of water based chemistry acceptable to sewer whenever possible
• If petroleum based fluids are used, capture and recycle with no discharge to drains
• Waste minimization practices at the machine includes;
  o The use of de-ionized water to mix with coolants or cutting fluid
  o Monitoring of pH of the fluid to prevent bacteria build-up and spoilage
  o Good preventative maintenance of machine sumps, filters, oil skimmers
• Use of portable recycling units used at the machine for small operations
• Use of central collection and recycling of large volumes using ultra-filtration, centrifuge, coalesce, evaporation or other membrane separation technologies

Selected Best References for Machining Operations


Cutting Fluid Management for Small Machine Operations, 3rd Edition
Parts Cleaning and Degreasing

One of the most common industrial processes found in nearly every shop that manufactures, fabricates or services metal parts is degreasing or cleaning. After the parts or components have been machined, they almost always require a cleaning or degreasing step prior to painting, plating, welding or other metal finishing processes. Service oriented businesses such as automobile maintenance facilities also need to clean and degrease parts as part of the automotive repair process.

In the past this was usually accomplished by using a solvent which frequently generated a hazardous waste because of toxicity or flammability. During the 1990’s the ramifications of using ozone depleting substances made it imperative for companies to find cleaning/degreasing chemistry without those problems. Since that time many companies have switched to using aqueous cleaning chemistry which has generally reduced air emissions and hazardous waste.

However aqueous cleaning does provide the potential for wastewater issues resulting from the aqueous cleaner used and the oil, grease and other contaminants cleaned from parts and discharged with the cleaning solution to the sewer. If the wastewater from aqueous cleaning is discharged in sufficient volume and loaded with pollutants such as oil it could be a problem for a small POTW.

For businesses that use aqueous cleaning, there are many options to deal with the pollutants in the wastewater. This includes all types of parts washing systems including simple sink and drum small parts washers, enclosed large parts or multiple parts washers and large parts washing systems that may have several wash and rinse stages.

Note Vapor degreasing systems are still in limited use but for the most part do not have a wastewater discharge and are heavily regulated under air regulations. It is likely that those systems will be replaced with aqueous cleaning where technically possible.

Small Parts and Enclosed Washers
These typically do not have a direct discharge to the sewer and options generally include simple oil skimming devices and filters. In essence any built in or add on devices or processes which will remove oil, grease and particulate are likely to be successful in extending the service life of the cleaning chemistry or making the wastewater allowable for sewerage. If the volume of wastewater is large enough, several washers for example, membrane separation technology could be used as a pretreatment or recycling system to reclaim the chemistry and water.
**Blended Solvents**
Blended solvents are also widely used in small parts washers. The purpose of using blended solvents is often to increase the flashpoint of the solvent to above 140 degrees Fahrenheit, which removes the solvent from the regulations for hazardous waste because of flammability. However the blended solvents still may contain regulated toxics which may not be acceptable for sewerage. Shops using this material can filter and reuse frequently but many also use solvent recovery services that take the solvent for recycling.

**High Production Staged Washing Systems**
This type of aqueous cleaning system is used extensively in large shops that produce many parts or process a high volume of parts prior to painting or other surface finishing steps. The systems usually have at least one wash stage followed by one or more rinses, perhaps a corrosion inhibitor stage followed by another rinse stage. The systems vary but the volume of rinse water discharged from the system can be problematic for the POTW without some level of pretreatment before discharge by the company.

In recent years there have been many successes in both recovering/recycling the cleaning chemistry from such systems as well as recycling the rinse water. Filtration, centrifuge, coalesce or some form of advanced membrane technology might be used.

**Organic Solvent Cleaning and Degreasing**
Although the use of aqueous cleaning is very common, many companies do continue to use organic solvents that could generate hazardous waste from toxicity or flammability characteristics as well as using chemistry that is listed as a hazardous waste in 40CFR or state regulations such as Wisconsin Administrative Coded NR 660-670. In those cases they cannot be discharged to a sewer. Those companies that continue to use flammable or toxic solvents for parts cleaning should strongly consider replacing them with aqueous cleaning chemistry as it presents far fewer environmental issues.

**Distillation**
However if that is not possible perhaps the next best option is to use solvent distillation to recycle the used solvents on site. Solvent distillation can be very effective with a recovery rate that might range from 65% to 95% depending upon the concentration of solids or contaminants that are in the spent solvent. Solvent distillation is a proven technology and the cost savings from reduced disposal and raw materials lost can be very large. It should be noted however that blended solvents are difficult to distill in a distillation unit because of varying boiling points of the solvents.

**Selected Best References for Parts Cleaning and Degreasing Operations**

**Minnesota Technical Assistance Program** [http://www.mntap.umn.edu/](http://www.mntap.umn.edu/)
Cleaning Web Page
[http://www.mntap.umn.edu/metalfinish/cleaning.html](http://www.mntap.umn.edu/metalfinish/cleaning.html)

Solvent Recycling Web Page

Membrane Filtration Web Page
[http://www.mntap.umn.edu/greenbusiness/water/5-MembraneFiltration.htm](http://www.mntap.umn.edu/greenbusiness/water/5-MembraneFiltration.htm)

Emulsified Oil and Water Separating Products Web page
[http://www.mntap.umn.edu/greenbusiness/water/6-EmulsifiedOil.htm](http://www.mntap.umn.edu/greenbusiness/water/6-EmulsifiedOil.htm)
Metal Finishing Operations

Metal finishing processes generally include anodizing, etching, electroplating and electro-less plating and phosphating of metal either as a finished coating or as a preparation prior to painting or another finish coating. The wastewater from metal finishing industries has been heavily regulated for many years due to the use of various heavy metals and toxic chemistry used in metal finishing processes. Many metal finishers will have a wastewater permit which includes categorical pretreatment standards which require them to pre-treat their wastewater to remove pollutants and adjust pH prior to discharging to the sewer.

The following best management practices are commonly found in metal finishing shops that are practicing good waste minimization and pollution prevention strategies.

- Replace Cyanide and Hexvalent-Chrome chemistry with an alternative chemistry
- Counter flow rinsing of parts to enable waste water reductions, recycling and recovery of both chemistry and rinse water
- Spray rinsing and other water conservation measures also to reduce wastewater and chemistry loss and reduced loading on the pretreatment system
- Regular pH probe cleaning and maintenance to extend chemistry service
- In tank filtration, water recycle and chemistry recovery techniques extending chemistry service life through advanced membrane filtration technology
- Zero Discharge of waste water when all of the above are incorporated and other technologies such as evaporation or membrane filtration is used.

Selected Best References for Metal Finishing Operations

Minnesota Technical Assistance Program http://www.mntap.umn.edu/
Metal Finishing Web Page http://www.mntap.umn.edu/metalfinish/index.html
Cleaning Web Page http://www.mntap.umn.edu/metalfinish/cleaning.html
Plating Web Page http://www.mntap.umn.edu/metalfinish/plating.html

Illinois Sustainable Technology Center, http://www.wmrc.uiuc.edu/
Painting Operations

After machining, cleaning and degreasing and if additional coating is needed after metal finishing the metal parts are almost always painted prior to or after assembly. This is for the aesthetic value of the product but more importantly for corrosion protection and other performance criteria. Painting operations frequently generate hazardous waste either from the paint itself or from solvents used for cleaning paint guns, purging lines and other activities. As with the other metal processing steps there are several industry standards that have developed. The following best management practices are found in painting shops that are practicing good waste minimization and pollution prevention strategies.

- High solids, waterborne and other low VOC coatings both for metal and wood
- Powder coating with powder recycle and recovery systems
- Metered mix and delivery systems for liquid spray painting systems
- Many new types of high transfer efficiency (TE) spray guns
- Solvent distillation for clean-up solvents

Selected Best References for Painting Operations


Less Paint is more at International Truck and Engine Corporation [http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/TN/tn08-090.pdf](http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/TN/tn08-090.pdf)
Many Additional Fact Sheets and Studies from WMRC Related to Painting [http://www.wmrc.uiuc.edu/main_sections/info_services/library_factsheets.cfm](http://www.wmrc.uiuc.edu/main_sections/info_services/library_factsheets.cfm)

Environmental Sustainability Center

National Paints and Coatings Resource Center
Technical Assistance Programs (TAP) Resources

Using the resources listed above and the technical assistance available from state TAP’s is an inexpensive way to help businesses using machining, cleaning, degreasing and other metal finishing processes to successfully reduce pollutant loadings. Access to those resources is readily available in all Great Lakes states through the following.

The University of Wisconsin-Extension-Solid and Hazardous Waste Education Center (SHWEC) is the state TAP for Wisconsin. SHWEC provides environmental information and assistance that can help reduce or eliminate wastes, waste water and air emissions through on-site visits and direct technical assistance. Visit www.uwex.edu/shwec to learn more about SHWEC services or to contact a specialist.

The Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) provides contacts to other Great Lake States TAP’s and access to additional national resources through the National Pollution Prevention Roundtable at http://www.p2.org/. The GLRPPR is an extensive resource for publications and information at: http://www.glrppr.org/ and provides direct access to the Publicly Owned Treatment Works “Topic Hub” through the GLRPPR web site.

Waste Water Regulation

Always check with your local POTW for an ordinance covering specific additional limits on waste water discharges. Many cities, towns and villages have their waste water ordinance on their web site. In Wisconsin and most states, waste water regulations are readily available on the internet. All Wisconsin statutes and administrative codes are at:
Wisconsin Statutes http://www.legis.state.wi.us/rsb/stats.html
Wisconsin Administrative Codes http://www.legis.state.wi.us/rsb/code.htm

The Wisconsin Department of Natural Resources portal to waste water regulation that affects this industry is at http://dnr.wi.gov/topic/wastewater/index.html and a condensed list of Wisconsin NR Chapters for Water/Waste Water/Storm Water is located at: http://dnr.wi.gov/topic/DrinkingWater/code.html.

Even when there is no local ordinance in place, all industrial facilities in Wisconsin are required to comply with the listed prohibited discharges in NR 211.10

Acknowledgement  This fact sheet is one of several developed by the University of Wisconsin-Extension, Solid and Hazardous Waste Education Center under a US-EPA Pollution Prevention Grant, Award Number NP-96589602, Using Pollution Prevention as a Strategy to Reduce Pollutant/Hydraulic Loading to Small Community POTWs, to provide information, ideas and technical assistance to address specific problems affecting POTW’s.

Updated 07/2012 by Jonathan Rivin, Pollution Prevention & Waste Management Specialist

For further information contact:

<table>
<thead>
<tr>
<th>Madison</th>
<th>Milwaukee</th>
<th>Stevens Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>UW Extension</td>
<td>UW UW Extension</td>
<td>University of Wisconsin</td>
</tr>
<tr>
<td>610 Langdon Street, Room 317</td>
<td>161 West Wisconsin Avenue, Suite 6000</td>
<td>800 Reserve Street</td>
</tr>
<tr>
<td>Madison, WI 53703</td>
<td>Milwaukee WI 53203</td>
<td>Stevens Point, WI 54481</td>
</tr>
<tr>
<td>608.262.0385 tel</td>
<td>414.227.3160 tel</td>
<td>715.346.2793 tel</td>
</tr>
<tr>
<td>608.262.6250 fax</td>
<td>414.227.3165 fax</td>
<td>715.346.3624 fax</td>
</tr>
</tbody>
</table>

University of Wisconsin, U.S. Department of Agriculture and Wisconsin counties cooperating.  
An EEO/AA employer, University of Wisconsin-Extension provides equal opportunities in employment and programming, including Title IX and ADA requirements