
Diversity is the hallmark of screw machine operations. Commonly, machine shops produce parts made from mild steel, brass, and alloys, such as stainless steel and aluminum. This variety of metals means the shop must utilize different metal-working fluids, cleaning methods, and finishes. Consequently, machine shops also generate several waste streams, such as solvent wastes, plating or anodizing wastes, metal wastes, and general trash.

Many solvent wastes must be disposed of as RCW hazardous waste. Spent solvents result from parts washing, usually with a petroleum distillate. Washing removes contaminating fluids and metal chips between machining operations and prepares them for finishing and packaging.

Small shops often let parts drip-dry after immersion in solvent, but some use vapor degreasers. Much waste (evaporation, spillage, and premature discard of solvents) is caused by poor operating procedures. Operator training and process changes can achieve a 50 percent reduction in solvent waste. Small solvent-recovery stills, that make on-site recycling economically feasible, are also available. Other operators have eliminated solvent cleaning by installing washers which use detergents and water. These systems can also recover metal-working fluids for reuse.

Plating or anodizing wastes resulting from most finishing processes consists of wastewaters which must be treated to remove suspended solids, metals, oil, and grease. The effluent normally is discharged to a community sewage treatment plant. In some locations, treatment must be complete enough to allow discharge under strict regulatory supervision to surface streams.

Sludge is another unwanted by-product of treating electro-plating wastewater. Most often, it must be disposed of as a RCRA hazardous waste. As with solvent waste, you can reduce wastewaters (and thus the volume of sludge) by operator training and procedural changes. Further reductions in sludge are possible by concentrating the rinsewater and returning it and its metal content to the plating baths. In some plants, operations that don’t produce hazardous waste send wastewater to a plating treatment plant “just because it’s there.” This causes an unnecessary increase in wastewater requiring treatment and in hazardous waste.

Metal waste is a favorite for recycling. Some operators report that revenue from scrap metal makes a difference between profit and loss. Because of machining and metals characteristics, much of this waste is “wooly” and retains coolant. Thus, valuable metal-working fluid is lost, and the scrap is less valuable. Separators which recover coolant by spin-drying the waste before recycling are effective but are not widely used. Even simple drain drums, which let the scrap drip into a recovery drum before it’s shipped, upgrade the scrap and recover fluid for re-use.

General trash is typical of any plant which receives and ships materials, conducts office activities, and is the daily habitat of several people. There are opportunities to utilize, re-use, and recycle over half of the wastes which we now bury in landfills. Industrial managers should recognize and reclaim resources which our present throw-away society discards.

by Bill Singleton
Waste Reduction Engineers

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Waste Reduction Assessment

Precision Screw Machine Operations

INTRODUCTION:

These companies make an almost infinite variety of intricately-machined small parts for a multitude of uses. Some examples:

» Carburetor parts
» Special fasteners
» Tubing fittings
» Valves for gas appliances
» All sorts of tiny gadgets - you name it, somebody makes it!

Many of the parts are given surface treatments to customer specification. Some of the common treatments include black oxide coating on steel or brass, phosphatiding, bright dipping, chromating on aluminum or zinc-plated items, and electroplating, usually either zinc or nickel.

OPERATIONS: (See Process Flow Diagram)

A typical shop will include most or all of the various operations indicated on the flow diagram. A good way to assess the wastes generated is to make a block diagram like this for the overall business. Once made, you can take it block-by-block, asking what wastes are generated in the operation represented by each. The remainder of this presentation will be an attempt to describe what goes on and to indicate the wastes that might be expected to be generated in each.
TYPICAL PROCESS FLOW

PRECISION SCREW MACHINE SHOP
WASTE REDUCTION DATA SHEET

NAME AND ADDRESS OF COMPANY:
Generic Manufacturing Corp.
710 S. Majestic Ave.
Podunk, Tn 98765 Tel. 123/456-7890

CONTACTS:
John Q. Doe, Plant Manager
Joseph P. Blow, Plating Supvr.

TYPE OF BUSINESS:
Automatic screw machine products, precision-machined to custom order (examples - fasteners, carburetor parts). Make a tremendous variety of intricately machined parts from low-carbon steel (± 60%), brass (± 20%), aluminum (± 12%), alloy and stainless steels (± 8%). Many of these parts are surface-treated and/or plated to customer specifications. The treatments include black oxide coatings on steel and brass, black phosphate, bright dipping, chromating on aluminum, and nickel and zinc plating. About 80% of the finishing operations involve plating with either nickel or zinc.

NO. OF EMPLOYEES:
About 80, working 1 full and 1 part (15-18 people) shift.

WASTE STREAMS AND THEIR DISPOSITION:

1. The normal solid trash, rubbish, etc. which goes to a local landfill.

2. There is also a rather large amount of solvent waste (Varsol#3) generated in the degreasing of parts. This is recycled off-site by another division of the company. Transport to the recovery site is accomplished in company trucks.

3. Treated process wastewater generated in the treatment of plating wastes. The wastewater is discharged to the POTW in Podunk, under the proper permit.

4. Sludge from the treatment of the plating wastewater. This is picked up periodically by Super Competent Waste of Memphis who stabilize it before transporting it to the Emelle, Ala. landfill.
DESCRIPTION OF PLATING AND PLATING-WASTE TREATMENT:

All of the metal surface-treatments are done in one large room where 2 walls are lined with solution vats. Regardless of the surface treatment desired, the parts are treated in this plating room. Basically, there are alkaline cleaners, acids of various types, chromate solutions, and nickel or zinc plating baths placed around the room.

The degreased parts are placed in either stationary perforated dipping baskets (for smaller batches), or in larger plastic rotating drums, then dipped as required in the various baths in order to accomplish the desired treatment. No solutions are dumped, but the various rinse baths are allowed to overflow to two open trenches which conduct the flow to the waste-treatment area. One trench is dedicated to solutions containing chromium compounds and all other solutions go to the second. The solution in the first trench passes into an under-floor tank where sodium bisulfite is mixed in to reduce the hexavalent chromium to trivalent. It appears that a pH sensor is used to determine that sufficient bisulfite has been added. The solution from this step and the solution in the second trench both then pass into a second under-floor tank where they are neutralized with sodium hydroxide to about pH 8. From this tank, the flow is through an outdoor drain into a group of five concrete septic tanks in series set into a descending slope. The liquid matter overflows from each tank to the next, eventually flowing to the local sanitary sewer system.

Sludge is allowed to settle out in the bottom of all the tanks. Occasionally, an air-operated diaphragm pump is used to pump the sludge out of the septic tanks into a vertical, cone-bottom steel tank which is used as a feed tank for a filter press which removes the sludge. The filtrate is put back into the string of settling tanks, and the filter cake is blown as dry as possible with compressed air. The blowing is continued for as much as 5 hours, and the final cake solids content is about 40%. At this solids content, there is no free water evident, but we were told that Super Competent Waste Management finds it necessary to add a stabilizer additive before moving the waste to Emelle. The sludge is accumulated in used 55-gallon drums (which are purchased for this purpose) until the time limit is near, then are picked up. The drums we saw were all empty, because a load had been taken away the day before, but proper storage and labeling procedures are followed.

The wastewater isn't metered, but the volume is estimated to be 50,000-70,000 gallons/month, based on total water usage.
The following information was obtained on the plating wastes:

**Wastewater to sewer:**

<table>
<thead>
<tr>
<th></th>
<th>Mean, Year</th>
<th>Sample, 9/5</th>
<th>Range, Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>1.87mg/l</td>
<td>1.17mg/l</td>
<td>0.48-4.5mg/l</td>
</tr>
<tr>
<td>Zinc</td>
<td>2.15mg/l</td>
<td>1.40mg/l</td>
<td>0.09-6.0mg/l</td>
</tr>
<tr>
<td>Hex Cr</td>
<td>0.47mg/l</td>
<td>0.18mg/l</td>
<td>0.14-1.4mg/l</td>
</tr>
<tr>
<td>Total Cr</td>
<td>1.12mg/l</td>
<td>0.93mg/l</td>
<td>0.77-2.0mg/l</td>
</tr>
</tbody>
</table>

**Sludge from filter:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>5- 100 ppm</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>100- 200 ppm</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>100- 200 ppm</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>&lt; 0.5 ppm</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8 to 10</td>
<td></td>
</tr>
</tbody>
</table>

The quantities of sludge generated and shipped, according to the manifests, were:

- **Last Year**: 3100 kg generated, 2560 kg shipped, 2 shipments.
- **This Year**: 2965 kg generated, 2910 kg shipped, 3 shipments.

**OBSERVATIONS AND THOUGHTS FOR FURTHER INVESTIGATION**

A number of the solution tanks had channels which allowed drainage from the parts drum to run to the floor trenches instead of draining back into the tank from which it came.

There are one or two points where drain and overflow pipes from chromium-containing solution tanks go to the 'non-chrome floor trench.

Drag-out from plating tank into the first rinse tank appeared to be rather heavy, even though it did not appear that there was pressure to move parts through in a hurry.

What do the wastewater analytical figures have to say about the operation of the system and unnecessary waste generation?

An exceptionally large proportion of the Chromium in the effluent is in the hexavalent oxidation state, even though a reduction step is being carried out in treatment. What does this say about operation and unnecessary hazardous waste generation?
SOLVENT PARTS WASHING AND SOLVENT WASTE:

The solvent waste that is generated here in parts cleaning is by far the greatest volume of waste they have. This waste is hauled by Generic vehicles to another Generic plant in New York which has distillation equipment. Though this material is actually being recycled, it must be counted in their hazardous waste totals because it leaves the plant site. Last year, they generated 10,820 kg of this solvent and their manifests show they shipped 11067 kg to the recovery site in 8 separate shipments. This year, the manifests show a total of 95 drums shipped. At approximately 160 kg per drum for this type of waste, this represents approximately 15,000 kg, for a 36% increase over last year. The solvent is a mineral spirits, having a declared flash point of 101°F which makes it a combustible liquid, rather than flammable, under DOT rules.

OBSERVATIONS AND THOUGHTS FOR FURTHER INVESTIGATION

The quantity of waste solvent developed appears to have little, if any, sort of control, with parts degreasing being done manually in a "homemade" washing system.

The parts are "dipped and swished" in perforated containers through a series of three solvent baths, then taken to a final wash cabinet where the basket is placed over a collecting trough while circulating solvent is pumped to a spray head which is manually directed over the parts.

The only specific management procedure for this operation is that "when the solvent gets 'too dirty' it is emptied to waste drums and more is taken from the tank".

Apparently no attempt is made to move parts and solvent countercurrent to one another.

After the final wash, the parts are 'spun' dry and taken to the plating room or to packaging if no surface treatment is required.

A certain quantity of oil gets into the various plating solutions, and there is a definite oily scum on top of the sludge-settling tanks, which has to be skimmed off periodically.

COST FACTORS:

It appears that considerable economic incentive for improvements is available in the area of solvent wastes. Unfortunately, Mr. Doe was unable to tell us how internal cost-accounting is handled regarding the transport of dirty solvent, recovery and return of the recovered solvent. Because the costs involved in the present operation must be defined internally in Generic, UTCIS can offer very little help in the economic analysis.
The volume of hazardous waste generated by the plating operation is relatively small. Beyond the procedural changes already listed, it would seem there are two likely avenues for waste reduction, both of which would require capital expenditure, and the payout times might be rather long. One avenue is to install an evaporator on the nickel-plating line to concentrate the rinse water (now discarded) for return to the plating tank, thus recovering most of the nickel now discarded in the rinse. The other would call for adding a dryer to reduce the water content of the treatment sludge from about 60% to about 10%. This would reduce the quantity of sludge to be disposed of, and having it in a completely dry form should make stabilization unnecessary.