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Number 93*Pollution Prevention Opportunities for PBT Chemicals***Copper and Copper Compounds**

Copper is necessary for good health. However, very large single or daily intakes of copper can harm human health. Long-term exposure to copper dust can irritate the nose, mouth, eyes and cause headaches, dizziness, nausea and diarrhea. Drinking water that contains higher than normal levels of copper may cause vomiting, diarrhea, stomach cramps and nausea.

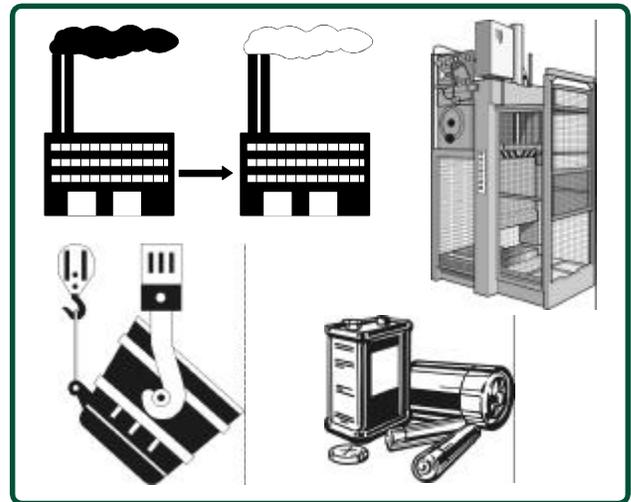
Chronic high intakes of copper can cause liver and kidney damage and even death.

**Where are Opportunities for Pollution Prevention?**

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment and air. Copper also occurs naturally in plants and animals.

Copper as a consumer product is most commonly seen in the U.S. as pennies, electrical wiring and some water pipes. It is also found in many mixtures of metals, called alloys, such as brass and bronze. Many compounds of copper exist, including naturally occurring minerals and man-made chemicals.

Copper is extensively mined and processed in the U.S. It is primarily used as the metal or alloy in the manufacture of wire, sheet metal, pipe and other metal products. Copper



compounds are most commonly used in agriculture to treat plant diseases like mildew, for water treatment and as preservatives for wood, leather and fabrics.

**What is Pollution Prevention?**

Pollution prevention means using source reduction techniques in managing waste problems and, as a second preference, environmentally sound recycling. The benefits of practicing pollution prevention include reduced operating costs, improved worker safety, reduced compliance costs, increased productivity, increased environmental protection, reduced exposure to future liability costs, continual improvement, resource conservation and enhanced public image. For

### Potential techniques for reducing copper usage and waste:

- ✓ **In etching, increase efficiency using thinner copper cladding.**
- ✓ **Recycle copper coating solutions or copper containing sludge.**

more details, see Ohio EPA's Office of Pollution Prevention fact sheet, *What Is Pollution Prevention?* at [www.epa.state.oh.us/opp/fact1\\_web.pdf](http://www.epa.state.oh.us/opp/fact1_web.pdf).

Local discharger limitations are constantly being reduced as more industries tie into existing publicly-owned treatment works (POTWs) and national pollutant discharge limitations become more restrictive. Due to low water quality values and domestic background concentrations, local limitations for mercury, silver and copper have been significantly reduced over the years. Recently, Ohio EPA re-evaluated its traditional methods of strictly applying numeric limitations to indirect dischargers and considered pollution prevention and source reduction as methods that could be effectively utilized to achieve stringent numeric local limits. Ohio EPA's Division of Surface Water has finalized new guidance, The Use of Best Management Practices (BMPs) as Industrial Local Pretreatment Limits, for implementing pollution prevention and source reduction as an effective tool for regulating indirect dischargers. The BMPs can be used in conjunction with or in place of numeric local limits. BMP conditions could also be issued as a term and condition of the indirect discharge permit. These terms and conditions would then be an enforceable condition of the permit. The guidance is available on the Division of Surface Water's Web page at [www.epa.state.oh.us/dsw/guidance/pretreatment1.pdf](http://www.epa.state.oh.us/dsw/guidance/pretreatment1.pdf).

### Copper Pollution Prevention in Industries

Pollution prevention in a manufacturing setting generally means material substitution, process improvement and product change or redesign. Often, pollution prevention practice involves applying one or more of these strategies in tandem.

**Material Substitution** is the use of different materials that are less toxic or non toxic. This may include the use of a non-copper containing raw material or different equipment that does not require copper.

One petroleum additives plant's wastewater was treated with aqueous copper sulfate solution to remove H<sub>2</sub>S odors. This was producing excessive amounts of copper in the discharge to a POTW. In addition, the usage was so high that it created storage and handling problems. Tote bins of copper sulfate had to be replaced about once every two days.

The facility selected an alternative odor control product using a metering pump system, along with other boiler treatment and biocides. The H<sub>2</sub>S was completely captured, resolving the odor problem. Copper levels in the effluent were reduced to barely appreciable amounts, eliminating the discharge of 2,000 pounds (907 kg) of solid copper waste per year. Labor costs for tote bin storage, change out and replacement were also eliminated. The net annual savings totaled \$10,000.

**Process Improvement** means to improve the operational process, thereby reducing or eliminating the need for copper usage. This includes, increasing the operating efficiency of an equipment or a process, good maintenance programs, and training to reduce the risk of waste generation.

Metal finishers can reduce the waste generation through techniques such as counter-current rinsing, water flow restrictors, drain boards and air knives. Recovery techniques such as evaporation, reverse osmosis, ion exchange, electro dialysis and electrolytic recovery can be used to reuse or recycle the valuable metals.

Reverse osmosis (RO) recovers plating chemicals from plating rinse water by removing water molecules with a semi-permeable membrane. The membrane allows water to pass through but blocks metals and other additives.

Diluted or concentrated rinse waters are circulated past the membrane at pressures greater than aqueous osmotic pressure. This action results in the separation of water from the plating chemicals. The recovered chemicals can be returned to the plating bath for reuse and the permeate, which is similar to the condensate from an evaporator, can be used as make-up water. RO units work best on dilute solutions. The design and capacity of an RO unit is dependent on the type of chemicals in the plating solution and the dragout solution rate. Certain chemicals require specific membranes. For instance, polyether/amide membranes are suggested for acid copper solutions. RO systems have a 95 percent recovery rate with some materials and with optimum membrane selection.

In electrolytic recovery, metal ions are plated-out of solution electrochemically by reduction at the cathode. There are essentially two types of cathodes used for this purpose: a conventional metal cathode (electrowinning) and a high surface area cathode (HSAC). The HSAC cathode can effectively plate-out metals, such as gold, zinc, cadmium, copper, nickel, etc. Therefore, electrolytic recovery can be used with most plating baths.

The application of electrolytic recovery can be illustrated by the following example in printed circuit manufacturing. In making printed circuits unwanted copper foil is etched away by an acid solution. Dissolved copper accumulates in the solution and reduces the effectiveness of the solution. The solution is typically regenerated by oxidizing the cuprous ion. The volume of this solution, however, increases steadily and the surplus liquor must be stored. Typically, the copper in the surplus liquor is precipitated as copper oxide and this sludge is landfilled. Utilizing electrolytic recovery along with a membrane which allows the passage of hydrogen and chloride ions but not the copper, copper is transferred to the cathode and recovered as pure flakes.

An Ohio facility uses plating baths in one step of manufacturing copper foil. By eliminating some rinsing steps and rerouting rinse water that is generated to feed process baths, the facility reduced rinse water generation by 100,000 gallons/month and saves 15,000 pounds of copper, a raw material, a month.

**Product Change or Redesign** may remove copper altogether from the manufacturing process, especially where copper is incorporated into the product.

### Systematic Approaches to Pollution Prevention

A systematic approach to pollution prevention establishes and maintains a systematic management plan designed to continually identify and reduce environmental impacts through pollution prevention. Many facilities are incorporating pollution prevention into their quality programs or environmental management systems. The options identified and implemented often incorporate the pollution prevention techniques mentioned earlier.

The “*Printed Circuit Board Manufacturing Pollution Prevention Opportunities Checklist*,” from Solid Waste Management, County Sanitation Districts Of Los Angeles County, compiles some key steps printed circuit board manufacturers can take in copper recovery and reuse. For example, on microetch lines, copper sulfate crystals may be recovered directly from the etch tank and reused in copper electroplating baths. On debur operations, particulate copper may be recovered using a centrifuge or paper filter. Etchant may be sent to an off-site reclaimer instead of being treated. More efficient etch machines can be investigated because an efficient etch machine results in less copper in rinsewater. For more details, please see <http://es.epa.gov/techinfo/facts/cheklst7.html>.

### Contact OPP

For more information and assistance on pollution prevention, contact Ohio EPA’s Office of Pollution Prevention (OPP) at (614) 644-3469 or visit OPP’s Web site at [www.epa.state.oh.us/opp](http://www.epa.state.oh.us/opp).

Ohio’s Materials Exchange (OMEx) at [www.epa.state.oh.us/opp/omex](http://www.epa.state.oh.us/opp/omex), lists “*materials wanted*,” including metal wastes, metal-bearing sludges and filter cakes. Users may also post their “*materials available*” on the listing. The exchange proves valuable in the reuse of materials and preventing them from becoming a waste.

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[www.epa.state.oh.us/opp](http://www.epa.state.oh.us/opp)

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The Office of Pollution Prevention was created to encourage multi-media pollution prevention activities in Ohio to reduce risk to public health, safety, welfare and the environment. Pollution prevention stresses source reduction and, as a second choice, environmentally-sound recycling, while avoiding cross media transfers. The office develops information related to pollution prevention, increases awareness of pollution prevention opportunities, and can offer technical assistance to business, government, and the public.



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