OhioEPA
State of Ohio Environmental Protection Agency

Office of Pollution Prevention

September 2002
Number 98

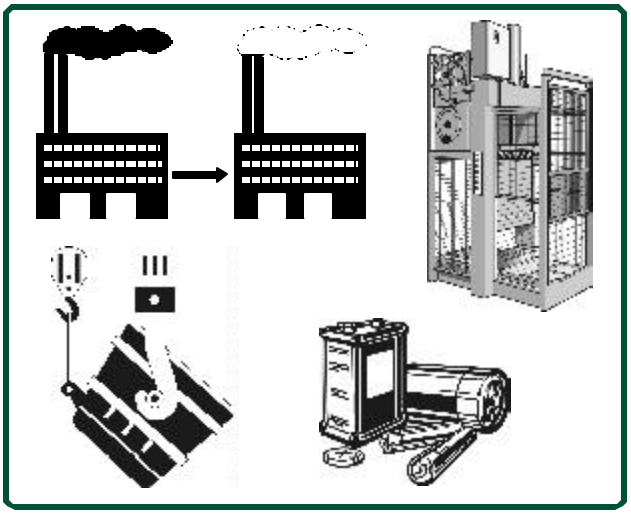
Pollution Prevention Opportunities for PBT Chemicals

Zinc and Zinc Compounds

Zinc is one of the most common elements in the earth's crust. It is found in air, soil and water and is present in all foods. Pure zinc is a bluish-white shiny metal.

Zinc is an essential element in people's diet. Too little zinc can cause health problems, but too much zinc is harmful. The U.S. Recommended Dietary Allowance (U.S. RDA) for zinc is 5 to 15 milligrams a day for humans. Not enough zinc in one's diet can result in a loss of appetite, a decreased sense of taste and smell, slow wound healing and skin sores, or a damaged immune system. Young men who don't get enough zinc may have poorly developed sex organs and slow growth. If a pregnant woman doesn't get enough zinc, her baby may experience growth retardation.

Too much zinc, however, can also be damaging to human health. Harmful health effects generally begin at levels from 10 to 15 times the U.S. RDA (in the 100 to 250 mg/day range). Eating large amounts of zinc, even for a short time, can cause stomach cramps, nausea and vomiting. For longer periods, it can cause anemia, pancreas damage and lower levels of high density lipoprotein cholesterol (the good form of cholesterol).



Breathing large amounts of zinc (as dust or fumes) can cause a specific short-term disease called metal fume fever. This is believed to be an immune response affecting the lungs and body temperature.

It is not known if high levels of zinc affect human reproduction or cause birth defects. Rats that were fed large amounts of zinc became infertile or had smaller babies. Irritation was also observed on the skin of rabbits, guinea pigs and mice when exposed to some zinc compounds. Skin irritation may occur in people.

- ✓ **In 1999, Ohio's hazardous waste program regulated facilities reported generating 107 million pounds of zinc and zinc compounds in waste.**
- ✓ **An Ohio manufacturer of reinforced rubber hose products reduced the zinc oxide content in the rubber raw materials without compromising the quality of the finished products. Non-zinc-bearing substitutes were found for a zinc sterate rubber coating used in some extrusion lines.**

Where are Opportunities for Pollution Prevention?

Zinc has many commercial uses. It is used as coatings to prevent rust, in dry cell batteries, and mixed with other metals to make alloys like brass and bronze. A zinc and copper alloy is used to make pennies in the United States.

Zinc combines with other elements to form zinc compounds. Zinc compounds are widely used in industry to make paint, rubber, dye, wood preservatives and ointments. Common zinc compounds found at hazardous waste sites include zinc chloride, zinc oxide, zinc sulfate and zinc sulfide.

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 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**.

Zinc 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 nontoxic. This may include the use of a non-zinc containing raw material or different equipment that does not require zinc.

To comply with government regulations, as well as reduce operating costs, a fiberglass plant needed to replace the chromate and zinc products used for corrosion and deposit control in its cooling water treatment program. After laboratory tests demonstrated that replacement products were effective, the cooling system was treated with alternative azole and polymer-based products for scale and corrosion inhibition, and other biocides for

microbiological control. The process was completely automated with a computerized monitoring, feed and delivery system. Elimination of chromate and zinc brought the plant into environmental compliance. Further benefits include improved control over treatment parameters, the ability to use recycled wastewater in the cooling system, reduced water usage and less wastewater disposal. Total net annual savings was more than $180,000.

Process Improvement means to improve the operational process, thereby reducing or eliminating the need for zinc usage. This includes, for example, 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, restricting water flow, drain boards and air knives. Recovery techniques such as evaporation, reverse osmosis, ion exchange, electrodialysis 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, polyamide membranes work best on zinc chloride and watts nickel baths. 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.

Product Change or Redesign may eliminate zinc altogether from the manufacturing process, especially where zinc 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.

One Ohio company produces electrogalvanized zinc and zinc-nickel cold rolled steel, primarily for the automotive industry. In 1989, the company embarked on an aggressive metals

recovery and reclamation program. After more than a year of engineering work, it was decided that recovery of zinc and nickel was possible through ion exchange.

Initial tests indicated that more than 90 percent metals recovery was possible. It was estimated that initial recovery efforts would result in approximately a 500-ton reduction in sludge generation. After proving the system on the zinc-nickel stream, expansion to the zinc process had the potential to further reduce sludge generation by an additional 350 tons.

During the first year of implementation, the project resulted in eliminating 515 tons of sludge. The second year, with improved methods, and the addition of the zinc stream, the system accounted for the elimination of more than 892 tons of sludge. This exceeded the engineering expectations of this project by five percent.

During this same time period, extensive efforts were made to find uses for the remaining metals which were not recoverable by the ion exchange method. The company was successful in its efforts and in the first year utilized 600 tons of material as feedstock for other industrial operations. Further development of secondary sources resulted in using more than 925 tons in the second year. The total impact of the company's waste minimization project was an annual reduction of more than 1,800 tons of sludge.

The total project costs were $3,167,573, while the annual savings were $2,035,000. Therefore, the payback period for the project, based solely on cost avoidance, was 1.5 years. However, when such issues as long-term liability and corporate responsibility to the community were considered, it was immediately apparent that this was a worthwhile project.

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.**

Ohio's Materials Exchange (OMEx) at **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.

www.epa.state.oh.us/opp

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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