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Office of Pollution Prevention

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Pollution Prevention Opportunities for PBT Chemicals

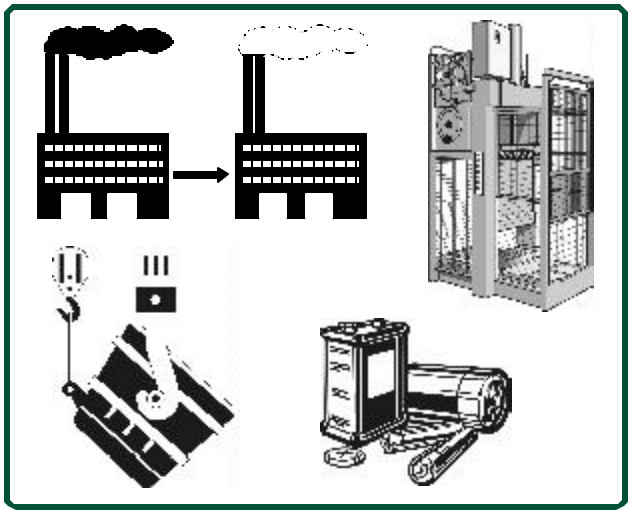
Nickel and Nickel Compounds

Nickel is an essential element for healthy animals and probably for humans. The most common adverse health effect of nickel in humans is an allergic reaction. People can become sensitive to nickel when jewelry or other items containing nickel touch the skin. Once a person is sensitized to nickel, further contact with the metal will produce a reaction. The most common reaction is a skin rash at the site of contact. In some sensitized people, dermatitis may develop at a site away from the area of contact. For example, hand eczema is fairly common among people sensitized to nickel. Less frequently, some people who are sensitive to nickel have asthma attacks. Some sensitized individuals react when they eat nickel in food or water, or breathe dust containing nickel.

Kidney and lung damage have been observed for large doses of nickel. Dust or fumes of nickel can be a human carcinogen.

Where are Opportunities for Pollution Prevention?

Pure nickel is a hard, silvery-white metal that has properties that make it very desirable for combining with other metals to form mixtures called alloys. Some of the metals that nickel can be alloyed with include iron, copper, chromium and zinc. These alloys are used in making metal coins, jewelry, valves and heat



exchangers. Most nickel is used to make stainless steel. There are many compounds of nickel combined with other elements, including chlorine, sulfur and oxygen. Many of these compounds dissolve fairly easily in water and have a characteristic green color. Nickel and its compounds have no characteristic odor or taste. Nickel compounds are used for nickel plating, to color ceramics, to make some batteries and as substances known as catalysts that increase the rate of chemical reactions.

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

✓ **In 1999, Ohio's hazardous waste program-regulated facilities reported generating 22 million pounds of nickel and nickel compounds in waste.**

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**.

Nickel 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-nickel containing raw material or different equipment that does not require nickel.

Process Improvement means to improve the operational process, thereby reducing or eliminating the need for nickel 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 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.

In 1991, an Ohio steel products manufacturer committed to the U.S. EPA's 33/50 Program. The company's efforts focused on reducing off-site releases of chromium, lead and nickel, as well as heavy metal from electric arc furnace (EAF) dust. It recycled 50 percent (600,000 pounds) of one plant's EAF dust on site and sent the remainder to a reclaimer, along with the dust from a second steel plant, for high temperature metals recovery. Its two steel plants implemented new emission control systems and baghouses with higher efficiency, which were able to capture 99.5 percent of EAF dust generated from the steel melting process. These changes combined to decrease the company's Toxic Release Inventory releases by more than 80 percent.

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

A manufacturer of industrial superabrasive products formed a Waste Minimization Task Force and a Pollution, Waste and Emissions Reductions (POWER) Team. Members of these groups were selected from all areas of the facility to assess pollution prevention opportunities. Plant-wide participation was achieved through subcommittees, proper education and communication, well-marked recycling bins and an employee suggestion program. The POWER task force conducted workshops with shop managers and process engineers to prepare annual mass balances for all shops. Mass balances are a foundation of the plant's pollution prevention activities, permitting it to focus on source reduction, set up programs and priorities, and track successes.

The plant built an on-site nickel recovery system through an 18 month, $1.3 million project. The reduction in nickel releases accounts for 85 percent of the facility's nickel loss along with a 1,100 ton reduction in filter cake landfilling.

Another 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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