Technical Factsheet on: NICKEL

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

The MCL and MCLG for Nickel were remanded on February 9, 1995. This means that while many water suppliers continue to monitor nickel levels in their water, there is currently no EPA legal limit on the amount of nickel in drinking water. EPA is reconsidering the limit on nickel. This partially outdated fact sheet is provided for your information.

Drinking Water Standards

MCLG: 0.1 mg/l
MCL: 0.1 mg/l
HAL(child): 1- to 10-day: 1 mg/L; Longer-term: 0.5 mg/L

Health Effects Summary

Acute: EPA has not found nickel to potentially cause health effects from acute exposures at levels above the MCL.

Short-term exposures in drinking water considered "safe" for a 10-kg (22 lb.) child consuming one liter of water per day: a one- to ten-day exposure to 1 mg/L; upto a 7 year exposure to 0.5 mg/L.

Chronic: Nickel has the potential to cause the following health effects from long-term exposures at levels above the MCL: decreased body weight; heart and liver damage; dermatitis.

Cancer: There is no evidence that nickel has the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

Production of nickel was 84.6 million lbs. in 1986, down slightly from 1982 report of almost 90 million lbs. In 1986 it was estimated that industries consumed nickel as follows: transportation, 25%, chemical industry, 15%; electrical equipment, 9%; construction, 9%; fabricated metal products, 9%; petroleum, 8%; household appliances, 7%; machinery, 7%; and other, 11%.

Nickel carbonate is used in nickel catalyst production for organic chemical manufacture, petroleum refining and edible oil hardening. Nickel oxide consumption in 1972 (representing over 30 million lbs. contained nickel) is estimated to have been as follows: 60% for stainless and heat resisting steels, 27% for other steel alloys, 8% for other nickel alloys, 2% for cast irons, and 3% for other uses.

Release Patterns

Nickel is found in many ores as sulfides, arsenides, antimonides & oxides or silicates; chief sources include chalcopyrite; others are pyrrhotite, pentlandite, garnierite, niccolite, millerite. The principal natural form of nickel oxide occurs in admixture with nickel sulfides in varying proportions in weathered ore. Nickel carbonate, found as the mineral zaratite, is a potential atmospheric and surface water pollutant.

Inadvertent formation of nickel carbonyl can occur in various industrial processes that use nickel catalysts, such as coal gasification, petroleum refining, and hydrogenation of fats and oils. Nickel oxide has been identified in residual fuel oil and in atmospheric emissions from nickel refineries. Trinickel disulfide is a major component in nickel refinery flue dust.

From 1987 to 1993, according to the Toxics Release Inventory nickel releases to land and water totalled nearly 27 million lbs., of which most was to land. These releases were primarily from nickel smelting/refining and steelworks industries. The largest releases occurred in Oregon and Arkansas. The largest direct releases to water occurred in Maryland and Georgia.

Environmental Fate

Nickel is one of the most mobile of the heavy metals in the aquatic environment. The mobility of nickel in the aquatic environment is controlled largely by the capability of various sorbents to scavenge it from solution. Although data are limited, it appears that in pristine environments, hydrous oxides of iron and manganese control nickel's mobility via co-precipitation and sorption. In polluted environments, the more prevalent organic material will keep nickel soluble. In reducing environments, insoluble nickel sulfide may be formed. Nickel chloride is water soluble and would be expected to release divalent nickel into the water.

The atmosphere is a major conduit for nickel as particulate matter. Contributions to atmospheric loading come from both natural sources and anthropogenic activity, with input from both stationary and mobile sources. Various dry and wet precipitation processes remove particulate matter as wash out or fallout from the atmosphere with transfer to soils and waters. Soil borne nickel may enter waters by surface runoff or by percolation into ground water.

Once nickel is in surface and ground water systems, physical and chemical interactions (complexation, precipitation/dissolution, adsorption/desorption, and oxidation/reduction) occur that will determine its fate and that of its constituents.

The only gaseous nickel compound of environmental importance is nickel carbonyl. Under ambient conditions in moist air, it decomposes to form nickel carbonate. Thus, in the atmosphere at concentrations near the ppb level, it has a half-life of about 30 minutes. The removal of nickel carbonyl by precipitation or by adsorption on surfaces has not been documented. Since this compound is soluble in water, precipitation scavenging is possible. Nothing is known about its reaction with natural surfaces or its uptake by vegetation. Thus, dry deposition rates cannot be predicted until some experimental investigations have been conducted.

Although nickel is bioaccumulated, the concentration factors are such as to suggest that partitioning into the biota is not a dominant fate process.

Chemical/Physical Properties

CAS Number: 7440-02-0

Color/ Form/Odor: Nickel is a silvery metal found only in combined form in nature.

Soil sorption coefficient: N/A; sorption related to that of iron/manganese oxides, organic matter.

Bioconcentration Factor: N/A; not expected to bioconcentrate

Common Ores: sulfide- chalcopyrite, heazlewoodite (disulfide); sulfate- morenosite; carbonate- zaratite; oxide- bunsenite; others- pyrrhotite, pentlandite, garnierite, niccolite, millerite

Solubilities:

acetate- 17% at 65 deg C
carbonate- 93 mg/L at 25 deg C
carbonyl- insoluble
chloride- 642 g/L at 20 deg C
cyanide- insoluble
disulfide- insoluble
fluoride- 40 g/L at 25 deg C
hydroxide- 0.13 g/L cold water
iodide- 1242 g/L at 0 deg C
nitrate- 48.5 Wt% at 20 deg C
oxide- 0.11 mg/L at 20 deg C
sulfate- 293 g/L at 0 deg C

Other Regulatory Information

Monitoring:

-- For Ground Water Sources:

Initial Frequency-1 sample once every 3 years

Repeat Frequency-If no detections for 3 rounds, once every 9 years

-- For Surface Water Sources:

Initial Frequency-1 sample annually

Repeat Frequency-If no detections for 3 rounds, once every 9 years

-- Triggers - If detect at > 0.1 mg/L, sample quarterly.

Analysis

Reference Source	Method Number
EPA 600/4-79-020	249.1; 249.1
NTIS PB 91-231498	200.7; 200.8; 200.9
Standard Methods	3111B; 3113; 3120

Treatment/Best Available Technologies: Ion Exchange, Lime Softening, Reverse Osmosis

Toxic Release Inventory - Releases to Water and Land, 1987 to 1993 (in pounds):

	Water	**Land**
TOTALS	**709,236**	**26,079,419**
Top Ten States *		
OR	459	6,256,532
AR	4,250	5,622,900
ID	1,000	2,200,250
IN	28,050	2,098,196
PA	19,680	2,052,736
AZ	767	984,817
TX	0	777,400
MD	77,200	666,637
CA	6,687	285,731
GA	61,100	193,111
Major Industries*		
Primary nonferrous meta	16,874	12,053,688
Blast furnaces + steel	304,891	6,784,227
Ind inorganic chems	22,689	2,519,468
Ind organic chems	109,141	1,105,934
Petroleum refining	186,499	949,411
Primary copper	1,272	996,817
Iron+steel foundries	500	409,000
Gray iron foundries	3,326	334,524
Inorganic pigments	62,394	193,111

* Water/Land totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

For Additional Information:

EPA can provide further regulatory and other general information:
EPA Safe Drinking Water Hotline - 800/426-4791

Other sources of toxicological and environmental fate data include:
Toxic Substance Control Act Information Line - 202/554-1404
Toxics Release Inventory, National Library of Medicine - 301/496-6531
Agency for Toxic Substances and Disease Registry - 404/639-6000