Reference Data Sheet on Elemental Mercury in the Environment (Quicksilver, Hg)

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Potential Exposure Sources And Uses

- Thermometers
- Batteries
- Lighting
- Photography
- Industrial Catalyst
- Pharmaceutical
- Fungicides
- Dental Amalgams
- Lubricating Oils
- Metallurgy
- Neutron Absorber
- Super Conductors
- Detonators
- Waste Water
- Contaminated Fish
- Surface Waters
- Ambient Air
- Sewage Sludge
- Fossil Fuel Combustion
- Mercury Rich Ores (Cinnabar)
- Paint Pigments
- Industrial Waste Disposal
- Packaging Inks
- Mirror Coatings
- Cathodes for Chlorine/Caustic Production
- Electrical Switches

Introduction

Man has been making useful products with mercury for thousands of years. Mined from the earth mostly as *Cinnabar* (HgS),[1] it is extracted by heating the ore in the presence of air or lime. Worldwide production of mercury in the 1960s was estimated at 15 million pounds by the U.S. Geological Survey. Environmental concerns have slowed the growth of mercury as an industrial chemical. In 1985, however, the United States alone produced approximately 1.3 million pounds.[2] The processing of mercury as an industrial chemical results in the potential for workplace exposure as well as release of mercury vapor to the environment. According to the USEPA's Toxic Release Inventory for 1992, American industry released nearly 16,000 pounds of elemental mercury to soils, surface waters, and the atmosphere.[3] It is estimated that 30,000 to 150,000 tons of mercury vapor is emitted annually into the earth's atmosphere through natural evaporation from the earth's crust.[4] Elemental mercury and most mercury compounds are highly toxic by inhalation; less toxic by ingestion and skin absorption. It is imperative that human exposure to this element and its compounds be monitored and controlled.

Definitions [1,4,5,6]

Elemental Mercury or Metallic Mercury - Mercury in the zero oxidation state, not combined with any other

element or compound (Hg_0).

Inorganic Mercury Compounds - Mercury in combination with non-carbon elements or compounds: mercuric chloride ($HgCl_2$), mercuric dichromate ($HgCr_2O_7$).

Metals - Elements that form positive ions when their compounds are in solution: compounds whose oxides combine with the hydroxl group (-OH) in water solutions.

Heavy Metals - Metals of atomic weight greater than sodium (23); metals that form soaps with fatty acids.

Organic Mercury Compounds - Mercury in combination with carbon or carbon-containing compounds: mercurous acetylene (Hg_2C_2); mercurous acetate ($C_4H_6Hg_2O_4$).

Surface Tension - In any liquid, the attractive force between the molecules just below the air/liquid surface and the molecules at the surface. The higher the surface tension in a liquid, the less it will tend to flow.

Vapor Pressure - The pressure a pure vapor exerts at any given temperature while in equilibrium with its pure liquid or solid form. The higher the vapor pressure, the more rapidly molecules will change phase from the liquid to the gaseous state.

Saturated Atmosphere - The condition whereby an atmosphere holds as much as possible of any element or compound before condensation occurs.

Physical Data On Elemental Mercury: [1]

A naturally occurring metallic element; number 80 on the periodic chart; chemical symbol Hg for hydrargyrum; molecular weight 200.6 grams/mole; silvery, extremely heavy liquid at room temperature at 13.59 grams/cc (water 1 gm/cc); melting point -38.85 °C (-38 °F); boiling point 356.6 °C (699.48°F). Soluble in nitric acid and lipids, insoluble in water, alcohol and ether. Surface tension 480 dynes/cm at 20 °C (water 73 dynes/cc), the highest for any liquid. Vapor pressure at room temperature 0.002 mmHg;[4] at 50°C 0.013 mmHg.[8] A standard atmosphere saturated with mercury will contain approximately 18 mg Hg/m³ of air.[4] Non-combustible. Odorless.

Implications:

Mercury vapor exhibits no warning properties such as odor, color, taste, eye irritation, or respiratory irritation; and, since elemental mercury has a significant vapor pressure at room temperature, there may be a need for engineering controls and/or the use of respirators.[11] Mercury vapor is readily absorbed by inhalation. It passes through the lungs where it is oxidized in red blood cells and transported to all parts of the body. If liquid mercury is heated or present in a confined space, the airborne Threshold Limit Value (TLV) - Time Weighted Average (TWA) of 0.025 mg/m³ can be rapidly exceeded.[7]

Health Effects [4,11,12,13]

Mercury is a neurotoxin and produces its primary toxic effects on the central nervous system. However, oxidized mercury in the form of mercury salts is toxic to all cells.

Acute Exposure - Possible Effects

Nausea - Blurring of vision - Inflammation of the mouth - Loosening of teeth - Painful breathing - Salivation - Diarrhea - Bronchitis - Pneumonitis - Sweating - Chest pain - Tremors - Anorexia - Weight loss

Chronic Exposure - Possible Effects

Hearing loss - Kidney damage - Memory disturbances - Hypertension - Reduced pain sensation - Fatigue - Gingivitis - Reproductive Effects - Vision problems - Enzyme interference - Hallucinations - Personality changes

Long term exposure symptoms may be similar to short term ailments but are more intense and may be irreversible.

Dose Response Information

- **Air Concentration**

Non-specific complaints:	0.01 - 0.05 mg Hg/m³ of air
Increased signs and symptoms:	0.24 - 0.27 mg Hg/m³ of air
Cough, chest pains:	1.2 - 8.5 mg Hg/m³ of air

- **Exposure Metabolism**

Tremor, memory difficulty, renal dysfunction	50 µg Hg/g creatinine in urine and 0.05 mg Hg/m³ in air
Majority of toxic effects	above 50 µg Hg/g creatinine in urine
Subclinical effects	50 -100 µg Hg/g creatinine in urine
Peripheral nerve damage	100-500 µg Hg/g creatinine in urine
Prediction of polyneuropathy	500-850 µg Hg/g creatinine in urine
Fatal	20 mg to 3 grams of mercury salt

Implications:

It may be difficult to assign symptoms to mercury especially in the early stages of exposure.

Background Levels [9,13]

Mercury is present in the non-workplace environment. Natural or background mercury levels have been measured and exemplar values listed below. This information may be useful to gauge the contribution of workplace exposure.

People	Water	Foods
Urine - 5 µg Hg/L	Surface Waters < 1µg/L	20 µg of Hg in an average daily diet
Hair - 10 µg Hg/gram hair	Drinking Water < 0.002 mg/L	0.5 mg Hg/kg of fish product (USFDA guideline for fish)
Blood - 0.2 µg Hg/deciliter		0.3 mg Hg/70 Kg person (daily intake limit)

Implications:

The general population is exposed to mercury through food, water and ambient air. Mercury is biomagnified or concentrated as it moves from smaller organisms to larger organisms in the food chain such as fish.[4] Therefore, people who consume large amounts of fish may take in more mercury than people who do not. Mercury emissions to ambient air are controlled (not eliminated) through the Clean Air Act in the United States. The Toxic Release Inventory tallies contributions to ambient air from industry. People who do not receive their drinking water from a Publicly Owned Treatment Works (POTW) facility where mercury levels are controlled at 0.002 mg/l, may need to consider drinking water as a source for mercury if exposure symptoms appear.

Regulations, Codes and Standards

Mercury is regulated in private industry and the workplace. It is a hazardous chemical and regulations exist for allowable occupational exposure and also proper handling, spill reporting, transport, disposal, and emissions reporting. Mercury is also regulated by the EPA under several Acts in order to protect the environment. A partial list of key regulations and standards are contained in the following Table.

Regulatory Limits and Standards for Elemental Mercury

Agency or Organization	Limit/Consideration	Reference
OSHA	Acceptable Ceiling Concentration 0.1mg Hg/m³ air	29 CFR 1910.1000 (1993)
OSHA	Hazardous Chemical	29 CFR 1910.1200 (1987)
ACGIH	Threshold Limit Value (TLV) 0.025 mg Hg/m³ air Time Weighted Average	ACGIH Threshold Limit Value (May 1994)
ACGIH	Total inorganic Hg in urine: Preshift 35 µg/g creatinine Total inorganic Hg in blood: End of Week 15 µg/L	ACGIH Threshold Limit Value (May 1994)
NIOSH	REL 0.1 mg Hg/m³ air Ceiling Value (TWA)	"Pocket Guide for Chemical Hazards" 1990
NIOSH	Immediately Dangerous to Life and Health (IDLH) 28 mg Hg/m³ air	"Pocket Guide for Chemical Hazards" 1990
USEPA	Maximum Contaminant Level (MCL) 0.002 mg Hg/liter	Safe Drinking Water Act PL 93-523 40 CFR 141.11 (1992 ed.)
USEPA	Reporting Requirements Incident: 1 pound	SARA Title III - Emergency Planning& Community Right to Know 40 CFR 372 (1986)
USEPA	Reportable Quantity per Release: 1 pound	Comprehensive Env. Response, Compensation and Liability Act(CERCLA) or Superfund 40 CFR 302.4 (Eff. 4/85)
USEPA	Regulated Hazardous Waste: U151	Resource Conservation and Recovery Act 40 CFR 261.33 (Eff. May 1980)
USEPA	National Emission Standard, Hazardous Air Pollutant(NESHAP) : 2300 gm/24 hours	40 CFR 61 (1992 ed.)
DOT	Classification: Corrosive Material Code Number: NA2809, UN2809 Designation: ORM-B	49 CFR 172 (1987 ed.)
ANSI	Hazardous Industrial Chemical: Precautionary Labeling	Z129.1-1988

Engineering Controls/Personal Protection

Ventilation is considered an acceptable engineering control option. For temporary situations such as equipment repair or emergencies, an appropriate respirator may be worn.

Concentration in Air	Minimum Protection

≤ 1.0 mg/m³	Supplied-air respirator; Self-contained breathing apparatus (SCBA)
≤ 5.0 mg/m³	Supplied-air respirator with full face piece; SCBA with full facepiece
≤ 28 mg/m³ (IDLH)	Type C supplied air respirator, positive pressure mode
≥ 28 mg/m³	SCBA with full face piece, positive pressure mode.

All respirators must be NIOSH or MSHA approved.

Clothing	Full body work clothes including chemical resistant footwear and gloves
	8-inch face shield

Measurement

It is always preferable to control and monitor mercury in the environment to prevent exposure at unacceptable levels. Mercury can be measured in air using stationary and personal absorption sampling devices (NIOSH Method 6009); hand-held gold film vapor analyzers; and ultraviolet light (UV) absorption devices. Inexpensive swabs that change color upon contact with mercury ions can be used to screen for contaminated dusts. More intrusive blood and urine sampling can be done to verify exposure to mercury and track its biological effects on the body.

References

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