Mercury Toxicity

Introduction

Mercury is a metallic element that occurs naturally in the environment.

It eagerly distributes into the air, water, soil, and biomass of the environment

Mercury, which has the lowest melting point (−39° C) of all the uncontaminated metals, is the merely uncontaminated metal that is liquid at room temperature

The method and amount of toxicity depend powerfully on the kind of complex and the redox state of mercury

Major uses and sources in drinking-water

The use of mercury in industrial processes significantly increased following the industrial revolution of the 19th century.

Mercury is or has been used for the cathode in the electrolytic production of chlorine and caustic soda, in electrical appliances (lamps, arc rectifiers, mercury cells), in industrial and control instruments (switches, thermometers, barometers), in laboratory apparatus and as a raw material for various mercury compounds.

The latter are used as fungicides, antiseptics, preservatives, pharmaceuticals, electrodes and reagents. Mercury has also been widely used in dental amalgams.

Mercury's industrial uses are decreasing because of environmental concerns and environmental legislation in many countries.

A less well characterized use is in ethnic and folk remedies, some of which can give rise to significant exposure of individuals

Major forms of Mercury Contamination in Water

Mercury is current in the surroundings in a numerous forms as :

fundamental mercury (HgO)

Inorganic mercurous (Hg^+)s

Mercuric ($Hg2^+$) salts and

as organic compounds (e.g. methyl-, ethyl and phenyl-mercury);

Every structure possesses diverse physicochemical property and toxicity profile

Environmental fate

The solubility of mercury compounds in water varies.

The elemental mercury vapour is insoluble, mercury(II) chloride is readily soluble, mercury(I) chloride is much less soluble and mercury sulfide has a very low solubility.

Methylation of inorganic mercury is an important process in water and occurs in both fresh water and seawater

Bacteria (*Pseudomonas* spp.) isolated from mucous material on the surface of fish and soil were able to methylate mercury under aerobic conditions

Environmental fate

Some anaerobic bacteria that possess methane synthetase are also capable of mercury methylation

Once methylmercury is released from microbes, it enters the food-chain as a consequence of rapid diffusion and tight binding to proteins in aquatic biota.

The enzymology of CH_3Hg^+ hydrolysis and mercury(II) ion reduction is understood

Environmental levels of methylmercury depend on the balance between bacterial methylation and demethylation

Toxic Effects of Mercury

Mercury and its compound are increasing toxin and in little quantity are harmful to human health.

The most important effect of mercury poison obvious as neurological and renal turbulence as it can simply bypass the blood-brain barrier and has consequence on the brain

The gastrointestinal area absorb about 95% of ingested methylmercury wherever it may be able then come in the red blood cells and the brain through binding covalently toward glutathione and cysteine protein group

Inhale vapor simply cross the pulmonary alveolar membranes to come in the circulatory system, wherever it invade primarily red blood cells, the central nervous system, and the kidneys

Neurological Effect

Toxic effects on the brain owing to methylmercury be earliest recognized in men with occupational contact

In the central nervous system (CNS) mercury can harm the blood brain and it facilitates diffusion of the brain by further poisonous metal and substance.
The main effect of mercury poison manifests as neurological and renal trouble as it can simply get ahead of the blood-brain barrier and has cause on the brain

Methyl mercury damages primarily the cerebellum and cerebrum

Neurological Effect

The effect of mercury poison effect in the CNS consist of depression, fear, tremendous irritability, hallucination, an inability to focus, memory failure, tremor of the hand, head, lips, tongue, jaw and eyelids, weight loss, continually low body temperature, drowsiness, headache, insomnia, and weakness.

Through nervous system effect, It also cause on other unusual sensory systems together with loss of sight, retinopathy, optic neuropathy, hearing loss, a compact sense of smell, and unusual touch sensation

The neurotoxic effects of Methyl mercury in adult mammals consist of ataxia, difficulty in locomotion, neurasthenia (a widespread weakness, destruction of hearing and vision, tremor, and loss of consciousness and death

Reproductive Effects

Mercury be able to effect on reproductive purpose by changing the circulate of level of follicle-stimulating hormone (FSH), luteinizing hormone (LH), inhibin, estrogen, progesterone, and the androgens

Reproductive effects of Methyl mercury in mammals range from developmental alteration in the fetus, which create bodily or behavioral deficit after birth, to fetal death

Remediation and passive decontamination for mercury pollution

Historically emitted mercury, adsorbed mainly by sediment, is still a dangerous threat to aquatic organisms, animals and even humans.

Even if source control of contaminated wastewater is achievable, it may still take a very long time, perhaps centuries, for mercury-contaminated aquatic systems to reach relatively safe mercury levels in both water and surface sediment naturally

It may take even longer to reduce mercury levels in deep sediment. Due to human activities or natural processes, e.g., hydrodynamic flows, bioturbation, molecular diffusion, and chemical transformation, the buried mercury can be remobilized into the overlying water.

Thus, proper environmental management procedures should be applied to lower mercury levels in mercury contaminated water systems.

Remediation

Source control, contaminated sediment remediation, or their combination, are the usual options for cleaning up mercury-contaminated sites.

In general, four kinds of treatments of contaminated sediment are available:

(1) in situ containment (2) in situ treatment, (3) ex situ containment, and (4) ex situ treatment

Sediment containment does not decompose the contaminants, but only separates them from the overlying water.

Sediment treatment processes involve contaminant removal or degradation.

Capping is widely used to contain sediment, whereas dredging can either contain or treat sediment, or both.

Natural attenuation is contamination reduction by naturally occurring processes. In natural attenuation, no containment or treatment measures are implemented to contaminated systems.

Capping

In situ capping (ISC) is on site placement of proper covering material over contaminated sediment in aquatic systems.

Laboratory research suggests that ISC can be effective in reducing the impact of mercury contamination in aquatic systems

Experimental tests show that the capping material, composed of a mixture of sand and finer particles, can adsorb mercury and other heavy metals very well

Thus, this capping layer can prevent the mercury that leached from the sediment from entering the overlying water.

In one test, capping material adsorbed 99.9% of mercury in concentrations at 200-500 µg/l

This test showed that a capping layer can be a good barrier between mercury-contaminated sediment and the overlying water.

CAPPING

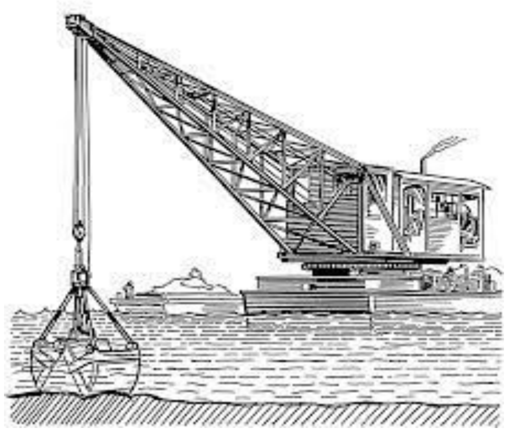
In ex situ capping (ESC), contaminated sediment is dredged and relocated to another site, where one or multiple isolating layers are placed over the sediment

ESC is a combination of dredging and capping.

In ESC, capping is used to minimize adverse environmental effects at the disposal site after sediment is dredged at the original in situ site

capping is a promising economical method for treating mercury-contaminated aquatic systems.

Dredging



Dredging is the excavation of material from a water environment.

Dredging appears to be an effective remedy for systems heavily polluted by mercury.

Minamata Bay, Japan, contained as high as 600 mg/kg of mercury in settled sediment

At most sampling points, mercury concentrations were below 5 mg/kg after dredging when compared with the initial concentrations, this dredging project was very effective.

Samples during and after dredging showed that mercury concentrations in water and fish were below the safety requirement

Dredging

A laboratory experiment mimicking ocean dredging discovered that about 5% of MeHg and less than 1% of HgT was released from contaminated sediment

It is suggested that a combination of mechanical and hydraulic dredging produces the least sediment resuspension

Mathematical models were developed to estimate dredging costs, efficiency, and environmental effects

dredging of the contaminated sediment is only a temporary solution to the problem

Natural Attenuation

Natural attenuation means contamination decrease by naturally occurring processes

Relying on natural attenuation alone, no aggressive remedial methods would be applied, and contaminated aquatic systems would be expected to recover naturally.

If no serious adverse environmental effects would occur, natural attenuation may be a choice for less contaminated sites.

The advantages of natural attenuation over active remedial methods include:

(1) no sediment resuspension,

(2) little or no cost,

(3) no change in benthic conditions

Natural Attenuation

The contaminated systems in natural attenuation should be regularly monitored to ensure environmental safety.

Biological (e.g., microbial decomposition), physical (e.g., advection, dispersion, adsorption, settling, and evaporation), and chemical (reactions) processes are major mechanisms involved in the transformation and transport of mercury

Natural attenuation approach was selected for some aquatic systems with inorganic or organic contamination

Experiments and field studies demonstrate possible natural attenuation of mercury contamination by reduction, demethylation, and volatalization.

Natural Attenuation

Two important ways to naturally reduce HgII in surface waters are photoreduction and microbial reduction.

In low mercury concentrations (low picomolar range), photoreduction is more effective than microbial reduction

In high mercury concentrations (over 50 picomole), microbial reduction is more effective

In deep anoxic environments, certain bacteria in the presence of humic substances are reductants of HgII

Microbial demethylation of MeHg was observed in contaminated sediment

Conclusion

The most important anthropogenic sources of mercury pollution in aquatic systems are:

(1) atmospheric deposition, (2) erosion, (3) urban discharges, (4) agricultural materials, (5) mining, and (6) combustion and industrial discharges.

Depending on the specific site, some of these sources may play more important roles than others.

For urban areas, the most important sources may be discharges from combustion and industry, as well as from other industrial or municipal sources.

Remediation and passive decontamination for contaminated sediment are possible alternatives to clean-up mercury-contaminated aquatic systems.

Conclusion

To evaluate and prevent potential adverse effects on the environment, careful risk assessment is necessary before remediation or passive decontamination

Field and laboratory studies suggest that ISC can be an effective and economical remedial approach to mercury contamination.

Dredging is an expensive remedial method and sediment resuspension is a major environmental concern. For heavily polluted systems, dredging seems to be more effective.

If there are no serious adverse environmental effects, natural attenuation, involving little or no cost, may be a choice for less contaminated sites.