



Accumulation and Biotransformation of Mercury Contamination in Plumbing Systems

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Introduction

- Mercury can be discharged with wastewater into plumbing systems from many different sources:
 - Spills from broken thermometers, flowmeters, sphygmomanometers and other devices that contain mercury
 - Laboratory reagents
 - Amalgam from dental clinic operations
 - As a contaminant in some types of bleach, drain opener and other janitorial chemicals.
- Most of the mercury discharged is in the elemental form-liquid metal or solid alloys with other metals (amalgams)
- Inorganic mercury compounds may also be dissolved in the wastewater.



Introduction

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- Most of the dissolved mercury passes through the plumbing and is released into the environment through wastewater treatment facilities.
- Some of the dissolved mercury accumulates in biofilms and other solids in pipes. The concentration of mercury in these solids may be many times higher than in the wastewater.
- Liquid mercury and amalgam wastes are heavy and settle by gravity into low spots in the plumbing system.
- Mercury that remains in the system may be changed into other more toxic forms by bacterial action.

Mercury is a Common Plumbing Contaminant

In older laboratory and hospital buildings liquid mercury metal may be found in a significant percentage of the sink traps.

When removing traps precautions to should be taken to prevent spills and worker exposure to vapors. Plan for containment and proper disposal of mercury wastes.

This photo shows a laboratory sink trap with its contents poured into a tray. Note the large droplet of mercury in the lower left corner.



Small Amounts of Mercury Can Cause Extensive Plumbing Contamination

Mercury discharged into sinks can flow out of traps and accumulate in joints and low areas of plumbing systems where it may persist for many years.

Mercury can also dissolve into some metals in plumbing such as copper and zinc forming liquid or solid alloys (amalgams) with them.

This photo shows what appears to be droplets of mercury in a pipe. It was taken with a video camera placed deep into the wastewater plumbing system under the basement floor of a laboratory building.



Mercury Can Contaminate Soil and Areas Around Leaking or Broken Pipes

Mercury can be released into the surrounding areas or soils from leaking or abandoned plumbing systems.

These releases may increase the potential for exposure to mercury vapors and they often have extremely high clean up costs.

This photograph shows droplets of mercury in an abandoned, rusted out pipe removed during decommissioning of a laboratory building.



Mercury is Also a Common Contaminant Laboratory Vacuum System Plumbing

Mercury can be aspirated into laboratory vacuum systems from thermometers, flowmeters, pressure gauges, coulter counters and other attached devices that contain mercury.

If such devices are in use vacuum systems should be protected with traps to prevent mercury from entering the vacuum system.

This photograph shows some of the mercury that spilled from a vacuum line removed during demolition of a laboratory building.

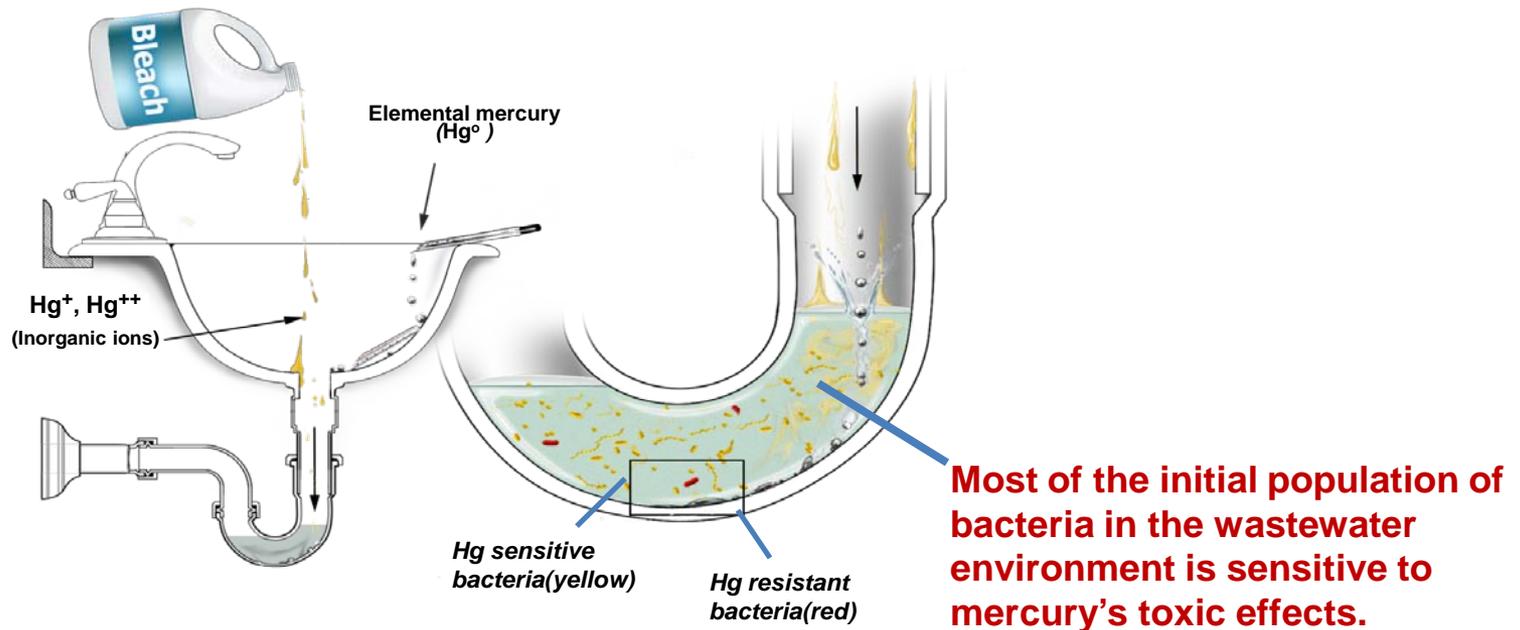




The remainder of this presentation shows how mercury enters and accumulates in plumbing systems, explains the microbial transformations that may occur there and the potential environmental consequences of these processes.

Discharge into the Wastewater System

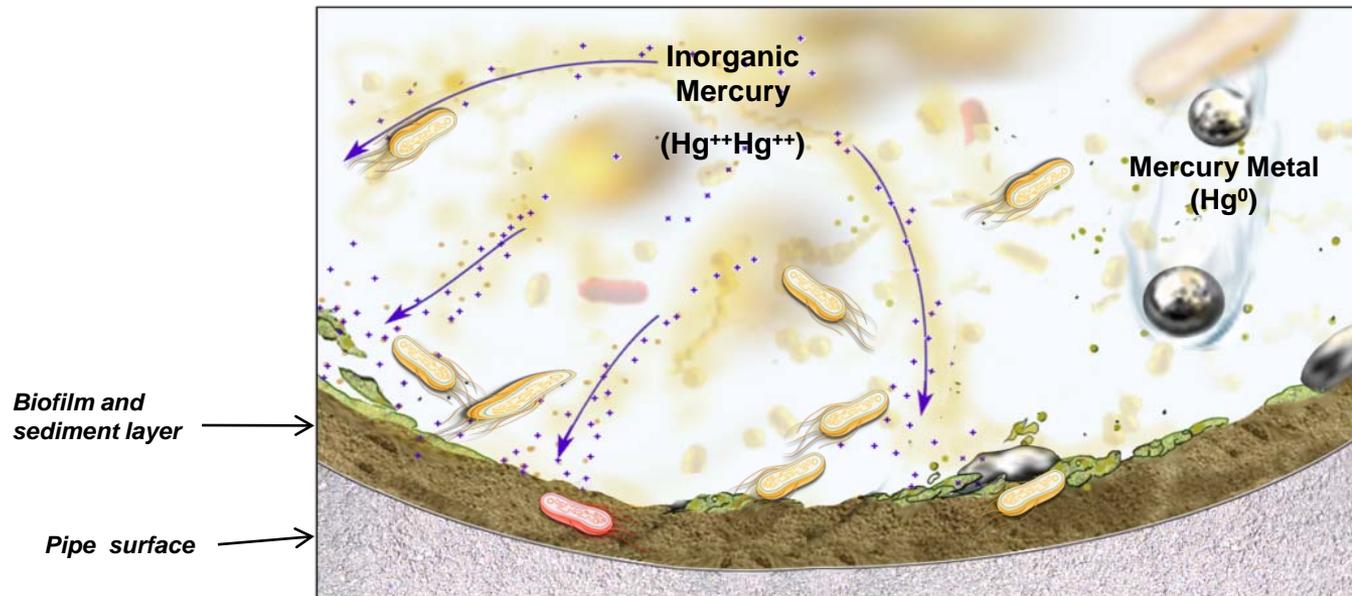
Common sources of mercury (Hg) in wastewater systems include contaminated janitorial products like bleach, amalgam waste from dental clinics and spills from broken thermometers.



Accumulation in Biofilms and Sediments

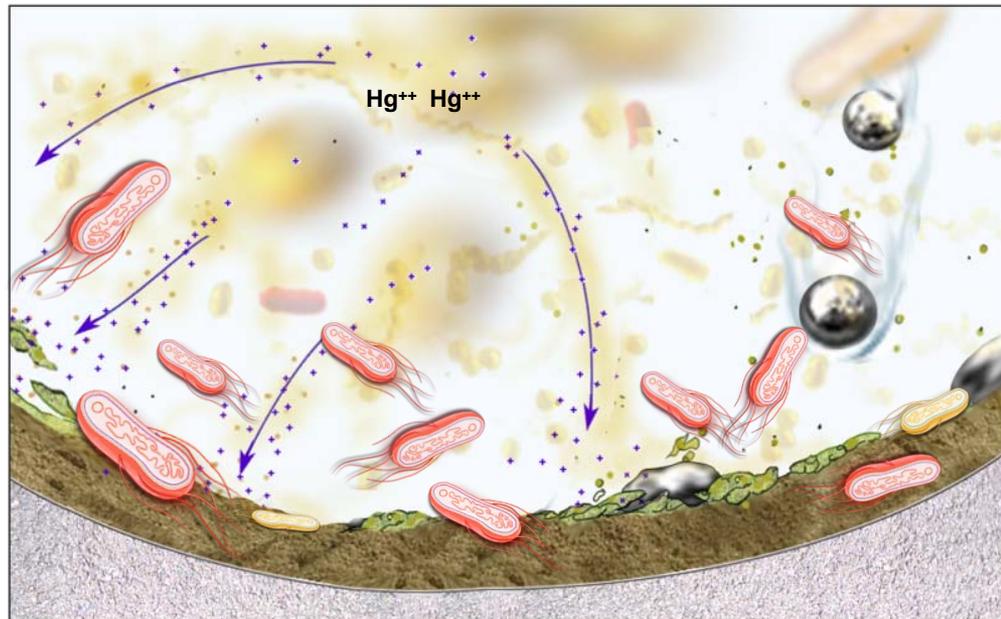
Inorganic forms of mercury dissolved in the water accumulate in biofilms and sediment. Heavy liquid mercury metal entering the system settles rapidly by gravity deposition and may form solid amalgams on contact with some metals such as copper and zinc.

Plumbing Surfaces and Sediments



Alteration of the Microbial Population

Bacteria that are not resistant to the toxicity of inorganic mercury compounds die off or are unable to grow. Resistant bacteria, shown here in red survive and become dominant.

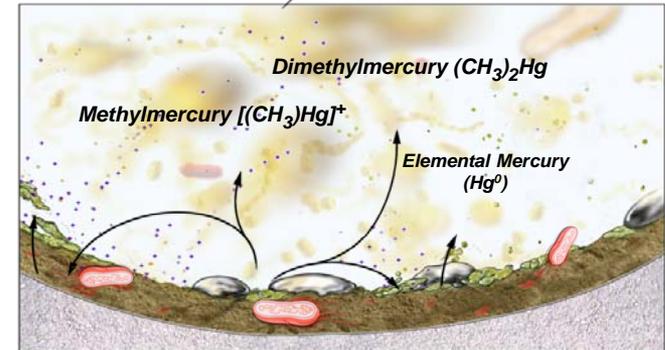
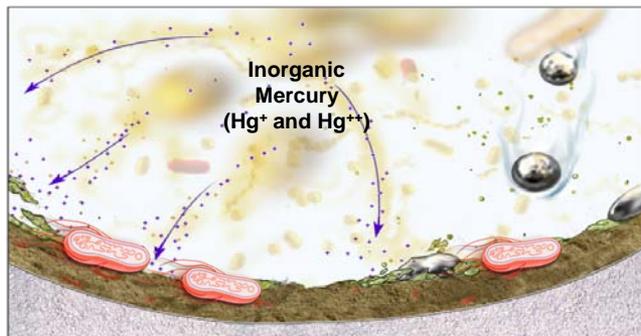
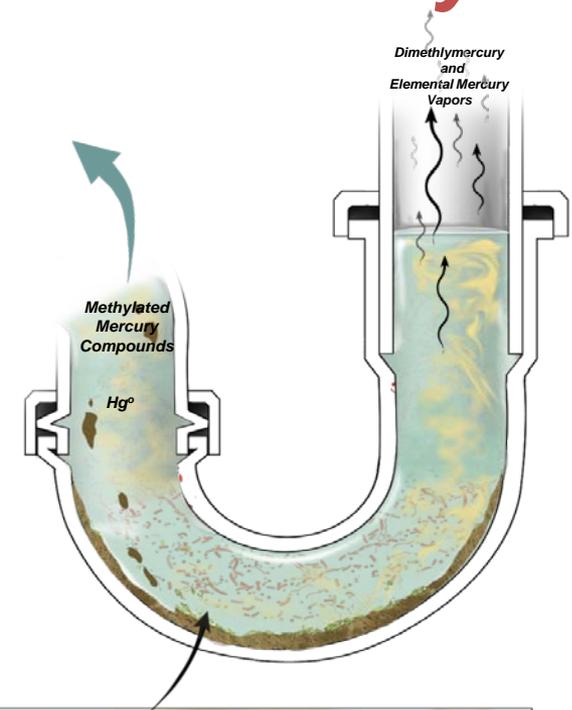


Biotransformation and Release Pathways

Bacteria resist the toxic effects of inorganic mercury by transforming it into other chemical forms that are less toxic to them. In anaerobic (oxygen free) areas of sediments sulfate reducing bacteria of the *Desulfobacteraceae* and *Desulfovibrionaceae* families metabolize and convert the inorganic mercury into methylated organic compounds, which are highly neurotoxic to animals, persistent and bioaccumulative in the environment. Other bacteria can reduce inorganic mercurous (Hg^+) and mercuric (Hg^{++}) ions to elemental mercury (Hg^0), which is slightly soluble in water.

Methyl mercury and elemental mercury may then volatilize and be released as vapors into the air above the water in the sink and into the room air.

Mercury and its compounds are discharged downstream dissolved in wastewater or with suspended solids when biofilms and sediments are removed from surfaces by turbulence and flushing action.





Environmental Impacts

- By the processes shown in the foregoing slides contaminated plumbing may become a chronic source of mercury and methylated mercury emissions to both indoor air and the external environment.
- Through the genetic mechanisms explained in the companion presentation mercury contaminated plumbing may also become a source of disease causing bacteria that are resistant to multiple antibiotics.
- The mercury concentration allowed by regulations in wastewater is very low.
- Costs for removal and disposal of contaminated plumbing and related spills can be extremely high.
- For these reasons it is important to eliminate all discharges of mercury into wastewater systems.

Prevent Mercury Pollution

- Discharges of mercury to wastewater systems can be greatly reduced or eliminated by taking these steps:
 - Eliminating all unnecessary uses of mercury in facilities.
 - Using only mercury free janitorial products.
 - Installing effective amalgam separators on waste lines from dental clinics and maintaining them properly.
 - Installing traps to protect vacuum systems in areas where mercury devices are in use.
 - Taking precautions to prevent mercury exposure and spills during plumbing repair and removal procedures.
- Never dispose of mercury or mercury contaminated wastes in sinks. Recycle or dispose of it following requirements for hazardous waste.

Mad as a HATTER?



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