

## Heavy Metal Toxicity and Human Health: A Review

C.L.Patil<sup>a</sup>, D.N.Shinde<sup>a</sup> and R.P.Chavan<sup>b</sup>

<sup>a</sup>Department of Chemistry, B.N.N. College, Bhiwandi Dist:Thane, Maharashtra, India.

<sup>b</sup>Department of Chemistry, Dnyanasadhana College, Thane, Maharashtra, India.

**Corresponding Author E-mail-clpatil1664@gmail.com**

### Abstract

Due to rapid civilization and industrialization the production of effluents affects the environment. The effluents contain toxic and non-toxic materials in the form of solids, liquids and gases.

Toxicity of a metal depends on the concentration used in various industrial processes, which affects the public health to a great extent. Present review paid attention towards cumulative impact of metal shown in biological and non-biological activities.

**Key words:**Toxicity, mercury, lead, Minamata disease

### Introduction

Multifarious activities in the industrial sector by human being generate heavy metals which pollutes the environment. Heavy metals such as arsenic, cadmium, chromium, lead, mercury and their compounds cause adverse effects on human health. Low concentrations of metals in the environment do possess any adverse effects while their higher concentrations are harmful. Residents nearby the industrial belt when exposed to these metals through ingestion or inhalation it affects their health. Hence in the present review describes some heavy metals causing health hazardous.

### Heavy Metal Toxicity and Human Health

#### Mercury (Hg)

Metallic mercury and its compounds are used to produce chlorine gas and caustic soda. It is also used in thermometers, dental fillings, switches, light bulbs, and batteries. Coal-burning power plants are

the major source of mercury emissions to the air. Mercury in soil and water is

converted by microorganisms to methyl mercury. 'Minamata disease' is the prominent incidence due to mercury in Japan. Disease occurs due consumption of Hg and they loss their lives due contaminated fishes.

Long term exposure of food to heavy metals, it was observed that trace quantities of contaminated food produces toxicity in enzymatic activity. (Agency for Toxic Substances and Disease Registry. (2008).

#### Health effects

The Environmental protection agency (EPA) has determined that mercuric chloride and methyl mercurial are carcinogenic to human beings. Brain signalling resulted in irritability, discrimination in sensory functions, and memory problems.(Eastern Research Group. (2001). Short-term exposure to

high levels of mercury vapours causes lung damage, diarrhoea, increases in blood pressure or heart rate, skin rashes, and eye irritation.(Occupational Health and Safety Administration. (2004).

#### **Regulatory limits**

EPA set permissible limit 2 parts per billion parts (ppb) in drinking water. Permissible limit is 1 part of methyl mercury in a million parts of seafood as per Food drugs and administration (FDA) regulations. Occupational safety and health administration (OSHA) set the limit 0.1 milligram of organic mercurial per cubicmeter at workplace in air and 0.05 milligrams per cubicmeter of metallic mercury vapour for 8-hour shifts and 40-hour work week.(Medha K Alur and C.L.Patil (2008)

#### **Cadmium (Cd)**

Cadmium occurs in earth's crust. While mining it may affect the workers' health. Though it is toxic, it acts as mineral fertilizers. Cd is having Industrial applications such as fabrication of batteries, pigments, metal coatings, plastics, and in electroplating.(C.L.Patil and Varsha Waikole(2009)Itai-itai disease is due to cadmium metal toxicity.

#### **Health effects**

Cadmium and its compounds are human carcinogens. Smokers get exposed to significantly higher cadmium levels than non-smokers. Lungs damaged through breathing of higher cadmium. Ingesting very high levels severely irritates the stomach, leading to vomiting and diarrhoea. Long-term exposure of Cd leads Cd accumulation in kidneys, lung and bones damage.

#### **Regulatory limits**

EPA set 5 parts per billion (ppb) of cadmium in drinking water. Food and Drug Administration (FDA) limits

concentration in bottled drinking water should not exceed 0.01 ppm.

#### **Chromium (Cr)**

Chromium is originated in rocks, animals, plants, and soil in liquid, solid, or gases state. Chromium compounds bind to soil and not to migrated to ground water but, persistently observed sediment form in water. It is used in the preparation of metal alloys such as stainless steel; protective coatings on metal, magnetic tapes, and pigments for paints, cement, paper, rubber, composition floor covering and other materials. Its soluble forms are used in wood preservatives. Hexavalent chromium is more toxic to human health than trivalent chromium .(Verma S.R., Sharma P. and Tyagi A,(1984).

#### **Health effects**

Chromium (VI) compounds are toxic and carcinogenic, whereas Chromium (III) is an essential nutrient. Breathing high level causes irritation to the nose, nose ulcers; runny nose; and breathing problems, such as asthma, cough, shortness of breath, or wheezing. Allergic reactions consisting of severe redness and swelling of the skin have been noted. Long term exposure may damage to liver, kidney circulatory and nerve tissues, as well as skin irritation.

#### **Regulatory limits**

According to EPA permissible limit is 0.1 ppm (parts per million) in drinking water. FDA prescribed limit that it should not exceed 1 milligram per liter (1ppm) in bottled water. As per OSHA the average limit set is in between 0.0005 and 1.0 milligram per cubic meter at workplace in air for an 8 hour duty period and 40-hour weekly working period.(WHO, 1971).

#### **Lead (Pb)**

Fossil fuel burning, mining, manufacturing of lead and its compounds increases the load in the environment. Lead is used in manufacturing of batteries, solder, pipes, and X-ray shielding devices and other metal products. It is a highly toxic metal as related with health concerns. Recently, health hazards were observed due to lead-based paint and water pipelines in older homes, contaminated soil, household dust, drinking water, lead crystal, lead in certain cosmetics and toys, and lead glazed pottery. (Altun Lokman et al, 2003) (Manivasakam N, 1984-85).

#### **Health effects**

Lead affects human organ and its system. Continuous exposure may result in decreased performance of the nervous system; weakness in fingers, wrists, or ankles; small increases in blood pressure; and anaemia. Exposure to high lead levels can severely damage the brain and kidneys and ultimately cause death. Miscarriage in pregnant women also one of the cause due to high exposure to lead is reported. High level exposure in men can damage the reproductive organs. (Tisdale Samuel and Nelson Werner, 1974) (Okarsson A. Heikensten M.I. (1997)).

#### **Regulatory limits**

According to EPA the permissible limit is 0.1 parts per million (ppm) in drinking water while 0.15 micrograms per cubic meter in air.

#### **Arsenic (As)**

Arsenic is released in environment in higher quantities through volcanic activity, erosion of rocks, forest fires, and industrial effluents from paints, dyes, metals, drugs, soaps semi-conductors industries and human activity. In U.S., about 90% of the industrial arsenic is used for the wood preservation.

Arsenic is also found in animal feeding operations, certain fertilizers and pesticides and released in high amounts to the environment through industrial practices such as copper or lead smelting, mining, and coal burning. Arsenic causes adverse effects on the function of the enzymes. (Ingale S.I. (1994)).

#### **Health effects**

Arsenic is odourless and tasteless, responsible for skin cancer, lungs, liver and bladder. Arsenic at Lower level causes vomiting, decreased production of red and white blood cells, abnormal heart beat, damage to blood vessels, and a sensation of "pins and needles" in peripheral organs. Long-term low level exposure also cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. (Shrivastava Neera et al 2003).

#### **Regulatory limits**

According to Environmental Protection Agency (EPA) permissible limit is 0.01 parts per million (ppm) in drinking water. Occupational Health and Safety Administration (OHSA) set limit of 10 micrograms per cubic meter of workplace air ( $10 \mu\text{g}/\text{m}^3$ ) for 8 hour shifts and 40 hour work weeks. (Bindslev Arnehalt D. and Larsen A.H. (1996).)

#### **Conclusion**

Above the permissible limits, if heavy metals are used for various purposes it imbalances the environment and human health.

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