

# Removal of Chromium & Lead Using Water Hyacinth and Bio-Sorbents

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**Abstract:** *There are two main types of water pollution sources, firstly Domestic and second Industrial. Stationary sources such as power plants, oil refineries, industrial units and factories pollute the river water introducing some heavy metals which are not acceptable. According to the survey; Nashik is facing major problems related to heavy metals introduced in river water compared to other cities. Heavy metals introduced in river water get percolated in the nearby soil, polluting the soil with harmful metals. When vegetables grown in this soil are consumed by the people, they face problem like Kidney Failure, Neurological Damage, Dental Amalgam, Severe Cancer related to skin, Mental Retardation etc. This genetic problem occurs due to heavy metals like Cadmium, Lead, Chromium, Arsenic etc. present in the soil introduced by polluted water. These heavy metals are treated with Phyto-remediation and by using some Bio-sorbents. Results using water hyacinth and bio-sorbents will be compared in the end and the result which is more satisfactory will be considered.*

**Keywords:** Water Hyacinth, Bio-Sorbents, chemical effects, Heavy Metals, Lead, Chromium

## 1. Introduction

The fast technological and industrial development and tumultuous demographic growth and rapid urbanization, especially in the last two decades, are confronting the mankind with four large problems: water, food, energy and environment. The water problem is particularly pronounced, because it is implicitly present in other three problems, that is in the food and energy production which depend primarily on the water and the key environmental problems are water quality protection and water damage control.

In India many causes of pollution including sewage, manure, and chemical fertilizers contain "nutrients" such as nitrates and phosphates. Deposition of atmospheric nitrogen (from nitrogen oxides) also causes nutrient-type water pollution. In excess levels, nutrients over-stimulate the growth of aquatic plants and algae. Excessive growth of these types of organisms clogs our waterways and blocks light to deeper waters while the organisms are alive; when the organisms die, they use up dissolved oxygen as they decompose, causing oxygen-poor waters that support only diminished amounts of marine life. Such areas are commonly called dead zones. Nutrient pollution is a particular problem in estuaries and deltas, where the runoff that was aggregated by watersheds is finally dumped at the mouths of major rivers.

Farmers often use chemicals to hinder bug infestations or other diseases from damaging or ruining their crops. They may also use chemicals to enhance the growth of their crops. Either way, these chemicals seep into the ground water or run off into lakes, creeks, or rivers, causing water pollution. Farmland that is irrigated and treated with chemicals in the form of fertilizers or pesticides is a major contributor to water pollution. Pesticides that get applied to farm fields and roadsides—and homeowners' lawns—run off into local streams and rivers or drain down into groundwater, contaminating the fresh water that fish swim in and the water we humans drink. It's tempting to think this is mostly a farming problem, but on a square-foot basis, homeowners apply even more chemicals to their lawns than farmers do to

their fields! Still, farming is a big contributor to this problem.

Industrial processes produce toxic waste containing heavy metals. When heavy metals filter into water, they are fatal to marine life. Shellfish and fresh fish are staple menu items for people around the world. Humans are affected by the heavy metals ingested by the fish and shellfish, causing health problems and sometimes death. The heavy metals in water have also been linked to severe birth defects, a damaged or suppressed immune system, cancer, fertility problems, and developmental problems in children. The construction industry is also at fault for contaminating our water resources with cement, lubricants, plastics and metals. Rivers and lakes are also polluted from heavy silt or sediment run-off from construction sites. Ground water pollution occurs when chemicals, debris, garbage, oil or other harmful contaminants enter the ground water supply over time. Ground water is often a resource for our drinking water. If it isn't treated properly, those harmful elements can cause serious health issues for human beings and domestic animals.

Water pollution is contamination of water by foreign matter that deteriorates the quality of the water. Water pollution covers pollutions in liquid forms like ocean pollution and river pollution. As the term applies, liquid pollution occurs in the oceans, lakes, streams, rivers, underground water and bays, in short liquid-containing areas. It involves the release of toxic substances, pathogenic germs, substances that require much oxygen to decompose, easy-soluble substances, radioactivity, etc. that becomes deposited upon the bottom and their accumulations will interfere with the condition of aquatic ecosystems. For example, the Eutrophication: lack of oxygen in a water body caused by excessive algae growths because of enrichment of pollutants. According to the water cycle, naturally, water around us will be absorbed to the land (soil) and rivers will stream from the upstream to the downstream and released to the sea. In normal situation organic pollutants are biodegraded by microbes and converted to a form that brings benefits to the aquatic life. And for the inorganic pollutants,

in the same situation, don't bring to much hazards because they are widely dispersed and have almost no effect to the environment which they are released to. Some of the pollutants like Lead (Pb), Arsenic (As), Mercury (Hg), Chromium (Cr) specially Hexa-valent Chromium, Nickel (Ni), Barium (Ba), Cadmium (Cd), Cobalt (Co), Selenium (Se), Vanadium (V), Oils and Grease, pesticides, etc are very harmful, toxic and poisonous even in ppb (parts per billion) range.

There are some minerals which are useful for human and animal health in small doses beyond which these are toxic. Zinc (Zn), Copper (Cu), Iron (Fe), etc fall into this category. For agriculture, some elements like Zinc, Copper, Manganese (Mn), Sulphur (S), Iron (Fe), Boron (B), together with phosphates, nitrates, urea, potassium, etc are useful in prescribed quantities. There are some compounds like Cyanides, Thio-cyanides, Phenolic compounds, Fluorides, Radioactive substances, etc which are harmful for humans as well as animals.

Environmental pollution from hazardous metals and minerals can arise from natural as well as anthropogenic sources. Natural sources are: seepage from rocks into water, volcanic activity, forest fires etc. Pollution also arises from partitioning of polluting elements (which are concentrated in clay minerals with high absorption capacities), between sedimentary rocks and their precursor sediments and water. With rapid industrialization and consumerist life style, sources of environmental pollution have increased. The pollution occurs both at the level of industrial production as well as end use of the products and run-off. These toxic elements enter the human body mostly through food and water and to a lesser extent through inhalation of polluted air, use of cosmetics, drugs, poor quality herbal formulations (herbo-mineral preparations) and 'Unani' formulations, and even items like toys which have paints containing lead.

Heavy metal pollution of surface and underground water sources results in considerable soil pollution and pollution increases when mined ores are dumped on the ground surface for manual dressing. Surface dumping exposes the metals to air and rain thereby generating much AMD. When agricultural soils are polluted, these metals are taken up by plants and consequently accumulate in their tissues (Trueby, 2003). Animals that graze on such contaminated plants and drink from polluted waters, as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues, and milk, if lactating. In summary, all

living organisms within a given ecosystem are variously contaminated along their cycles of food chain.

### 1.1 Heavy Metals

"Heavy metals" is a collective term, which applies to the group of metals and metalloids with a atomic density greater than 4 g/cm<sup>3</sup>, or 5 times or more, greater than water. Heavy metal contamination is not a modern problem arising out of industrialization. It began when humans started processing ores. Since then the use of metals and their impacts on the environment have accelerated, with a major increase during the 19th and 20th centuries.

#### 1.1.1 Sources

Generally, most of the heavy metals enter the in river from different sources, it be can be either natural by erosion and weathering and or anthropogenic. In view of the intense human activity, natural sources of heavy metals from leaching and weathering of rocks in the environment, are usually of little importance. The presence of heavy metals in sediments is due to precipitation of their carbonates, hydroxides, and sulphides, which settle down and form the part of sediments. The most important anthropogenic sources of heavy metal are various industries and domestic sewage. The practice of discharging waste from industries and untreated domestic sewage into the aquatic ecosystem is continually going on that leads to the increase in the concentration of heavy metals in river water.

The most important heavy metals from the point of view of water pollution are Zn, As, Cu, Pb, Cd, Hg, Ni, and Cr. Some of these metals (e.g. Cu, Fe, Mn, Ni, and Zn) are required as nutrients in trace amount for life processes in plants and microorganisms but become toxic at higher concentrations. Other such as Pb, Cr, and Cd has no known biological function, but are toxic elements. These heavy metals are not readily degradable in nature and accumulate in the animal as well as human bodies to a very high toxic amount leading to undesirable effects beyond a certain limit. The fatal diseases such as eyelid edema, nephritis, renal tumour, extensive lesions in the kidneys, anuria, nasal mucous membranes and pharynx congestion, increase blood pressure and cardiovascular diseases, osteoporosis, cancer, headache and malfunctions of different systems of the body caused by heavy metals have been reported by several authors. They are also known to interfere with synthesis and metabolism of the hormones.

Metal	Target Organs	Primary Sources	Clinical Effects
Arsenic	Pulmonary Nervous System, Skin	Industrial Dusts, Medicinal Uses Of Polluted Water	Perforation of Nasal Septum, Respiratory Cancer, Peripheral Neuropathy: Dermatomes, Skin, Cancer
Cadmium	Renal, Skeletal Pulmonary	Industrial Dust And Fumes And Polluted Water And Food	Proteinuria, Glucosuria, Osteomalacia, Aminoaciduria, Emphysemia
Chromium	Pulmonary	Industrial Dust And Fumes And Polluted	Ulcer, Perforation of Nasal Septum,

		Food	Respiratory Cancer
Manganese	Nervous System	Industrial Dust And Fumes	Central And Peripheral Neuropathies
Lead	Nervous System, Hematopoietic System, Renal	Industrial Dust And Fumes And Polluted Food	Encephalopathy, Peripheral Neuropathy, Central Nervous Disorders, Anemia.
Nickel	Pulmonary, Skin	Industrial Dust, Aerosols	Cancer, Dramatis

## 1.2 Water Hyacinth

In the last three decades a special interest in the world is aroused by the potential of using the biological methods in the waste water treatment, whose application as of natural and not artificial procedures of tertiary processing of effluents provides the effluents of required quality in an economically acceptable way in the technically simple structures. There is a plant named water hyacinth which has the capacity to absorb heavy metals through its roots and reduce water pollution.

Water hyacinth (*Eichhornia crassipes*) is a free floating (but sometimes rooted) freshwater plant of the family *Pontederiaceae* that has proven to be a significant economic and ecological burden to many sub-tropical and tropical regions of the world. Water hyacinth is listed as one of the most productive plants on earth and Water hyacinth shows logistic growth as does another floating aquatic weeds. Water hyacinth has invaded freshwater systems in over 50 countries on five continents; it is especially pervasive throughout Southeast Asia, the South-Eastern United States, central and western Africa, and Central America.

## 1.3 Kolhapur Region

Rankala Lake in the heart of Kolhapur city having an area of 107 hectars and average depth of 10 m was impounded during 1883. Rankala lake is an important Bird Area. Other fauna like two species of lizards and eleven species of snake are recorded in Lake Area. Seven species of insects are found in the marshes of "Partalla" region and around lake water. About 24 different types of fishes are found in the lake. Tragically, Lake's extremely diverse fauna was decimated pollution from various sources. Effects of noxious water weeds and other associated problems threaten the sustainability of the lake's resources. Water Hyacinth incidence in water body caused enormous problems to the economy and the environment.

## 1.4 Nashik Region

In India, groundwater is the major source which is used to meet the domestic, agricultural and industrial needs and in Maharashtra state its dependence is reaching upto 65%. According to a UNESCO report, majority of Indian population has no access to safe drinking water and about 66 million people rely on unsafe ground water for consumption. Nashik is an important ancient city of Maharashtra. It is located on the banks of River Godavari at a distance of about 565 m above mean sea level. It lies between 190-33' and 200- 53' North latitude and 730-16' and 750-6' East longitude. It is spread on an area of 259.13 km<sup>2</sup>. The climate

is dry except during south-west monsoon. The average rainfall is 1034 mm, July being the rainiest month. The hottest month is May having average daily maximum temperature of 41 degree Celsius and coldest month being December with mean daily temperature of 10.2 degree Celsius (*Source: Report on Environmental Status of Nashik region, Maharashtra by MPCB*). Nashik district gets its water supply from wells, lakes, rivers and percolation tanks. The Darna, Gangapur, Chanakapur and Waghad lakes have been formed by constructing dams across rivers. The main source of water to Nashik city is Gangapur Dam. Ground water is used as secondary source of water and used to a maximum extent in summers as dam water supply gets depleted. The monitoring of water quality is one of the important tools for sustainable development and provides important information for water management. Due to increase in anthropogenic activities, the composition of different kinds of micronutrients and heavy metals are changing, which affects soil fertility and ultimately the quality of ground water.

Heavy metals are stable and persistent environmental contaminants since they cannot be degraded or destroyed. Therefore, they tend to accumulate in soils and sediments. Elevated concentrations of heavy metals in soils may cause phytotoxicity, direct hazard to human health, indirect effects due to transmission through the food chain or contamination of ground or surface waters. Environmental Protection Agency (EPA) has declared Cr (VI) as carcinogenic metal and its exposure via inhalation route can be fatal. The studied locations fall under Ambad area, which is surrounded by industries, mainly electroplating.

## 1.5 Treatment Methods

Methods for treating industrial wastewater containing heavy metals often involve technologies for reduction of toxicity in order to meet technology-based treatment standards. Physico-chemical removal processes such as adsorption on new adsorbents, ion exchange, membrane filtration, electro dialysis, reverse osmosis, ultra filtration and photo catalysis. All these chemical methods are not economical and nowadays industries want to go economical.

Some of these are biological methods like using Water Hyacinth, Bio-sorbent like Papaya seeds etc. Water hyacinth has direct effects upon water chemistry. It can absorb large amounts of nitrogen and phosphorus, other nutrients and elements. It is this ability to pick up heavy metals which has led to the suggestion that water hyacinth could be used to help clean industrial effluent in water. By absorbing and using nutrients, water hyacinth deprives phytoplankton of them. This leads to reduced phytoplankton, zooplankton and fish stocks.

### 1.6 Bio-Sorbents

In the processes of biological treatments microorganisms play a role of settling solids in the solution. Bioadsorption is a new biological method and various low cost bioadsorbents (papaya seeds, agricultural waste, forest waste, industrial waste, algae etc.) are used for maximum removal of heavy metals from wastewater. Bioadsorption techniques are eco-friendly best solutions for removing heavy metals from wastewater rather than physico-chemical methods.

## 2. Literature Review

- 1) Manju Mahurpawar (2015) focuses on various harmful effects of heavy metals on human health. The study is carried out on Bio toxic effects of heavy metals, impact on body when consumed above the bio-recommended limits. The major harmful heavy metals studied are: Arsenic, Cadmium, Phosphate, Chromium, Copper, Lead, Nickel, Zinc, and Mercury which causes diseases like Cancer, Kidney damage, etc. It has health effects, such as developmental retardation, several types of cancer, kidney damage, endocrine disruption, immunological, neurological effects and other disorders. The ongoing research works throw more light onto new insights and biochemical and molecular mechanisms involved in the development of pathological conditions in human.
- 2) Ajibade F. O. , Adeniran K. A. , Egbuna C. K (2013) studied the suitability and efficacy of water hyacinth in domestic sewage treatment. The study was carried out in the Department of Agricultural and Bio-systems Engineering. This treatment included 1kg and 2kg density of water hyacinth was taken and sample was collected. Sewage was fetched and batched into three 80litres of plastic drum each. The whole experiment lasted for six weeks and was regularly harvested during the course of study. Purification of water was rapid during the first three weeks and there was low absorption in last two weeks. Parameters such as Cl, Fe, Cu, Mn, Pb, K, F, Nitrate and Sulphate were drastically reduced. Therefore water hyacinth proved to be useful in treating effluents polluted with toxic heavy metals. It can also be concluded the higher the density of plant (water hyacinth), the more the absorption of pollutants, and the best of purification will be obtained.
- 3) A. Mary Lissy P N, B. Dr.G.Madh (2011) conducted an experiment. Water hyacinth was collected from three different local ponds. This experiment was conducted in tank as well as jars to find out efficiency of plant in removing the pollutants. The standard procedure was carried out with known concentrations of chromium and copper. The change in pH, TDS, BOD, Cr and Cu concentrations were found out at regular intervals using APHA methods. The results of experiments carried out in tank showed that the plant has ability to absorb heavy metals chromium and copper from waste water. The TDS values increased by placing plants inside the tank. The jars with plant showed considerable decrease in Cr and Cu concentration. The results obtained indicated that water hyacinth could be used as an effective means for the removal of heavy metals from waste water.
- 4) Igwe, J. C. & Abia A. A. (2006) made a detailed description of the adsorption properties and mode of action of these bio-sorbents is offered in order to explain the heavy metal selectivity displayed by these bio-sorbents. Bio-sorption of copper was carried out using different bio-sorbent like sunflower stalk, Sargassum Filipendulam, Sargassum Fluitans, Sargassum Vulgare. Wastewater was discharged into a collecting tank and Bio-sorbent was also held in a tank after pre-treatment and activation. The two are allowed to flow into a continuously stirred tank reactor (CSTR) where the adsorption takes place after a specified hydraulic retention time (HRT). The solution is allowed to flow into a filtration tank where the adsorbent loaded with heavy metal is separated from the treated wastewater. Conventional methods of removal are expensive, hence the use of low cost, abundant environmentally friendly bio-sorbents were tested.
- 5) Ravikumar K, Prof. Sheeja A K - (May 2013) In the paper thousands of chemicals have been identified in drinking water supplies around the world and are considered potentially hazardous to human health at relatively high concentrations. According to author heavy metals are the most harmful of the chemical pollutants and are of particular concern due to their toxicities to humans and Moringa Oleifera seed acts as a natural coagulant, adsorbent and antimicrobial agent. The coagulation mechanism of the Moringa oleifera coagulant protein has been described as adsorption, charge neutralization and interparticle bridging. It is mainly characteristic of high molecular weight polyelectrolyte. Analysis of the heavy metals cadmium, copper, chromium, and lead were performed before and after treatment of water with Moringa oleifera seed coagulant is carried out. In this study the advantage of proposing a sequential process using coagulation with Moringa Oleifera seed and double filtration (Up-flow roughing filtration followed by rapid filtration) for the removal of heavy metals from water is analysed.
- 6) Satya Narain, Ojha.C.S.P, Mishra.S.K. , Chaube.U.C, Sharma.P.K- (2011). The author suggests that Phyto accumulation is an alternative technique of heavy metals remediation. In this paper, using free floating plant (Water hyacinth) which was obtained from an aquatic system, the removal of heavy metal, such as Chromium and Cadmium were investigated. It is necessary to maintain the quality of these ponds within permissible limits and the samples were collected from Ganga River.

### Problem Definition

It has been observed that Heavy Metals have been linked with Cancers in exposed Human Population, Chronic Poisoning in man etc. Also in Kolhapur it is one of the cause for various Genetic Problems like Central Nervous System, Cardiovascular, Gastrointestinal, Neurological, Reproductive, Immunological Systems, whereas in Nashik Region, there have been the problem of contamination of vegetables due to heavy metals.

### Objectives

- 1) To remove heavy metals by using bio-sorbent and water hyacinth.

- 2) To compare and check work efficiency of both the methods.
- 3) Utilisation of water hyacinth efficiently.

### 3. Methodology

- 1) Review of Literature related to project.
- 2) To study the effect of introduction of Water Hyacinth into wastewater.
- 3) To study the effect of Papaya Seeds on wastewater.
- 4) Noting down the Concentration of Cr & Pb on multiple occasion of gaps(days).
- 5) Preparation of Report.

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