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Contamination of Heavy Metal in Water of Bhimgadh Dam at Seoni District Mp: Transporting, Toxicity and Treatment

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Abstract
The term ‘‘heavy metal'' refers to any metal and metalloid element that has a relatively high density ranging from 2.1 to 7 g cm^3 in any water body. Generally heavy metals can a water body supply by industrial consumer waste or even from acidic rain breaking down soil and releasing heavy metals into streams, lakes, rivers and ground water. Toxic or poisonous at low concentrations, and includes mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), zinc (Zn), nickel (Ni), Copper (Cu) and lead (Pb); Although ‘‘heavy metals'' is a general term defined in the literature, it is widely documented and frequently applied to the widespread pollutants of soils and water bodies. This study was carried out to the concentration of heavy metals in water of Bhimgarh dam near Seoni city. The detection of heavy metals by different analytical process and confirmation by Atomic Absorption spectrophotometer as required.

***Keywords:** Heavy metals; Concentration; Spectrophotometer; Toxic metal; Water pollution*

Introduction

Among Water pollution is contamination of water by foreign matter that decrease the quality of the water. Water pollution occurs in the oceans, lakes, streams, rivers, underground water and bays, in short liquid containing areas. It involves the release of toxic substances, radioactivity, that becomes deposited upon the bottom and their accumulations will interfere pathogenic germs, substances that require much oxygen to decompose, easy soluble substances, with the condition of aquatic ecosystems e.g. 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 too much hazards because they are widely dispersed and have almost no effect to the environment which they are released. 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 according WHO [1,2]. There are some minerals which are useful for human and animal health in small doses, which these are e.g. Zinc (Zn), copper (Cu), iron (Fe) [3,4] etc of all into this category. In agriculture field some elements like zinc, copper, manganese (Mn), sulphur (S), iron, boron (B), together with phosphates, nitrates, urea, potassium, etc are useful in insecticides and pesticides as prescribed quantities.

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Materials and Methods

Sources of heavy metal

Environmental pollution from hazardous metals and minerals can arise from natural well as anthropogenic sources. Natural sources like: seepage from rocks into water, volcanic activity, forest fires, 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 increase. The pollution occur both level of industrial production as well as end use of the products. 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 and `Unani' formulations, even items like toys which have paints containing lead. Sources of heavy metals Chromium Mining, industrial coolants, chromium salts manufacturing and leather tanning (Table 1).

- **Mercury (Hg)**: Chlor alkali plants, thermal power plants, fluorescent lamps, hospital waste, electrical appliances etc [5].
- **Lead (Pb)**: lead acid batteries, paints, E waste, Smelting operations, coal based thermal power plants, ceramics, bangle industry
- **Arsenic (As)**: Geogenic/Natural processes, smelting operations, thermal power plants and fuel
- **Copper (Cu)**: Mining, electroplating, smelting operations
- **Vanadium (V)**: Spent catalyst, sulphuric acid plant
- **Nickel (Ni)**: Smelting operations, thermal power plants, battery industry.
- **Cadmium (Cd)**: Zinc smelting, waste batteries, e waste, paint sludge, incinerations and fuel combustion
- **Molybdenum (Mo)**: Spent catalyst.
- **Zinc (Zn)**: Smelting, electroplating.

TABLE 1. **Standard level of heavy metal concentration in drinking water and their effects on human health.**

SN	Metal	Effects	Drinking water standards
1	Lead	• Phytotoxic [6,7]. • Tiredness, irritability anemia and behavioral changes of children. • Toxic to humans, aquatic fauna and livestock High doses cause metabolic poison [8]. • Hypertension and brain damage.	• maximum concentration: 0.1 mg L^{-1}. • By European Community: 0.5 mg L^{-1}. • According to water quality (India) 0.1 mg L^{-1}.
2	Nickel	• High phytotoxicity Damaging fauna • High conc. can cause DNA damage [9]. • Eczema of hands..	• By the Environmental Protection Agency. • maximum concentration: 0.1 mg L^{-1} By (India): 0.1 mg. • According to water quality (India) 0.1 mg L^{-1}.
3	Chromium	• Necrosis nephritis and death in man (10 mg kg^{-1} of body weight as hexavalent chromium). • Irritation of gastrointestinal mucosa.	• By the Environmental Protection Agency. • maximum concentration: (hexavalent and trivalent) total 0.1 mg L^{-1}. • By European Community: 0.5 mg L^{-1}. • Regulation of water quality (India) 0.1 mg L^{-1} [10].
4	Copper	• irritation followed by depression • Causes damage in a variety in aquatic fauna. • Mucosal irritation and corrosion Central nervous system .	• By the Environmental Protection Agency maximum concentration: 1.3 mg L^{-1}. • By European Community: 3 mg L^{-1} • According to water quality (India)

			0.01 mg L^{-1}.
5	Zinc	• Lack of muscular coordination abdominal pain etc [11]. • Phytotoxic Anemia.	• By European Community: 5 mg L^{-1} • According to water quality (India), 0.1 mg L^{-1}. • By the Environmental Protection Agency maximum concentration: 0.4 mg L^{-1}.
6	Cadmium	• Emphysema. • Anemia Acute effects in children. • Cause serious damage to kidneys and bones in humans Bronchitis.	• By the Environmental Protection Agency maximum concentration: 0.004 mg L^{-1}. • By European Community: 0.02 mg L^{-1}. • Regulation of water quality (India) 0.005 mg L^{-1}.
7	Mercury	• Poisonous. • Disturbs the cholesterol. • Causes mutagenic effects.	• By the Environmental Protection Agency maximum concentration of Hg: 0.002 mg L^{-1}. • By European Community: 0.001 mg L^{-1}. • According to water quality (India) 0.003 mg L^{-1}.
8	Arsenic	• Causes toxicological and carcinogenic. • Effects Causes melanosis. • Keratosis and hyperpigmentation in humans Genotoxicity through generation of reactive oxygen species and lipid. • Peroxidation. • Immunotoxic Modulation of co-receptor expression.	• World Health Organization guideline of 0.01 mg L^{-1}. • By European Community: 0.01 mg L^{-1}. • According to water quality (India): 0.05 mg L^{-1}.

Experiment

Water samples were collected from different sample sources of the different region of the Bhimgadh Dam, Seoni city in the period of October 2018 to Decemebr 2018. The water samples volume 500 ml in polythene bottles which acidify with nitric acid to bring down the pH up 2.0. The samples for heavy metals analysis were collected separately and acidify immediately. Metals like Pb, Ni, Hg, As, Cd, Cr, Cu, Fe, Mn and Zn were analyzed by different analytical estimation method and after analyzed by Perkin Calmer Flame AAS (Model 2380) using standard methods. All water samples were analyzed in January 2019.

Purification techniques

Bioaccumulation of heavy metals in food chains and their toxicity to biological systems due to increased concentration over time have led to tremendous pressure for their separation and purification. Heavy metals can enter into water bodies through agricultural runoff, industrial effluents, household uses and from commercial applications. We can remove heavy metals from drinking water very easily with reliable technology. Several technologies available in the market remove a huge range of metals commonly found in drinking water and wastewater effluents. There are various remediation technologies that have been used for the removal of heavy metals from waste water. These remediation technologies are summarized as:

1. Precipitation and coagulation
2. Ion exchange
3. Membrane filtration
4. Bioremediation
5. Heterogeneous photo catalysts
6. Adsorption

Electro-coagulation

Electro-coagulation consists of electrodes that act as the anode and cathode, where oxidation and reduction takes place. Many physicochemical processes such as oxidation reduction, coagulation and adsorption govern the electro-coagulation. Similarly to other treatment techniques, the electro-coagulation of heavy metals offers a cost effective and easy handling technique on an industrial scale.

a. Clays/Layered Double Hydroxides (LDHs)
b. Biomass and Bio-sorption of Metal Ions
c. Magnetic Nano particles as Nano sorbents
d. Removal of Iron and Manganese from Water

Ion exchange

Ion exchange resins provide many advantages and are one of the most widely techniques used for treatment of wastewater effluents. Lee and Nicol have used the Diphonix resin to remove ferric iron from a cobalt sulfate solution with various pH ranges. A lower pH and higher dose of resin gives a higher removal of iron from solution. Elution of iron was observed with an increase of Ti (III) in the sulfuric acid eluent. These workers found that the iron elution enhancement with Ti (III) was due to the combined effects of a reduction of Fe (III) and competitive adsorption of Ti (III) and Ti (IV) ions. A mathematical mode was used to predict the equilibrium, which gave a good fit for the experimental data in various solutions.

Membrane filtration

Membranes are complex structures that contain active elements on the nanometer scale. Modern day reverse osmosis membranes are typically homogeneous polymer thin films supported by a porous support structure.

Phytoremediation

Bioremediation is the technological process whereby biological systems, plants and animals, including microorganisms, are harnessed to affect the cleanup of pollutants from environmental matrices.

Heterogeneous catalysts and catalysis

Remarkable discovery much research has been carried out on the efficiency of Cr (VI) and TiO_2 as a photo catalyst. During the past few years, the applications of TiO_2 for environmental cleanups have been performed by several laboratories for the treatment of industrial effluents.

Activated carbons

Activated Carbon is used in water filter purifiers because activated carbon removes from the water most toxic organic compounds in water like pesticides and heavy metal organic compounds. It makes water safe to drink by removing most toxic organic compounds in water like pesticides and heavy metal organic compounds. Activated carbon water filter works is because activated carbon is an extremely porous material that attracts and holds on its surface harmful chemicals by a process known as 'Adsorption'. Adsorption happens due to electrostatic forces of attraction known as 'Van-der Waals forces' or 'chemisorption'. Activated carbon is very effective in removing bad odour from air or water. Activated carbon can also remove bad taste from water.

Result and Discussion

In the above study (Table 2) heavy metal Fe (iron) and copper (Cu) are found nearest level of standard value according to WHO. On the other side Ni (0 mg/l), and Hg (0 mg/l) are absent in the water sample, Whereas Pd, As, Cd, Cr, Mn and Zn are found less quantity respect to standard value of WHO [10].

TABLE 2. **Analytical results of heavy metal in various sample of different water sample of Bhimgadh Dam at Seoni City.**

S.N	Heavy Metal	standard value in (mg/L) According (WHO)	observed values in (mg/L)
1	Pb (Lead)	0.05 mg/l	0.001 mg/l
2	Ni (Nickel)	0.02 mg/l	0 mg/l
3	Hg (Mercury)	0.001 mg/l	0 mg/l
4	As (Arsenik)	0.05 mg/l	0.001 mg/l

5	Cd (Cadmium)	0.005 mg/l	0.003 mg/l
6	Cr (Chromium)	0.1 mg/l	0.04 mg/l
7	Cu (Copper)	1 mg/l	0.8 to 0.2 mg/l.
8	Fe (Iron)	0.1 mg/l	0.1 mg/L
9	Mn (Mangnige)	0.5 mg/l	0.01 to 0.03 mg/l
10	Zn (Zink)	5.0 mg/l	2.0 mg/l

Conclusion

The presence of heavy metals and their toxicity to the water and to human beings is posing a serious challenge to environmental engineers [12,13] with respect to the treatment of Waste water effluents prior to discharge into the nearby water bodies. Several removal techniques have been developed and applied for the treatment of water to remove the toxic metal ions. Techniques such as microbe assisted: phyto-remediation [14,15], ion exchange, membrane filtration, photo-catalytic oxidation and reduction and adsorption [16,17] have their own advantages and disadvantages over metal ion sequestrations from environmental matrices. Adsorbents such as clays, LDHs [18], zeolites, carbon nano-tubes and their composites, activated carbons, biomass derived bio-sorbents, inorganic nano-materials, inorganic organic hybrid nano-composites and magnetic nano-materials have been synthesized and investigated for their ability to sequester metal ions from water [19]. Magnetic nano-particles are very promising for applications in catalysis, bio-labeling and bio-separation [20,21]. In liquid-phase extraction of heavy metals and dyes in particular, such small and magnetically separable particles may be useful as they combine the advantages of high dispersion, high reactivity [22], high stability under acidic conditions and easy separation [23].

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