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Accumulation of Heavy Metals in Water and Soil through Industrialization by ICP-AES technique

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ABSTRACT

The accumulation of heavy metals (Viz. Cu, Zn, Mn, Fe, Co, Ni, Pb, Cd, Hg, As) have been studied in industrial wastewater, ground water and amended soil. This work describes the detection of concentration of these metals in industrial wastewater, ground water and amended soil by ICP-AES (Inductively Coupled Plasma Atomic Emission Spectroscopy) technique. In industrial wastewater samples Cu, Zn, Mn, Fe were detected. In drinking (ground) water Cu, Zn, Mn, Fe, Ni and Pb were detected whereas in amended soil samples Pb, Cd, Mg and As were not detected. For the accumulation of metals by the wastewater were collected and analyzed. This concentration of metals is due to the industrialization. The wastewater sample, drinking water samples and soil samples were collected from MIDC Taloja (Navi Mumbai). At this point the soil is getting polluted by the disposal of different industrial waste water. Detected some of the metals are toxic.

Keywords: Accumulation, Heavy metals, ICP-AES, wastewater, drinking water and soil samples.

INTRODUCTION

Industrial growth is an essential feature of the developing country. Without industrial growth a nation can‘t stand amongst the global scenario. Due to this rapid industrialization environmental pollution is becoming the most challenging threat to human beings [1, 2]. Pollutants in various forms are thrown into the nearby areas by industries. These pollutants pollute air, soil, surface water as well as ground water [3]. The industrial activities have contributed quantitatively as well as qualitatively to the large increase in the discharge of metallic pollutants into environmental sink. The heavy metals present in industrial effluents interact with organic and inorganic species and form complexes. Insoluble complexes are deposited on the surface of the soil but soluble complexes formed have a tendency to percolate through the soil [4] which affects the quality of ground water and soil.

For this study the samples were collected from the MIDC, Taloja is located near Navi Mumbai in Maharashtra. In this industrial area most of the industries are being discharged the effluent into the open places, rivers and sea. Most of the industrial waste waters are containing organic, inorganic matter and hazardous metals [5]. These heavy metals and organic compounds affect the quality of soil and ground

water of the area. The heavy metals like Cu, Zn, Mn, Fe, Ni, Co, Pb, Cd, Hg, and As and some water soluble pollutants percolate into the ground water [6]. Due to industrialization and urbanization population growth all the sources of water are either polluted or contaminated [7]. Release of treated and untreated industrial effluents in unplanned manner is one of the major causes of water pollution. The effluents which are released into various surface water bodies not only affect the water quality and soil but also pollute the ground water due to percolation of some water soluble pollutants [8].
The main objectives are to understand and evaluate water quality to control and minimize the incidence of pollutant oriented problems and to provide water of appropriate quality of various water users as urban water supply, irrigation water etc. In order to keep the quality of water at an optimal level, continuous periodical monitoring of water quality parameters is necessary. So that appropriate steps may be taken for water resources management practices [9].In this area no such type of study was reported so far, therefore this study was undertaken to detect and identify metals present in effluents, drinking water and amended soils which are being polluted at Taloja, Mumbai.

MATERIALS AND METHODS

Sampling technique: The wastewater, amended soil and ground water samples were collected from M.I.D.C. Taloja, Navi Mumbai (Maharashtra) India. The samples were collected in well sterilized and pre cleaned plastic bottles with tight lid, and adding 5 ml nitric acid for preserving the metals in the samples [10)]
Metal Analysis: The 100 ml of water sample (industrial effluent and ground water) were acidified by adding 10 ml of conc. HCl and 5 ml of conc. HNO_3 and evaporated this mixture on hot plate or sand bath up to 20 ml. Further to this mixture again add 5 ml of conc. HCl and 2.5 ml of conc. $HNO_{3.}$ Again evaporate this mixture on sand bath or on hot plate up to 5 ml., cool this mixture and then make this volume up to 100 ml by adding conductivity water. To prepare metal extract from soil, 1 gm. of finally crushed soil sample was refluxed with 25 ml 4N HNO_3 at 80^oc for about 12 hours in a water bath by using air condenser in a round bottom flask. After digestion, sample was filtered through Whatman-42 paper and solution was diluted up to 100 ml by adding conductivity water. This extracts were used for the determination of heavy metals Cu, Zn, Mn, Fe, Ni, Co, Pb, Cd, Hg, and As. The concentration o these metals was determined by ICP-AES technique at SAIF, IIT Mumbai [11].

RESULTS AND DISCUSSION

The results obtained by ICP-AES analysis of industrial wastewater, drinking water and soil samples were given in tables 1-3.

Table 1. Concentration of heavy metals in industrial wastewater samples

Site of Sample	Cu	Zn	Mn	Fe	Co	Ni	Pb	Cd	Hg	As
1. CETP Before treatment	0.011	0.525	0.101	30.351	0.011	0.007	0.059	ND	ND	0.029
2. CETP After treatment	1.632	0.32	0.083	1.137	ND	ND	0.122	ND	ND	ND
3. Ducol Organics Before treatment	44.42	0.851	0.104	8.17	ND	ND	0.122	ND	ND	ND
4. Ducol Organics After treatment	ND	0.257	0.119	0.651	ND	0.222	0.024	ND	ND	ND
5. EurolineChemicals Before Treatment	48.956	216.234	0.614	0.311	ND	ND	0.048	ND	ND	ND

6. Euroline Chemicals After Treatment	78.103	239.140	0.749	0.8	ND	ND	0.124	ND	ND	ND
7. Super Chemicals Waste water sample	0.055	1.192	0.052	1.016	ND	0.025	0.063	ND	ND	ND
8. Drugs & Pharma Waste water sample	0.203	2.12	0.063	1.89	0.015	0.762	0.019	ND	ND	ND
9. Pharma Company Plot No.56 Waste	410.704	6.225	13.354	1074.51	0.057	6.34	0.044	0.026	ND	ND

Table 2: Concentration of heavy metals in drinking water samples

Site of Sample	Cu	Zn	Mn	Fe	Co	Ni	Pb	Cd	Hg	As
1. CETP	0.123	0.704	0.048	4.306	ND	0.058	0.051	ND	ND	ND
2. JEN PHARMA	ND	0.372	0.027	0.027	ND	0.361	0.035	ND	ND	ND
3. Municipal Corp	0.022	0.207	0.036	1.087	ND	ND	0.032	ND	ND	ND

Table 3: Concentration of heavy metals in industrial Soil samples

Site of Sample	Cu	Zn	Mn	Fe	Co	Ni	Pb	Cd	Hg	As
1. Soil Sample-1	10.275	3.74	9.279	732.416	0.423	1933	ND	ND	ND	ND
2. Soil Sample-2	11.601	9.756	24.804	544.509	1.961	9.264	ND	ND	ND	0.076

(* ND means less than 0.01 ppm) (* All values in ppm)

The results in table 1 clearly indicate the concentration of heavy metals in the effluents. The concentration of Cd, Hg, As and Co was not detected. In this analysis the concentration of Cu in industrial waste water was in the range of 0.011 to 410.79 ppm. The concentration of Zn was found to be in the range of 0.257 to 239.14 ppm. The concentration of Mn was found to be in the range of 0.052 to 13.35 ppm. Zn is commonly found in small quantities in all samples due to corrosion of galvanized iron and brass in condensing, cooling and distributing system [12].

Lead is common metal contaminant at hazardous waste in effluent and in drinking water. The concentration of Pb in wastewater was found in the range of 0.019 to 0.124 ppm while in drinking water it was found in the range 0.032 to 0.051 ppm, while in soil sample Pb was not detected. Toxic level of lead in human body is 500 mg, beyond which it causes anemia, brain damage, vomiting, loss of appetite; its amount more than 800 mg in the body causes coma and death. The WHO has set a concentration of 0.1 ppm as a maximum tolerable limit in drinking water [13].

The concentration of Fe was found to be in the range of 0.311 to 1074.51 ppm. The concentration of Ni was found in only 2-3 samples in the range of 0.007 to 6.34 ppm. Nickel is micronutrient for most organisms, but excessive quantities have toxic effects. Cadmium is one of the most toxic heavy metal. It is generally released into natural water from metal plating, mining, pigments and alloy industries. It can be spread into the environment through soil and water and brings a chief threat to human health [14]. Cd causes lung insufficiency, bone lesions and hypertension [15]. Cadmium was not detected in most of the industrial wastewater. Only one of the sample contains 0.026 ppm(table 1). In other samples of drinking water, Cd was not detected (table 2) and one of the amended soil sample contains Cd in 0.042 ppm in less amount (table 3).

Arsenic is accumulative poison, causing vomiting and abdominal pains prior to death. Arsenic is concentrated by organism exposed to it and accumulates long food chains. Arsenic accumulates in hair and nails. Normal level in hair and nails are 1.0 ppm or less [16]. During the analysis of sample only one sample detected arsenic about 0.029 ppm in waste water (table 1) while in other drinking water samples it was not detected (table 2) and one of the amended soil sample detected about 0.076 ppm (table 3).
During this analysis always most of the waste water samples, drinking water samples and amended soil samples arsenic, mercury, cadmium and cobalt were not detected.

APPLICATIONS

With this analysis we can highlight the urgent need for continuous monitoring which will affect on environment.

CONCLUSIONS

On the basis of above results (tables 1-3) it will be logical to say that the industrial effluent has its impact on the quality of ground water in the nearby area. The detected metals affect the quality of soil and also on aquatic life. Even very low concentration of heavy metals in water bodies may alter the quality of aquatic environment. This can cause physiological, chemical and biological deterioration of water bodies. Due to non biodegradability of heavy metals their concentration in environment continuously increases. With our analysis we want to highlight the urgent need for continuous monitoring which will affect on environment.

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