Heavy Metals Status of Industrial Effluents and Its Impacts on Human Life

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Summary: Wastewater samples were collected from Hayatabad Industrial Estate, Peshawar and investigated for physical and chemical parameters. pH was in the range of 6.2 to 7.6, magnesium was 0.456-10.523mg/L, Copper was 1.035 to 10.230 mg/L, lead was 1.023-6.52 mg/L, manganese was 0.231- 9.852 mg/L, zinc was 0.231-12.34 mg/L, cadmium was 0.120-8.523 mg/L, cobalt was 0.214 – 4.562mg/L, silicon 0.321 – 14.52 mg/L, nickel was 0.231-12.3 mg/L, iron was 0.231-11.23 mg/L, and chromium was 0.123-6.321 mg/L. The values were compared with the standards of NEQS and it was found that some of the parameters show deviations due to the direct disposal of effluents into the environment and may affect life when they enter the water bodies. Therefore the effluents must be treated before they enter the environment.

Introduction

Comprising over 70 % of the earth's surface, water is undoubtedly the most precious natural resource that exists on our planet. Natural and artificial sources are slowly and surely polluting the rivers, lakes and oceans at alarming rate. In addition to the harm done to animal and plant life, our drinking water has been greatly affected as is our ability to use water for recreational purposes. In order to combat water pollution, we must understand the problems and become part of the solution [1-11].

Major sources of water pollution can be classified as municipal, industrial, and agricultural. Municipal water pollution consists of waste water from homes and commercial establishments. For many years, the main goal of treating municipal wastewater was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds, and harmful bacteria. Currently more stress has been placed on improving means of disposal of the solid residues from the municipal treatment processes. The characteristics of industrial waste waters can differ considerably both within and from industry to industry. The impact of industrial discharges depends not only on their characteristics, such as biochemical oxygen demand (BOD) and the amount of suspended solids, but also on their content of specific inorganic and organic substances. Three options are available in controlling industrial wastewater. Control can take place at the point of generation in the plant; wastewater can be pretreated before discharge for the municipal treatment; or wastewater can be treated completely at the plant and either reused or discharged directly into receiving waters [1-11].

Estimates suggest that nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to waterborne diseases [1]. Untreated sewage, garbage, and oil spills have started to overwhelm the diluting capabilities of the oceans and most coastal waters are now polluted. Beaches around the world are closed regularly, often because of high amounts of bacteria from sewage disposal even marine wildlife is beginning to suffer. Perhaps the most important reason for a worldwide effort to monitor and restrict global pollution is the fact that most forms of pollution do not respect national boundaries [1-11]. Yuan and Weng studied the removal of metals (Cr, Cu, Fe, Ni, Pb, Zn) from an industrial wastewater by electro-kinetic process [12]. The removal priority was found as: Cu > Pb > Ni > Fe > Zn > Cr. Rule *et al.* [13], determined heavy metals (cadmium, chromium, copper, mercury, nickel, lead and zinc) in the

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wastewater collected from an urban area. The concentrations of most metals in the samples were higher on Monday which is attributed to leaching from stagnant water remaining in the pipe works of office buildings over the weekend. Martin *et al.* [14], studied the cytotoxic effect of the heavy metals Cd, Zn and Cu on three different species of ciliated protozoa isolated from an urban wastewater treatment plant. They reported that the order of toxicity was Cd > Cu > Zn depending on the microbial species. Some scientists have used certain enzymes for the removal of heavy metals from water using the *Allium cepa* (onion) system [15]. These antioxidant enzymes were tested in onion bulbs exposed to certain heavy metals taken separately, the test metals taken in combination, as well as the industrial wastewater especially found to contain these metals. Atomic absorption spectrophotometry was used for the detection of Cd, Cr, Cu, Hg, Pb and Zn in the water sample. In the present study, the determination of heavy metals was carried out in the industrial effluents of Hayatabad Industrial Estate Peshawar and its toxic impacts on human life were studied.

Results and Discussion

Wastewater samples were collected from selected industries and the main canal of Hayatabad Industrial Estate, Peshawar and were analyzed for various parameters like pH, Ca^{+2}, Mg^{+2}, Ni^{+2}, Cu^{+2}, Zn^{+2}, Cr^{+3} and Fe^{+3} etc.

pH

The most important environmental impact of pH is its effect on the solubility and toxicity of other substances. Runoff from agricultural, domestic and industrial areas may contain iron, lead, chromium, ammonia, mercury and other elements. As the pH falls many insoluble substances become more soluble and thus available for absorption. For example, 4 mg/L of iron would not present a toxic effect at a pH of 8. However, as little as 0.9 mg/L of iron at a pH of 5.5 can cause fish to die. For aquatic life the pH should be between 6.0 and 9.0. As evident from Fig. 1, the pH of Marble Industry was 6.3, Frontier Woolen Mills 6.7 and Khyber Match Factory 6.2. The recommended limit of W.H.O [16] is from 7.0 to 8.5. However, if above 8.5 it may cause, burns in the mouth, esophagus and stomach with pain, nausea and vomiting. Its inhalation causes coughing, burning in the throat, choking sensation, inflammation of the

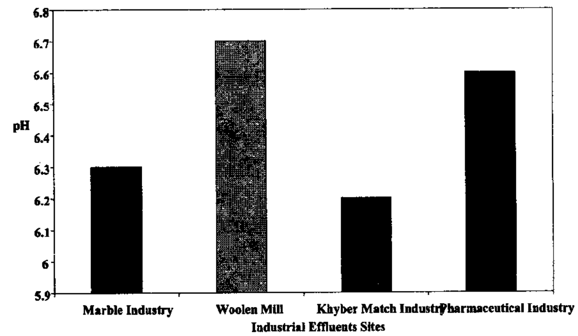

Fig. 1: pH of industrial effluents of Hayatabad industrial Estate, Peshawar.

nose, throat, eyes and digestive disorders in the human beings [17].

Calcium

Calcium salts and calcium ions are among the most commonly occurring in nature in the form of carbonates, bicarbonates, sulphates, chlorides and nitrates. They may result from the leaching of soil and other natural sources or from sewage and industrial wastes. Calcium is usually one of the most important contributors to hardness. Even though the human body requires approximately 0.7 to 2.0g calcium/day as a food element, excessive amounts can lead to the formation of kidney and gall bladder stones [18]. In natural water it is known to reduce the toxicity of many chemical compounds on fish and other aquatic life. The concentration of calcium in the samples of different industries was found as shown in Table-1. Calcium in main canal at zero meter was found (5.621 mg/L), at 100 meter (4.231 mg/L) and at 200 meter (3.123 mg/L) as can be seen in Table-2 and Figs. 2-7. All water samples have calcium below the recommended value of WHO *i.e.* 75 mg/L. Above this level it may cause problems like depositions in water system and excessive scale formations [19].

Magnesium

Magnesium ions are of particular importance in water pollution. They may contribute to water hardness. High concentration is undesirable in potable water, as it causes scale formation and cathartic and diuretic effects especially when associated with sulphates. The concentration of magnesium in the samples of different industries was found as shown in Table-1. Magnesium in main canal

Table-1: Concentration of metals in the industrial effluents of Hayatabad Industrial Estate, Peshawar.

Metals	KMF	PM	MI	UGI	PI	FWM
Calcium	4.123 ± 0.0122	6.452 ± 1.2316	5.444 ± 0.0369	4.112 ± 0.0112	7.852 ± 0.0552	3.412 ± 0.0620
Magnesium	4.523 ± 0.0234	7.895 ± 1.0322	6.123 ± 0.0258	9.123 ± 0.0212	10.52 ± 0.0662	0.456 ± 0.0410
Iron	3.452 ± 0.1235	6.421 ± 0.2010	3.451 ± 0.0147	6.123 ± 0.0231	6.123 ± 0.0113	0.231 ± 0.0523
Nickel	3.425 ± 0.0423	2.456 ± 0.0352	6.8410 ± 0.471	6.123 ± 0.0521	1.023 ± 0.0821	0.652 ± 0.0301
Copper	2.456 ± 0.0852	3.741 ± 0.0362	5.987 ± 0.0285	2.452 ± 0.0663	1.035 ± 0.123	1.352 ± 0.0410
Zinc	2.451 ± 0.0951	4.963 ± 0.0231	6.981 ± 0.0396	6.952 ± 0.0551	0.231 ± 0.0142	3.412 ± 0.0510
Cadmium	3.146 ± 0.0753	3.456 ± 0.0521	4.532 ± 0.0963	8.452 ± 0.0226	0.120 ± 0.0120	2.134 ± 0.0231
Lead	1.032 ± 0.0159	2.652 ± 0.0951	6.520 ± 0.0852	2.134 ± 0.0331	ND	ND
Manganese	1.023 ± 0.0423	3.452 ± 0.0312	7.015 ± 0.0741	9.852 ± 0.0412	0.423 ± 0.0103	1.234 ± 0.0952
Chromium	2.045 ± 0.0741	3.456 ± 0.0412	6.214 ± 0.0789	6.123 ± 0.0542	0.741 ± 0.1205	0.452 ± 0.0412
Cobalt	2.014 ± 0.0321	4.562 ± 0.0842	2.314 ± 0.0456	3.452 ± 0.0652	0.214 ± 0.0410	1.234 ± 0.0974
Silicon	2.013 ± 0.0148	3.452 ± 0.0999	6.412 ± 0.0123	12.45 ± 0.0445	0.985 ± 0.0505	2.314 ± 0.0541
Aluminum	2.452 ± 0.0236	6.123 ± 0.0412	5.982 ± 0.0159	4.956 ± 0.0995	2.314 ± 0.0202	4.256 ± 0.0621
Molybdenum	2.034 ± 0.0234	5.123 ± 0.0312	6.452 ± 0.0357	2.314 ± 0.0774	0.123 ± 0.0305	2.314 ± 0.0102

± Standard deviation

KMF = Khyber Match Factory
PM = Paper Mills
MI = Marble Industry
UGI = Umar Glass Industry
PI = Paper Industry
FWM = Frontier Woolen Mill

Table-2: Concentration of metals in the main canal effluents of Hayatabad Industrial Estate, Peshawar.

Metals	Main canal (0 meter)	Main canal (100 m)	Main canal (200 m)
Calcium	5.621 ± 0.0214	4.231 ± 0.0235	3.123 ± 0.0852
Magnesium	10.23 ± 0.0621	9.452 ± 0.0621	6.521 ± 0.0481
Iron	11.23 ± 0.0321	8.452 ± 0.0952	6.321 ± 0.0752
Nickel	12.31 ± 0.0621	7.542 ± 0.0532	4.521 ± 0.0741
Copper	10.23 ± 0.0512	6.452 ± 0.0421	3.452 ± 0.962
Zinc	12.34 ± 0.0841	6.001 ± 0.0523	4.521 ± 0.0354
Cadmium	8.523 ± 0.0751	5.014 ± 0.0532	3.122 ± 0.215
Lead	6.123 ± 0.0523	5.001 ± 0.0621	2.314 ± 0.0234
Manganese	5.231 ± 0.0621	4.852 ± 0.0952	1.231 ± 0.0162
Chromium	6.321 ± 0.0541	4.721 ± 0.0231	1.023 ± 0.0352
Cobalt	4.123 ± 0.0633	4.012 ± 0.0542	0.845 ± 0.0214
Silicon	6.123 ± 0.0654	3.845 ± 0.0412	14.52 ± 0.03621
Aluminum	2.314 ± 0.0752	3.245 ± 0.0741	2.134 ± 0.0532
Molybdenum	6.123 ± 0.0632	3.145 ± 0.0963	2.014 ± 0.0632

± Standard deviation

at zero meter was found (10.23 mg/L), at 100 meter (9.452 mg/L) and at 200 meter (6.521 mg/L) as can be seen in Table-2 and Figs. 2-7. None of the samples meets the recommended level of WHO *i.e.* 50 mg/L.

Copper

The concentration of copper in the samples of different industries was found as shown in Table-1. Copper in main canal at zero meter was found (10.23 mg/L), at 100 meter (6.452 mg/L) and at 200 meter (3.452 mg/L) as can be seen from Table-2 and Figs. 2-7. The recommended value of W.H.O is 3.0 mg/L. The marble industry, paper mills and main canals effluents have higher value than the recommended level (3.0 mg/L). Therefore it can cause problems like gastroenteritis with nausea and haemochromatosis [18].

Manganese

The biochemistry of manganese is very important because this trace mineral is an enzyme activator for the utilization of some nutrients including choline, biotin, vitamin C, and thiamine. It seems as if manganese plays a part in all biological processes including fatty acid and cholesterol synthesis, production of proteins, fats, and carbohydrates, and in regulating blood sugar levels. Other important functions of this mineral are the production of milk for lactation, maintaining sex hormone production, and the formation of urea, blood and collagen. About 40 % of the manganese consumed is absorbed by the small intestine. Very little of this mineral is stored; however the pancreas, liver, bones, and pituitary contain up to some extent. The National Research Council suggests the following amounts: newborns-6 months 0.3-0.6mg, 6 months-1 year 0.6-1.0mg, children 1-3 years 1.0-1.5mg, children 4-6 years 1.5-2.0mg, children 7-10 years 2.0-3.0mg, adults 2.0-5.0mg. The concentration of manganese in the samples of different industries was determined as shown in Table-1. Manganese in main canal at zero meter was found (5.231 mg/L), at 100 meter (4.852 mg/L) and at 200 meter (1.231 mg/L) as can be seen from Table-2 and Figs. 2-7. Excess amounts of this mineral will cause a reduction in the utilization and storage of iron, thus cause iron-

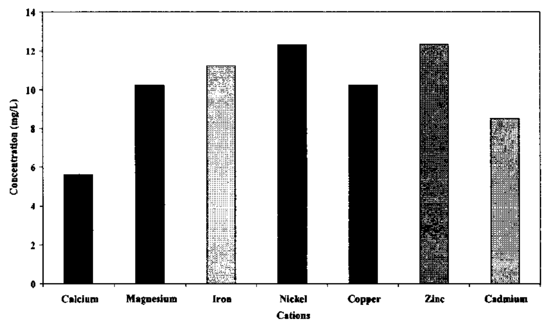

Fig. 2: Concentration of metals in the main canal effluents collected at 0 meter of Hayatabad Industrial Estate, Peshawar.

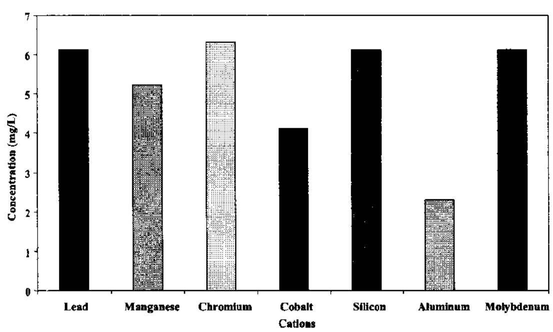

Fig. 3: Concentration of metals in the main canal effluents collected at 0 meter of Hayatabad Industrial Estate, Peshawar.

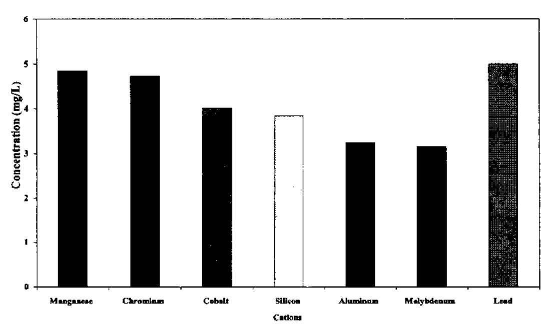

Fig. 4: Concentration of metals in the main canal effluents collected at 100 meters of 2 Hayatabad Industrial Estate, Peshawar.

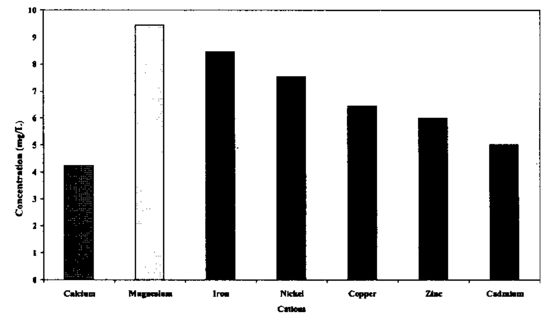

Fig. 5: Concentration of metals in the main canal effluents collected at 100 meters of Hayatabad Industrial Estate, Peshawar.

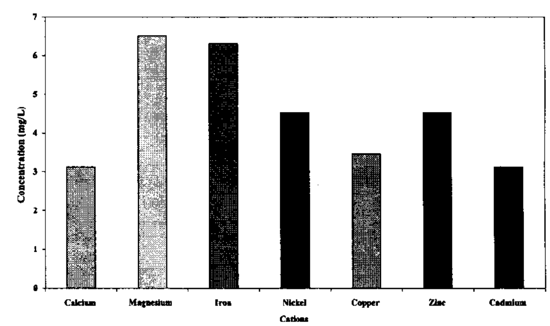

Fig. 6: Concentration of metals in the main canal effluents collected at 200 meters of Hayatabad Industrial Estate, Peshawar.

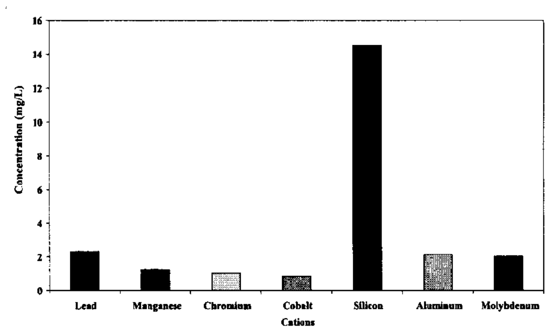

Fig. 7: Concentration of metals in the main canal effluents collected at 200 meters of Hayatabad Industrial Estate, Peshawar.

deficiency-anemia. Symptoms of toxicity include headaches, leg cramps, speech impairment, instability and motor difficulties. In case of deficiency the body is unable to remove excess sugar from the blood this results in diabetes. Other problems caused by a deficiency are convulsions, dizziness, ear noises and loss of muscular coordination, myasthenia gravis. Other complications that are created include multiple sclerosis, osteoarthritis, depression, fatigue and dizziness [18].

Iron

Natural waters contain variable amounts of iron depending on the geological area and other chemical components. Iron in groundwater is normally present in the ferrous or bivalent form [Fe^{++}] which is soluble. It is easily oxidized to ferric iron [Fe^{+++}] or insoluble iron upon exposure to air. Iron is a trace element required by both plants and animals. It is a vital part of the oxygen transport mechanism in the blood (hemoglobin) of all vertebrate and some invertebrate animals. Ferrous (Fe^{++}) and ferric (Fe^{+++}) ions are primary cause for concern in the aquatic environment. Other forms may be bound to either organic or inorganic compounds. The ferrous form Fe^{++} can persist in water void of dissolved oxygen and usually originates from groundwater or mines that are pumped or drained. It appears to be more of a nuisance than a potential health hazard. Taste thresholds of iron in water are 0.1 mg/L for ferrous iron and 0.2 mg/L for ferric iron, giving a bitter or an astringent taste. Water to be used in industrial processes should contain less than 0.2 mg/L iron. Black or brown swamp waters may contain iron concentrations of several mg/L in the presence or absence of dissolved oxygen, but this iron form has little effect on aquatic life. The maximum permissible limit of iron for drinking water according to W.H.O is 1 mg/L [16]. The concentration of iron in the samples of different industries was monitored as shown in Table-1. Iron in main canal at zero meter was found (11.23 mg/L), at 100 meter (8.452 mg/L) and at 200 meter (6.321 mg/L) as can be seen from Table-2 and Figs. 2-7. At high concentration iron may cause diseases like vomiting, weakness, pale face, coldness, restlessness, backache, rapid respiration [18].

Cadmium

Primary industrial uses for cadmium are in plating, battery manufacture, pigment, and plastics industries. Cadmium is a non-essential element and is considered to be a potential toxic to man resulting in kidney dysfunction, bone defects, high blood pressure and reproductive defects. Cadmium is widely distributed in the environment at low concentrations. It can be found in fairly high concentrations in sewage sludge. The concentration of cadmium in the samples of different industries was as shown in Table-1. Cadmium in main canal at zero meter was found (8.523 mg/L), at 100 meter (5.014 mg/L) and at 200 meter (3.122 mg/L) as can be seen from Table-2 and Figs. 2-7. The maximum permissible value for cadmium according to NEQS is 0.1 mg/L. Our samples show high amount of cadmium concentration so it can cause poor appetite, slower growth of human, anemia, retarded testicular development, enlarged joints, scaly skin, liver problem, kidney damage and increase in mortality [18].

Nickel

The concentration of nickel in the samples of different industries was determined as shown in Table-1. Nickel in main canal at zero meter was found (12.31 mg/L), at 100 meter (7.542 mg/L) and at 200 meter (4.521 mg/L) as can be seen from Table-2 and Figs. 2-7. The recommended limit according to NEQS is 0.5 mg/L. Our data shows nickel above the recommended amount therefore it can have hazardous effect like allergic dermatitis known as nickel itch. It also adversely affects lungs and nasal cavities [18].

Zinc

The concentration of zinc in the samples of different industries was found as shown in Table-1. Zinc in main canal at zero meter was found (12.34 mg/L), at 100 meter (6.001 mg/L) and at 200 meter (4.521 mg/L) as can be seen from Table-2 and Figs. 2-7. The permissible value issued by WHO is 15mg/L. Our data is lower than the recommended level and therefore is safe from causing diseases like dysfunction of pancreas, diabetic hyposmia and hypogemsia or coma [18].

Chromium

Chromium is ubiquitous in the environment, occurring naturally in the air, water, rocks and soil. It is used in industries of stainless steel, electroplating dyes, leather tanning and wood preservatives. Natural sources of water contain very low concentrations of chromium. It is a micronutrient and an over dose of chromium-VI has been associated with birth defects and cancer; however, chromium-III is not associated with these effects. Chromium, particularly Cr-III plays an important role in the body function while other forms of chromium are toxic and have no function in the body. For example, chromium is found in the pancreas which produce insulin. One useable form of chromium is the Glucose Tolerance Factor (GTF), an organic compound containing glutanic acid, cysteine and hiacin. The absorption of trivalent chromium in GTF is about 10-25 % only 1 % of inorganic is absorbed. GTF is essential for the efficient use of insulin. It enhances the removal of glucose from the blood. Cr also acts as an activator of several enzymes. Deficiency of chromium decreases the efficiency of insulin and increases sugar and cholesterol level in the blood. Plants and animals do not bio-accumulate chromium; therefore, the potential impact of high chromium levels in the environment is acute toxicity to animals. In animals and humans this toxicity may be expressed as skin lesions or rashes and kidney and liver damage [18]. The criterion for total chromium in a domestic water supply is 0.05 mg/L. The aquatic life criteria is less than 0.011 mg/L for chromium VI and less than 0.207 mg/L for chromium III. The concentration of chromium in the samples of different industries was found as given in Table-1. Chromium in main canal at zero meter was found (6.321 mg/L), at 100 meter (4.721 mg/L) and at 200 meter (1.023 mg/L) as can be seen from Table-2 and Figs. 2-7. Therefore it is not safe and must be removed from the effluents before subjecting into the environment.

Lead

Water generally contains trace amounts of lead (2-30 ppt). On average rivers contain between 3 and 30 ppb. The WHO stated a legal limit of 50 ppb for lead in 1995, which is to be decreased to 10 ppb by 2010. Under normal conditions lead does not react with water. However when lead comes in contact with moist air reactivity with water increases. The tetra-ethyl lead is applied as an additive in fuels. This organic lead compound is quickly converted to inorganic lead, and ends up in water, sometimes even in drinking water. Lead dissolved or suspended in wastewater mostly stems from streets, pipes and soils. The man body contains approximately 120 mg of lead. About 10-20 % of lead is absorbed by the intestines. Symptoms of overexposure to lead include colics, skin pigmentation and paralysis. Generally the effects of lead poisoning are neurological or teratogenic. Organic lead causes necrosis of neurons. Inorganic lead causes axonal degeneration and demyelination. Both types of lead may cause cerebral oedema and congestion. Organic lead compounds are absorbed quicker, and therefore pose a greater risk. Organic lead derivates may be carcinogenic. Women are generally more susceptible to lead poisoning than men. Lead causes menstrual disorder, infertility and spontaneous abortion, and it increases the risk of stillbirth. Foetuses are more susceptible to lead poisoning than mothers, and generally foetuses even

Table-3: Atomic absorption spectrophotometeric conditions.

Element	Wavelength (nm)	Slit width (nm)	Lamp current (mA)	Flame
Calcium	422.7	0.7	10	Air-Acetylene
Magnesium	285.2	0.7	6	Air-Acetylene
Iron	248.8	0.2	30	Air-Acetylene
Zinc	213.9	0.7	15	Air-Acetylene
Manganese	279.5	0.2	20	Air-Acetylene
Cobalt	240.7	0.2	30	Air-Acetylene
Chromium	357.9	0.7	25	Air-Acetylene
Nickel	232.0	0.2	25	Air-Acetylene
Copper	324.8	0.7	15	Air-Acetylene
Lead	283.3	0.7	10	Air-Acetylene
Cadmium	228.8	0.7	4	Air-Acetylene

Table-4: WHO standards for drinking water.

S. NO.	POLLUTANTS	PERMISSIVE	EXCESSIVE
1.0	**Physical:**		
1.1	Turbidity (Units of Silica)	5 Units	25Units
1.2	Colour (Units On Platinum Cobalt Scale)	5 Units	25 Units
1.3	Taste and Odour	Nothing	Disagreeable
2.0	**Chemical:**		
2.1	pH	7.0-8.5	< 6.5 or > 9.2
2.2	Total Solids	500 mg/L	1500 mg/L
2.3	Total Hardness (as $CaCO_3$)	300 mg/L	600 mg/L
2.4	Calcium (as Ca^{+2})	75 mg/L	200 mg/L
2.5	Magnesium (as Mg^{+2})	50 mg/L	150 mg/L
2.6	Iron (as Fe^{+3})	0.3 mg/L	1.0 mg/L
2.7	Manganese (as Mn^{+2})	0.1 mg/L	0.5 mg/L
2.8	Copper (as Cu^{+2})	1.0 mg/L	3.0 mg/L
2.9	Zinc (as Zn^{+2})	5.0 mg/L	15 mg/L
2.10	Chlorides (as Cl^{-1})	250 mg/L	1000 mg/L
2.11	Sulphate (as SO_4^{-2})	250 mg/L	400 mg/L
2.13	Fluorides (as F^{-1})	1.0 mg/L	2.0 mg/L
2.14	Nitrates (NO_3^-)	20 mg/L	50 mg/L
3.0	**Toxic Substance:**		
3.1	Arsenic (as As^{+3})	0.2 mg/L	0.2 mg/L
3.2	Chromium (as Hexavalent)		0.05 mg/L
3.3	Selenium (as Se^{+4})		0.05 mg/L

protect mothers from lead poisoning. Earlier, lead was applied as a measure of birth control, for example as a spermicidal and to induce abortion. Children may absorb a larger amount of lead per unit body weight than adults (up to 40 %). Consequently, children are generally more susceptible to lead poisoning than adults. Symptoms include lower IQs, behavioural changes and concentration disorder. Lead accumulates in leg tissue. The most severe type of lead poisoning causes encephalopathy. Lead toxicity is induced by lead ions reacting with free sulfydryl groups of proteins, such as enzymes which are deactivated. Furthermore, lead may interact with other metal ions [18]. Drinking water must contain less than 0.015 mg/L. The amount of lead in the samples of different industries was found as shown in Table-1. Lead in main canal at zero meter was found (6.123 mg/L), at 100 meter (5.001 mg/L) and at 200 meter (2.314 mg/L) as can be seen from Table-2 and Figs. 2-7.

Silicon

Deeper water layers may contain 2 ppm silicon and rivers generally contain 4 ppm silicon. Silicon is usually not ionized. Rivers transport large amounts of silicon to sea. Most likely, less than 20 % of dissolved silicon is removed from rivers by means of biological or chemical transformation processes. As silicon is a part of various minerals from which it may be released during weathering processes. It is also released under water during volcanic activity. Sand is the primary substance for commercially produced silicon. Minerals such as talc, mica, feldspar, nepheline, olivine, vermiculite, perlite and kaolinite also contain silicon. Glass and porcelain production is based on sand. Silicon is applied as an aid in steel and chemical industries, where it is processed under high temperatures. Industrially significant silicon compounds are rubber- or resin-like compounds, which are generally water resistant and also withstand oxidation processes and chemical weathering. The human body contains a total amount of 1 gram of silicon, which decreases at a later age. For a number of organisms silicon is a dietary requirement and consequently it is considered a dietary requirement for humans as well. Organisms mainly require silicon for bone development, whereas the element is found mostly in skin and connective tissue. Daily intake may vary between 20 and 1200 mg, and is mostly met by eating grains. All naturally occurring types of silicon, sand and silicon compounds are non-toxic. Elementary silicon has no clear mechanisms of toxicity. High concentrations of soluble silicon compounds may disturb phosphorilation. A number of silicon compounds have a fiber-like texture and are carcinogenic, for example asbestos. Fine particles of silicon compounds may cause silicosis, a typical profession related illness of mine workers or stone grinders. Pulmonary alveoli harden and their flexibility decreases. This results in shortness of breath, panting and coughing. Only inhalation of silicon particles may cause these effects. Silicon breast implants may cause auto immune disorders and even cancer [18]. The concentration of silicon in the samples of different industries was found as given in Table-1. Silicon in main canal at zero meter was found (6.123 mg/L), at 100 meter (3.845 mg/L) and at 200 meter (14.52 mg/L) as can be seen from Table-2 and Figs. 2-7.

Cobalt

This mineral has an important role in replacing manganese and zinc in some enzymes. For proper functioning and maintenance of red blood cells, cobalt must be present. This nutrient must be taken in through the diet because the human body cannot synthesize it. For this mineral to be absorbed it must be in the form of vitamin B12. The liver, kidneys, pancreas, and spleen are the sites of cobalt storage. Since this mineral is present in most protein foods and the need for it is low, there is no RDA established. 5-8μg is the average amount taken in. The thyroid gland may be enlarged with an excess of cobalt. Symptoms of toxicity include paleness, diarrhea, fatigue, and numbness in the fingers and toes. A condition called polycythemia may arise as well. Nervous disorders are a result of a deficiency, untreated these disorders may become permanent. Pernicious anemia may be treated with the use of cobalt since it plays a role in the functioning of red blood cells. The concentration of cobalt in the samples of different industries was found as shown in Table-1. Cobalt in main canal at zero meter was found (4.123 mg/L), at 100 meter (4.012 mg/L) and at 200 meter (0.845 mg/L) as can be seen from Table-2 and Figs. 2-7.

Experimental

Sampling

Water samples were collected from the industrial effluents in clean polyethylene bottles on 20th November 2006. Before taking the samples, the bottles were rinsed with the sample water and were then filled to overflow so that no air bubble was left trapped in the samples. Parameters like pH, calcium, magnesium, manganese, copper, zinc, chromium, and iron were studied in the samples.

pH Measurement

The pH of the collected samples was noted in the laboratory by using pH meter. First pH meter was calibrated with buffers 4, 7 and 9 and then the pH values of samples were determined.

Preservation

Few drops of chloroform ($CHCl_3$) were added to each sample in order to avoid the biological activities of microorganisms. For cations, 5 ml HNO_3

and 10ml HCl were added and then heated near boiling point, then cooled and stored for metal determination through atomic absorption spectrophotometer (A-Analyst 700-Perkin-Elmer USA).

Conclusions

The following most vital conclusions were drawn from the present study.

1. pH of the samples is slightly acidic than the recommended W.H.O limit.
2. All water samples have calcium below the recommended value of WHO *i.e.* 75 mg/L.
3. Magnesium was found at lower level than the recommended value of WHO *i.e.* 50 mg/L.
4. The marble industry, paper mills and main canals effluents have higher value than the recommended level of copper (3.0 mg/L). Therefore it can cause problems like gastroenteritis with nausea and haemochromatosis.
5. Manganese in the samples was above the WHO limit (0.5 mg/L). Therefore it may be toxic to aquatic and human life.
6. Iron was above the excessive limit set by WHO (1.0 mg/L).
7. The samples of the study area show higher cadmium concentration than the maximum permissible level for cadmium according to NEQS which is 0.1 mg/L.
8. The concentration of nickel in the samples was above the recommended limit. Therefore it may be toxic.
9. The permissible level for zinc issued by WHO is 15mg/L. Our data shows lower values than the recommended level.
10. Drinking water must contain less than 0.015 mg/L. The concentration of lead in the samples of different industries was above the limit.

In the present study some of the parameters were found above the permissible limits set by W.H.O. Therefore these effluents must be treated before they enter the environment.

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