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An Evaluation of Heavy Metals Content in Dyeing and Printing Industrial Effluents in GIDC Surat: A Statistical Approach

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The present paper reports the heavy metals content in dyeing and printing industrial effluents from Gujarat Industrial Development Corporation (GIDC) area of Surat. The effluent of this area is discharged into rivulet and finally goes to the creek. The metals monitored are Cd, Pb, Fe, Cr, Ni, Zn, Cu, Hg, As, Mn, Se, Sb, Mo. The results are compared with WHO and Indian standards.

Key Words: ICP-AES, Industrial effluents, Heavy metals contents.

INTRODUCTION

Environmental pollution is one of the serious issue with respect to environmental balance. Population explosion, urbanization and industrialization result in the deterioration of environmental quality. Among the industries dyeing and printing industries exert their effect on environmental pollution. The dyeing and printing industrial effluents directly or indirectly get discharged into Arabian sea and thus pollute the sea water[1]. The industrial effluent discharges heavy metals into aquatic ecosystems. Even very low concentration of heavy metals in aquatic water bodies may alter the quality of aquatic environment. This can cause physiological, chemical and biological deterioration of aquatic water bodies[2].

Heavy metals in aquatic environment can become toxic to aquatic organisms and can also reach to human beings *via* food chain as bioaccumulation. The heavy metals discharge through dyeing and printing industrial effluents also affect the nearby soil, vegetation and ground water quality[3]. Hence it is essential to assess the heavy metals content in the effluents generated from dyeing and printing industries. In GIDC sector, Surat city consist large number of dyeing and printing industries which includes Sachin, Pandesara and Kadodara regions. The geographical location of Surat is in 21°12′ N latitude and 72°51′ E longitude.

EXPERIMENTAL

In the present study, near by following areas of GIDC, Surat was selected for heavy metals pollution monitoring namely as; K1: Dyeing Printing House, Pandesara. K2: Kirty Dyeing and Printing Mill, Pandesara. K3: Tarana Dyeing and Printing

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Mill, Pandesara. K4: Gagan Dyeing and Printing Mill, Kadodara. K5: Best Processor, Kadodara. K6: Bhavana Dyeing and Printing Mill, Kadodara. K7: Sona Dyeing and Printing Mill, Kadodara. K8: Prabhavana Dyeing and Printing Mill, Sachin. K9: Suprabhat Printing Pvt. Ltd., Sachin. K10: Bajaj Fashion Pvt. Ltd., Sachin.

The study was carried out in April 2007. The samples were collected in between 7.30 to 9.00 AM and 7.30 to 9.00 PM. The industrial effluent samples were collected in plastic bottles. The samples were acidified with 6 N nitric acid (2 mL/100 mL) to avoid losses due to adsorption on the walls of container. The samples were digested with 3:1 portion of conc. HNO_3, conc. HCl as per APHA[4]. The heavy metal concentrations were determined by using the Inductive coupled plasma atomic emission spectrophotometer at SAIF (RSIC) IIT, Mumbai.

RESULTS AND DISCUSSION

The results of different metals in various samples are given in Table-1. The TLV for cadmium is 2.0 mg/L. The cadmium content in the samples is less than 0.1 mg/L. Organo cadmium compounds act as catalyst. The drinking water having more than 0.1 mg/L of cadmium can cause bronchitis, itai-itai, anemia, renal stone formation, hyper tension and arteriosclerosis in animals and human[5,6]. Lead is used in manufacturing of pigments and lead based paints. The TLV for lead is 0.1 mg/L, its concentration in the samples is less than 1 mg/L. The TLV for iron is 3.0 mg/L and it observed to be ranging from 0.2 to 4.8 mg/L. The high concentration of iron is due to the addition of ferrous sulphate and ferric chloride in treatment plant of the precipitation of direct dyes[7,8]. Chromium is generally occurs in oxidation states ranging between Cr^{2+} to Cr^{6+}. Chromium is used in manufacture of chrome pigments, mordant dyeing. Textile waste contains chromium up to 32 ppm. The TLV for chromium is 0.1 mg/L. Chromium content ranges between 0.1 to 3.4 mg/L.

TABLE-1
CONCENTRATION OF HEAVY METALS PRESENT IN THE DYEING AND PRINTING INDUSTRIAL EFFLUENTS COLLECTING FROM DIFFERENT SAMPLING STATIONS OF GIDC SURAT, GUJRAT

Sample	Cd	Pb	Fe	Cr	Ni	Zn	Cu	Hg	As	Mn	Se	Sb	Mo
K1	ND	ND	1.5	0.1	3.0	0.7	0.4	ND	1.0	0.7	ND	ND	ND
K2	ND	ND	2.7	0.1	4.8	0.5	0.4	ND	1.2	0.7	ND	ND	ND
K3	ND	ND	2.1	0.1	4.9	0.5	0.4	ND	1.2	0.7	ND	ND	ND
K4	ND	ND	2.8	0.1	4.8	0.5	0.4	ND	0.7	0.2	ND	ND	ND
K5	ND	ND	1.2	0.1	5.6	0.5	0.4	ND	0.7	0.3	ND	ND	ND
K6	ND	ND	0.5	0.1	5.3	0.5	0.3	ND	0.7	0.2	ND	ND	ND
K7	ND	ND	1.3	0.1	6.0	0.4	0.3	ND	0.7	0.3	ND	ND	ND
K8	ND	ND	1.9	0.1	4.2	0.4	0.3	ND	0.7	0.4	ND	ND	ND
K9	ND	ND	4.8	3.4	6.6	0.8	0.5	ND	1.1	0.4	ND	ND	ND
K10	ND	ND	0.2	0.1	4.2	0.4	0.2	ND	1.0	0.4	ND	ND	ND

All the values expressed in mg/L.
ND for Cr, Sb, Cd, Mo is less than 0.1 mg/L. and Pb, Se, Hg less than 1 mg/L.

Nickel is used in electroplating. High concentrations of Ni are found in fossil fuels. It is present virtually in every kind of sample including water, plants and animal tissues[9]. Its concentration is found to be very high in all the samples ranging from 3.0 to 6.6 mg/L. The TLV for nickel is 3.0 mg/L. Zinc is used mainly in alloy, paint and pigment industries. The TLV for zinc is 5.0 mg/L. zinc amount in the samples is ranging from 0.4 to 0.8 mg/L. Copper is one of the most common metals which are widely used in dyes, paints, pigments, ceramics, alloys, batteries, *etc*. The TLV for copper is 3.0 mg/L. The amount of copper ranges from 0.2 to 0.5 mg/L. Main source of mercury is cinnabar and combustion of fossil fuels. The amount of mercury found in samples is less than 1 mg/L. The TLV for mercury is 0.01 mg/L. Arsenic amount in the samples is ranging from 0.7 to 1.2 mg/L. The TLV for arsenic is 0.2 mg/L. Manganese is used in dyes, dry batteries, electrical coils, matches, glasses, welding rods, fertilizers. Manganese amount in samples is ranging from 0.2 to 0.7 mg/L. The TLV for manganese is 2.0 mg/L. The correlation and regression analysis of the collected results are being tabulated in Tables 2 and 3. The correlation coefficient 'r' among all the detected metal was calculated.

TABLE-2
CORRELATION COEFFICIENT BETWEEN METALS FROM INDUSTRIAL EFFLUENTS OF SACHIN, PANDESARA AND KADODARA GIDC, SURAT, GUJRAT

Metals	Fe	Cr	Ni	Zn	Cu	As	Mn
Fe	1						
Cr	0.7700	1					
Ni	0.3986	0.5135	1				
Zn	0.7327	0.8244	0.3643	1			
Cu	0.8511	0.6028	0.4983	0.8058	1		
As	0.3961	0.3206	-0.2118	0.4097	0.3504	1	
Mn	0.2174	-0.0526	-0.4457	0.1157	0.2385	0.8809	1

TABLE-3
VALUES OF REGRESSION COEFFICIENT FOR DYEING AND PRINTING INDUSTRIAL EFFLUENT SAMPLES OF SACHIN, PANDESARA AND KADODARA GIDC, SURAT, GUJRAT

Parameter pairs	A	B
Fe-Cr	-0.7237	0.6072
Fe-Ni	4.3372	0.4295
Cr-Ni	4.6996	0.7139
Zn-Cu	0.1000	0.5718
Zn-As	0.5333	0.7220
Zn-Mn	0.2166	0.1766
Cu-As	0.5625	0.9194
Cu-Mn	0.1937	0.5196
As-Mn	0.0245	0.6848

Conclusion

The iron and chromium content in sample K9 was found higher than their TLV values. Nickel content in samples K2 to K10 was found higher than its TLV value. The arsenic content in all samples was found greater than its TLV value. The Cr, Sb, Cd, Mo contents were found less than 0.1 mg/L and Pb, Se, Hg were found less than 1 mg/L. This industrial effluent gets discharged in the rivulet without effluent treatment and finally goes to creek. During this process the concerned ecosystem is disturbed. Hence, some new treatment methodologies are recommended for checking and controlling the effluent quality.

In dyeing and printing industrial effluents, the metal pairs like Cr-Fe, Zn-Fe, Zn-Cr, Cu-Fe, Cu-Cr, Cu-Zn and Mn-As show strong positive correlation while metal pairs like As-Ni, Mn-Cr and Mn-Ni show negative correlation.

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