International Journal of Advanced Chemistry, 8 (2) (2020) 235-238

International Journal of Advanced Chemistry

Website: www.sciencepubco.com/index.php/IJAC

Research paper

Heavy Metal Chemistry of Waste Water of Textile Dyeing Industries, Tongi, Gazipur, Bangladesh

Saima Hossain [1], A. H. M. Selim Reza [1], Sudip Saha [1] *, Md. Aminul Ahsan [2]

[1] *Department of Geology and Mining, University of Rajshahi, Rajshahi-6205, Bangladesh*
[2] *Analytical Research Division Laboratories, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh*
**Corresponding author E-mail: sudips_geologist@yahoo.com*

Abstract

The present research work shows the dominance of iron in the industrial waste water and river water samples of the investigated area of Gazipur district. The mean iron concentrations for both types of water samples are higher than the maximum permissible limits of WHO and NEQS. The excess amount of iron in water can cause health hazards of the human beings and ecosystem. Attempts should be taken to remove the excess amount of iron from the waters of the study area. On the basis of median concentration values of the heavy metals, they can be arranged as Fe>Zn>Ni>Cr>Pb. The factor analysis reveals the dominance of first two factors which comprise 83.298% of the total variance. The factor-1 is characterized by the contamination of Fe, Ni and Zn whereas factor-2 is dominated by the presence of Cu and Pb.

Keywords: *Heavy Metals; Iron; Lead; Factor Analysis and Waste Water.*

1. Introduction

Heavy metals are considered very harmful as they are non-biodegradable in nature, have long biological half-lives and their potential to accumulate in different body parts (Manaham 2005: Wilson and Pyatt 2007). Excessive accumulation of heavy metals in agricultural soils through waste water irrigation, may not only result in soil contamination, but also affect food quality and safety (Muchoweti et al. 2006). Some research also confirmed that heavy metal such as Cd, Pb, Cu, Zn and Ni have carcinogenic or toxic effects on human beings and environment (Trichopowos, 2001; Turkdegan et al, 2002, Kocasoy and Sahin, 2007).
The management of effluent water is becoming increasingly difficult due to the presence of heavy metals (Zorpas et al. 2008). It is now established that application of effluent water into land can increase soil water holding capacity, decrease soil bulk density, increase soil aeration and root penetrability a stimulate soil microorganism activity (Kvarnstiom et al, 2000). In addition, land utilization of sludge could represent a step forward to more suitable farming practices and municipal waste management. Achieving this purpose, it is pivotal to know the heavy metal content in textile without investigating toxic substances it is not feasible to use effluent water as a soil conditioner or fertilizer land.
Tongi industrial area is located in the southern part of Gazipur Sadar. The location of geographical co-ordinates between 23°54′N to 23°56′N latitudes and 90°27′E to 90°29′E longitudes (Figure 1).
The objectives of the present research work are to reduce the environmental impact during the treatment of waste water and control over the waste handling procedures to reduce the environmental impact and finally reduce the impact environmental pollution on human health.

Fig. 1: Location Map of the Study Area.

2. Materials and methods

The selected three sites are located in Tongi industrial area, Tongi, Gazipur, Bangladesh. From these industrial areas, effluents are directly discharged into nearby Turag river through a drainage system. Sample bottles were first cleaned with tap water thoroughly and with de-ionized distilled water, afterwards. Samples were collected from the different sites of the selected area in a wide mouth polyethylene bottle. Reference water sample was taken from textile and dyeing industries before refining and after refining. Effluent samples were immediately preserved mixing with concentrated nitric acid for heavy metal analysis. After acidification the sample were stored at 4°C in refrigerator to prevent change in volume due to evaporation.
The heavy metals were analyzed using AAS (Perkin Elmer Analysis Flame Atomic Absorption Spectrophotometer). The AAS was calibrated for all the metals by running different concentrations of standard solutions. Average value of three replicates were taken for each determination. The analysis for the majority of the trace metals like Chromium (Cr), Cadmium (Cd), Nickel (Ni), Zinc (Zn), Copper (Cu), Lead (Pb) and Iron (Fe) was done by AAS.

3. Results and discussion

Generally, concentrations of heavy metals in the environment occur due to continuous disposal of untreated industrial effluents generated during operational phase of industries. Among various industries, Textile industries are major producer of metals like chromium, iron, manganese, copper, lead, cadmium, zinc and nickel etc. Hence, all the collected samples were analyzed for chromium, iron, manganese, copper, lead, cadmium, zinc and nickel of the analyzed samples.

Table 1: Distribution of Heavy Metals in the Water Samples of the Study Area

Metals	WHO 2000	FEPA (1991)	NEQS 2000	Site-1 Refined Waste Water	River Water	Site-2 Refined Waste Water	River Water	Site-3 Refined Waste Water	River Water	Remarks
Cr mg/L	0.05	<1.0	1.0	0.014	0.017	0.011	0.024	0.017	0.02	No Problem
Ni mg/L	0.1	<1.0	1.0	0.013	0.04	0.015	0.036	0.015	0.06	No Problem
Zn mg/L	5.5	<1.0	5.0	0.079	0.071	0.064	0.121	<0.1	0.281	No Problem
Cu mg/L	0.05	<1.0	1.0	< 0.1	< 0.1	< 1.0	< 1.0	0.02	0.01	Not efficient
Pb mg/L	<0.05	<1.0	-	0.009	0.003	0.009	0.003	0.02	0.01	No Problem
Fe mg/L	0.3	-	2.0	5.399	4.74	0.96	4.556	0.275	5.399	Not efficient

The concentration of chromium (Cr) varies from 0.011 mg/L to 0.024 mg/L (Table 1), where the median concentration is 0.017 mg/L in the studied water samples. The average concentration of the nearest river water is 0.020333 mg/L which is higher than the average Cr content of the waste water (after refining) whose numerical value is 0.014 mg/L (Figure 2). The concentrations of Cr in the studied water samples are lower than the recommended permissible limits of WHO 2000, FEPA 1991 and NEQS 2000.

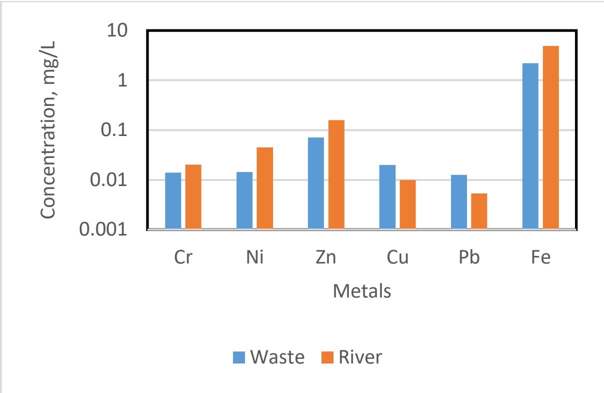

Fig. 2: The Mean Concentrations of Heavy Metals in Waste Water After Refining and Nearby River Water.

The mean content of nickel (Ni) of the waste water is 0.014333 mg/L. The present study reveals that the mean value of the Ni content for the nearest river water samples is 0.045333 mg/L. The average Ni concentration of is low in the studied waste water (Figure 2) and it shows that the river water is might from the other sources. The concentrations of Ni of the water samples from all the sites are below the permissible limit of WHO 2000.

The maximum concentration of zinc is 0.281 mg/L and it is reported from the river water of the investigated area. The median value of Zn content of the water samples is 0.079 mg/L. None of the samples exceed the recommended permissible limits of WHO 2000, FEPA 1991 and NEQS 2000.

The mean copper (Cu) concentration value of the waste water after refining remained higher than the mean Cu content of the river water. Attempts should be taken for the removal of Cu from the industrial waste water as the amount of copper remains under the river water.

The average amount of lead (Pb) of the waste water after refining is 0.012667 mg/L which is higher than the average Pb content of the nearest river water samples. It is worthy to note that the concentrations of lead of both of the waste water after refining and the river water is well below the recommended maximum permissible limits of WHO 2000 and FEPA 1991.

The investigated waste water and river water samples are characterized by the abundance of iron. The mean iron content of waste water after refining and the river water are higher the permissible limits of WHO 2000 and NEQS 2000. The concentrations of iron of the river water is higher than the industrial waste water samples of the investigated sites that reveals the influx of iron from different sources into the river water. Higher iron content may produce undesirable effects such as astringent taste, depolarization, turbidity, deposits and growth of iron bacteria in pipes affecting the acceptability of water for domestic use (Das and Borah 1983).

4. Factor analysis

Table 2: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.271	54.521	54.521	3.271	54.521	54.521
2	1.727	28.776	83.298	1.727	28.776	83.298
3	.595	9.915	93.213			
4	.288	4.805	98.018			
5	.119	1.982	100.000			
6	1.596E-016	2.659E-015	100.000			

Extraction Method: Principal Component Analysis.

Table 3: Component Matrix[a]

	Component	
	Factor-1	Facor-2
Cr	.621	.484
Ni	.832	.451
Zn	.791	.385
Cu	-.469	.874
Pb	-.758	.599
Fe	.879	-.134

Extraction Method: Principal Component Analysis
a. 2 components extracted.

The factor analysis for the geochemical concentrations of different trace metals were performed using SPSS-20 software. The study shows that the first two factors comprise 83.298% of the total water samples. The first factor, Factor-1 is characterized by the dominance of Fe, Ni and Zn and constitutes 54.521% of the total variance (Table 2). Factor-2 is contaminated by the heavy metals like Cu and Pb and consists of 28.776% of the total variance.

5. Conclusion

The present study shows the concentration of different heavy metals like Cr, Ni, Zn, Cu and Pb in the waste water of textile dyeing industries after refining and comparison with the nearest river water where the waste waters are being finally dumped. The concentrations of iron both in the waste water and the river water samples are higher than the recommended permissible limits of WHO 2000 and NEQS 2000. The concentrations of iron of the river water is higher than the industrial waste water samples of the investigated sites that reveals the influx of iron from different sources into the river water. Higher iron content may produce undesirable effects such as astringent taste, depolarization, turbidity, deposits and growth of iron bacteria in pipes affecting the acceptability of water for domestic use. The factor analysis shows the dominance of first two factors and factor-1 is distinguished by Fe, Ni and Zn and factor-2 is marked by the presence of the heavy metals like Cu and Pb. These two factors together comprise 83.298% of the total variance. The future research works can be taken on the physical parameter and major element geochemistry like nitrate of the industrial waste water, soils and removal of pollutants from the industrial waste water as well as river water.

Acknowledgement

The authors are pleased to thank to Professor Dr. Golam Sabbir Sattar, Chairman Department of Geology and Mining, University of Rajshahi, Bangladesh for arranging the research work. The authors are thankful to the Analytical Research Division Laboratories, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka for providing kind permission to analyze the water samples in the Laboratory of BCSIR, Dhaka

Funding

No funding.

Conflict of interest

No conflict of interest.

References

[1] Das HB and Borah K, Iron excess in drinking water of Darrang district of Assam and Some adjoining areas, Det Sci J., 1983; 33(1): 31-7. https://doi.org/10.14429/dsj.33.6126.
[2] FEPA, Federal Environmental Protection agency, S.1.8 National environmental Protection (Effluent Discharge Limitation), 1991.
[3] Kacasoy, G. and V. Sahin, 2007. Heavy metal removal from industrial wastewater by clinoptilolite. J. Environ. Sci. Health Part A, 42: 2139-2146. https://doi.org/10.1080/10934520701629617.
[4] Kvarnstrom, E., C. Morel, J. Fardeau and J. Morel, 2000. Changes in the phosphorers availability of a chemically precipitated urban sewage sludge as a result of different dewatering processes. Waste Manage. Res., 18: 249-258. https://doi.org/10.1034/j.1399-3070.2000.00116.x.
[5] Manaham, S.E., 2005. Environmental Chemistry. 8th Edn., Lewis Publisher, Boca Raton, Florida, ISBIV 1566706335.
[6] NEQS 2000 National Environmental Quality Standards http://epd.punjab.gov.pk/system/files/National_Environmental_Quality_Standards_for_Municipal_and_Liquid_Industrial_Effulents.pdf
[7] Trichopoulos, D., 2001. Epidemiology of Cancer. In: Cancer: Principles and Practice of Oneology, Re Vita, V.T. (Ed). Lippincott company, Philadelphia, ISBN: 0-781-72229-2, PP: 231-258.
[8] Turkdegan, M.K., Kilicel, K. Kara and I. Tuncer, 2002. Heavy metals in soil, vegetables and fruits in the endmic upper gastrointes tiral cancer region of Turkey. Environ. Toxicol. Pharmacol., 13: 175-179.
[9] WHO Air Quality Gidelines, World Health Organization Europe Regional office, Copenhagen, 2nd ed. 2000.
[10] Wilson, B. and F.B. Pyatt, 2007. Heavy metal dispersion, persistence and bioaccumulation around and ancient copper mine situated in angleses......... UK. Ecotoxicol. Environ. Safety, 66: 224-231.
[11] Zorpas, A.A., U.J. Inglezais and M. Loizoidou, 2008. Heavy metals fractionation before, during and after composting of sewage sludge with natural zeolite Waste Manage. 28. 2054-2060.