Investigation of Heavy Metal Concentration in Effluent of Dyeing Industry

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Abstract

The city of Bhiwandi is famous for its textile industries which are both a boon and a bane to the people living in and around this area. The textile industry is the main source of pollution of ground water. The waste streams from the wet processing operations of the textile industry such as scouring, bleaching, dyeing and printing are very harmful. These chemical processes discharge chemicals in to the water causing pollution in the water which disturbs the normal functioning of living organisms present in the water. The waste water effluents of two dyeing industries were collected to determine the heavy metal concentrations. Spectroscopic studies were carried out for metals like Copper and Zinc. Results indicate that Copper in the industrial effluent water samples was found to be greater than the standard values prescribed by standard bodies making it hazardous for health. The Zinc content was found to be negligent making it safe to be used for agricultural purposes.

Keywords: Dyeing Industry, Effluent, Heavy Metal, Spectroscopy.

Introduction

Pollution of water due to discharge of industrial and domestic effluents are creating serious threats to the human population. This topic has been chosen as it deals with the study of concentration of Copper and Zinc metals in effluent water samples procured from two different dyeing industries in Bhiwandi city. These metals have been selected because at higher concentrations these harmful metals become toxic to animal and human beings. These heavy metals through the ground water get mixed with the water reservoirs which may or may not be the source of drinking water. Due to the indiscriminate use of these metals in different chemical industries for different chemical process, the level of heavy metals gets increased in the ponds, lakes, rivers and oceans. These heavy metals have a tendency to get concentrated from one tropic level to another tropic level in the food chain. As the food chain gets disturbed, the entire aquatic ecosystem gets destroyed by the metal toxicity. Heavy metal toxicity thus becomes significant not only among the scientific community consisting of biologists, environmentalists and chemists but also among the human population who have some basic knowledge about the harmful effects of heavy metals [1].

Some heavy metals are significant and important for human metabolism functioning but at high concentration it leads to various adverse health effects. It is also a fact that Mercury, Cadmium, Lead and Arsenic are the most toxic metals that are deficient in any crucial belongings and absorption of these heavy metals over a period of time can lead to debilitating illness. Hence the development of novel, specific, selective and sensible techniques for the determination of heavy metals is currently receiving considerable attention [2].

Health and welfare of humans are affected by factors like industrialization. Industrial factories with several production processes and usage of raw and synthetic materials produce other unwanted harmful and toxic byproducts like waste water, solid waste and pollutant gases. Heavy metals of the toxic

materials that exist in many of the industrialized products can potentially cause cancer and have adverse effects on physical and psychological life of human beings [3].

Textile processing is a general term that covers various processes ranging from singeing (protruding fiber removal), desizing, bleaching and dyeing to finishing and printing of fabric. Bleaching is a process to make the fabric or yarn look brighter and whiter. Dyeing is a process of applying coloring matter directly on fiber without any additives. Finishing is the final process to impart the required end use finishes to the fabric. The last process which involves printing on fabric is considered to be a science as well as an art. Textile auxiliaries such as chemicals are used for all stages of the textile manufacturing process that is from pre-treatment to dyeing and printing and finishing.

The textile industry occupies a leading position in the hierarchy of the Indian manufacturing industry. It has witnessed several new directions in the era of liberalization. While textile exports are increasing and India has become the largest exporter in world trade in cotton yarn and an important player of readymade garments, the country's international textile trade constitutes a mere 3% of the total world textile trade. Several mills have opted for modernization and expansion and are going in for export-oriented units (EOUs) focused on production of cotton yarn. It has passed through cyclical oscillations and at present, it is witnessing a recovery after a downturn [4].

Experimental Work

This study has been carried out on two different dyeing industries of Bhiwandi city, District Thane, Maharashtra. A detailed survey has been done and waste water effluent samples were collected in the afternoon periods between 12.0pm to 1.0pm. The samples of dyeing industrial effluents were collected in a one liter capacity container. (The container was initially washed with distilled water then with 3.0% nitric acid solution, rinsed with distilled water and then kept for complete drying in an oven at 30-35^{0}C). The samples were brought immediately to the laboratory and then analyzed for heavy metal content (on the same day of sampling) [5].

Material and Methods

Zinc and Copper were determined by UV-Visible spectrophotometry by the following method: 0.0393gm copper sulphate was dissolved in 1000ml distilled water to form 100 ppm solution of Copper. From this solution series of various concentrations of Copper is prepared. Copper forms yellow coloured complex with sodium diethyl dithiocarbamate. All the samples thereby formed yellow complex. This yellowish brown coloured complex was extracted in chloroform using a separating funnel. Lower organic layer (yellowish brown in colour) was first removed from the separating funnel; the upper aqueous layer was discarded. Organic layer was then transferred back to the separating funnel. To this organic layer, 5% H_2SO_4 was added and solution was agitated. The yellowish brown layer becomes more distinct due to this washing with 5% H_2SO_4. The absorbance of this organic layer was measured on a Spectrophotometer at 435nm. Blank was also given the same treatment. 2.0844 gm Zinc Chloride was dissolved in one liter of distilled water to prepare a solution containing 100 ppm of Zn from which various concentrations of standard solution of Zinc were prepared. The pH is maintained at 4.0 by addition of buffer solution of pH 4.0 (at this pH Zinc metal reacts with the complexing agent dithizone). Sodium thiosulphate is added to remove the interferences. To this solution 10 cm^3 of dithizone in chloroform is added which immediately forms a purple coloured Zn-Dithiozonate complex. This purple coloured organic layer is removed from the separating funnel and to the aqueous phase fresh dithizone in chloroform is added to extract the remaining amount of zinc. All the extracted Zinc present in the organic layer is taken together diluted to

volume and absorbance determined spectrophotometrically at 530nm. Blank was also given the same treatment [5, 6].

Observations

Determination of Copper:

Copper was determined by calibration curve method as follows:

Table 1: Calibration curve for Copper

Sr. No.	Concentration of Copper in ppm	25% Aqueous Citric Acid	Liquor Ammonia	4%EDTA	0.2% Aqueous Na-DDC	OD
01	Blank	5.0	2.0	15.0	10.0	0.00
02	10.0	5.0	2.0	15.0	10.0	0.795
03	15.0	5.0	2.0	15.0	10.0	1.194
04	20.0	5.0	2.0	15.0	10.0	1.610
05	25.0	5.0	2.0	15.0	10.0	2.100
06	30.0	5.0	2.0	15.0	10.0	2.596

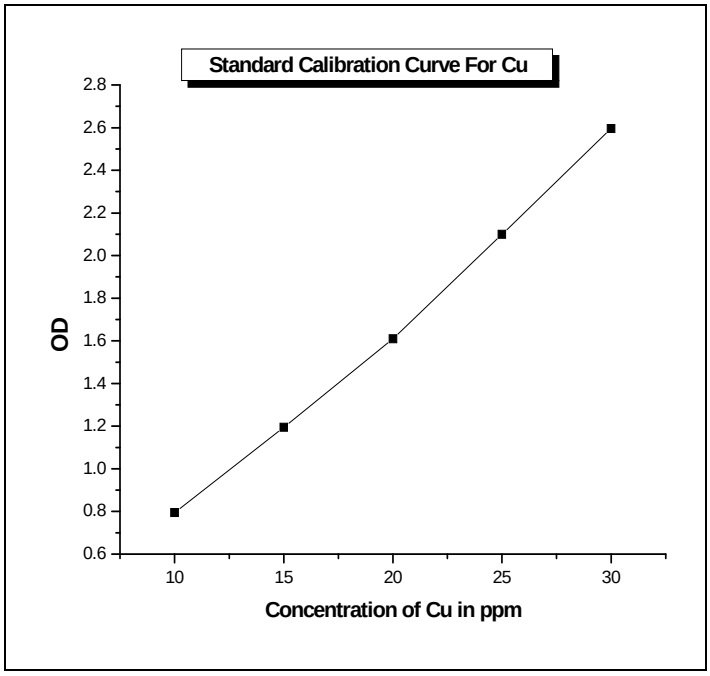

Figure 1: Graph of OD Vs Concentration of Copper in ppm

Table 2: Amount of Copper in effluent water samples

Sr.No	Dyeing Industrial Effluents	Concentration of Copper (ppm)
01	Effluent I	6.20
02	Effluent II	5.00

The following graph indicates the comparative study of copper metal concentration in the effluent water samples collected from two different dyeing industries.

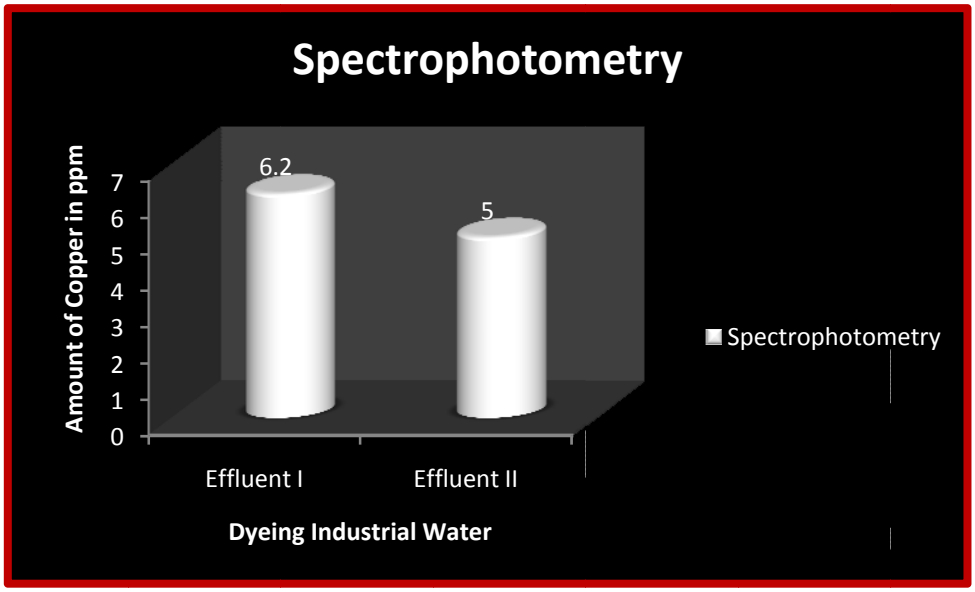

Figure 2: Concentration of Copper in effluent water samples

Determination of Zinc

Zinc was determined by calibration curve method as follows:

Table 3: Calibration curve for Zinc

Sr.No.	Conc. of Zn in ppm	Acetate buffer pH=4 in ml	25% Sodium Thiosulphate in ml	Dithizone (ml) 100mg/1000ml Chloroform	OD
01	0.0	5.0	1.0	10.0	0.00
02	5.0	5.0	1.0	10.0	0.009
03	10.0	5.0	1.0	10.0	0.490
04	15.0	5.0	1.0	10.0	1.240
05	20.0	5.0	1.0	10.0	1.801

Results and Discussion

The amount of Copper in the industrial effluent water samples were found to be greater than the standards provided for Irrigation (0.20ppm). It was also found to be greater than the standard limits provided by the PCD (Not more than 2.0 ppm). The amount of Zinc in the industrial effluent water samples were found to be less than the standards provided for Irrigation (2.0ppm). The amount of Zinc in both industrial effluents was zero. The dyeing mill effluent water is thus found to be safe for irrigation purpose with respect to Zinc metal pollutant. The concentration of zinc found to be less than the standards provided for PCD (Not more than 5.0 ppm).

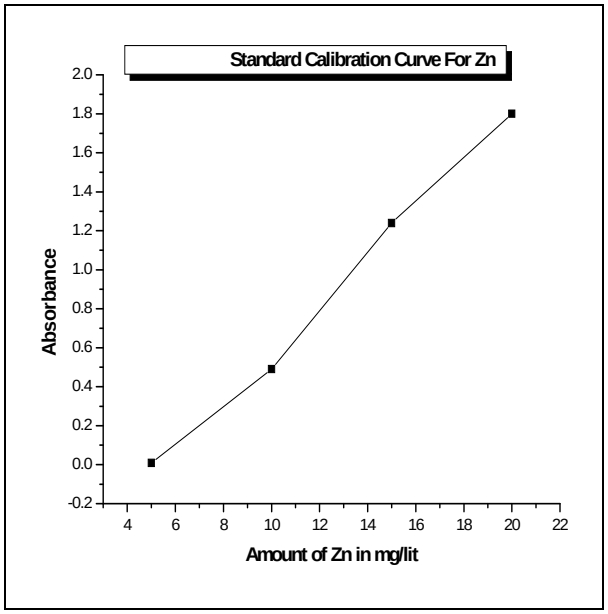

Figure 3: Graph of Absorbance against amount of Zinc in ppm

Table 4: Amount of Zinc in effluent water samples

Sr.No	Dyeing Industrial Effluents	Concentration of Zinc (ppm) in Industrial Effluent
01	Effluent I	0.00
02	Effluent II	0.00

Table 5: Quality of Industrial Effluent with the Standard Limits and Guidelines

Sr.No.	Parameters	Central Government , Environment Protection Rule 1986, For Dye Industry			
		Disposal in surface water	Disposal in Marine water	On Land for Irrigation	Public Sewer
1	Copper	2.0	3.0	-----	3.0
2	Zinc	5.0	15.0	--------	15.0

Conclusion

It is important to carry out such heavy metal analysis as it concerns the health of human beings. Industrial activities released heavy metals (understudy) into the water bodies were confirmed by carrying out the analysis. It was found that effluent water samples collected from dyeing industry in Bhiwandi city were contaminated. When this water is discharged into the water reservoirs, the industrial activities deteriorated the aqua quality rendering water not fit for use by human beings. These industrial activities cannot be stopped completely but awareness could be generated regarding the pollution and measures could be suggested to reduce the pollution. Both the dyeing effluent water samples were free from zinc metal toxicity and were found to be safe for irrigation purposes. However the concentration of copper is high which indicates copper toxicity in the water reservoir in which this effluent water gets mixed. This could lead to various water borne diseases in the human population who consume the water from this reservoir.

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