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Study of metal content by absorption spectroscopy

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Abstract
Fast progress in the textile dyeing industry and direct discharge of the effluents in to sewage connections leads to pollution masses on the water reservoir. This study was carried out to examine the water quality of dyeing industry effluents of Bhiwandi city. The analyses of effluents have been carried out to find out the concentration of heavy metals such as Cadmium and Lead and to determine what toxic effects it could cause if the concentration of these heavy metals goes high. Detection of heavy metals has been carried out by spectroscopic technique by measurement of absorption of coloured complexes. The amount of cadmium and lead are found to be greater than the standard values provided by standard body. It is therefore suggested that the careless release of the dyeing effluents should be discouraged and suitable managing systems should be in use to reduce the water pollution for saving the environment.

Keywords: effluent, lead (Pb), cadmium (Cd), pollution, spectroscopy

1. Introduction

For this research problem a dyeing mill industries of Bhiwandi city, District Thane, Maharashtra have been selected. A brief introduction about the history of Bhiwandi city is given as: Bhiwandi is in the district of Thane, in the western state of Maharashtra, India, located 60 km to the north – east of Thane [on the Mumbai – Agra highway].

The city of Bhiwandi, known in the early twentieth century was a small town inhabited by Maharashtrian and Konkani Muslims. The main occupation of the people at that time was agriculture, fishing and handloom. With the advent of electricity the hand loom began to be fast replaced by power looms and the city became famous for its hand loom, carpets and silk fabrics resulting in the flourishing dyeing mill industry. The economy of Bhiwandi is mostly dependent on the power loom industry.

Of the various textiles, cotton is ecologically friendly, but more than 50% of its production volume is dyed with reactive dyes. Unfortunately, dyes are unfavorable from an ecological point of view, because the effluents generated are heavily colored, contain high concentrations of salts, and exhibit high chemical oxygen demand (COD) values. In the dyeing textile industry, ecological standards are strictly applied throughout processing from raw material selection to the final product. This has become more critical since the German environmental standards regarding dye effluents became effective. The main challenge for the textile industry today is to modify production methods, so that they are more ecologically friendly at a competitive price, by using safer dyes and chemicals and by reducing cost of effluent treatment/disposal [2].

In textile and paper coloration industries synthetic dyes from residual dye baths are released in to waste streams. It is estimated about 10-15% of dyes goes unused in textile effluents containing the organic dye, account for up to 70% of all textile dyestuffs produced and are the most common organic compound in reactive dyes. The reactive organic dyes-containing effluents from industries have caused serious environment pollution because the presence of dyes in water is highly visible and affects their transparency and aesthetics even if the concentration of the dyes is low. Most of these dyes are toxic and potentially carcinogenic and their removal from industrial effluents is a major environmental problem. In mammals most of the dyes are reduced to harmful reductase. Therefore, industrial effluents containing dyes must be treated before their release into the environment. Many physical and chemical methods including adsorption, coagulation, precipitation, and oxidation have been used for the treatment of organic dye-contaminated effluents [6].

The textile industry is one of the industries that generate a high volume of waste water. Approximately 10, 000 different dyes and pigments are manufactured worldwide with a total annual market of more than 7×10^5 metric tons per year. In India textile is one of the oldest establishments with nearly 1569 large cotton textiles industries, which gives employment to nearly thirty million people. India is the second largest exporter of dyestuffs, where ~ 80,000 tons of dyes and pigments are produced annually. There are over 100, 000 varieties of dyes such as acidic, basic, reactive azo dyes etc available in the market. The textile dye effluent consists of heavy metals such as Cadmium, Lead and Zinc either as free ionic metals or complex metals. This textile dye effluents cause serious environmental problems in receiving water bodies like streams, rivers and lakes etc by absorbing light and ultimately interfering with aquatic biological processes. The water containing textile effluent when used for irrigation contains heavy metals like Cadmium (Cd), Lead (Pb) and Zinc (Zn), which accumulate in various parts of plants. This results in various clinical problems in animals as well as in human beings who consume these plants including hepatic and renal system damages, mental retardation and degradation of basal ganglia of brain [3].

Materials and Method

This study has been carried out on effluent water samples collected from two different dyeing industries of Bhiwandi city, District Thane, Maharashtra. A well planned and strategic survey was carried out initially.

Dyeing industrial effluent samples were collected in the afternoon period between 12.00 noon and 1.00 p.m. in one liter capacity containers. The container is washed with distilled water then with 3.0% nitric acid solution, again rinsed with distilled water and then kept for complete drying in an oven at 30-35^{0}C. The collected effluent water samples were brought to the laboratory immediately and then analyzed for heavy metals on the same day of sampling [1].

Cadmium and Lead were determined by UV-Visible spectrophotometry by calibration curve method:

Cadmium

Standard solution of Cadmium was prepared by dissolving 68.4 milligram $CdSO_4$ in one liter of distilled water. From the above standard solution, a series of standard solutions were prepared. All the standard solutions and effluent water samples were treated with a complexing agent, Ditizone in the alkaline medium. Cadmium reacts with Dithizone in Chloroform, in the alkaline media to form pinkish orange coloured complex of Cd-Dithiozonate. Absorbance of this coloured complex was measured spectrophotometrically at 530nm against blank.

Table 1: Determination of Cadmium

Sr. No.	Conc. of Cd(II) in ppm	Trisodium Citrate in gms	0.1M NaOH	Dithizone (100mg/100ml Chloroform) Soln in ml	Chloroform in ml
01	0.00	0.1	7 to 8 Drops of NaOH is added to make pH between 9-11	7.5	17.5
02	Increasing concentration of Cd	↓		↓	↓

Lead

Standard solution of lead was prepared by dissolving 6.7 milligram of Lead Chloride in one liter of distilled water. From the above standard solution, a series of standard solutions were prepared. All the standard solutions and effluent water samples were treated with a complexing agent Dithizone in the alkaline medium. Lead metal reacts with Dithizone in Chloroform, in the alkaline media to form red coloured complex of Pb-Dithizonate. Absorbance of this red coloured complex was measured spectrophotometrically at 510 nm against blank [1, 7].

Table 2: Determination of Lead

Sr. No	Conc. of Pb in ppm	Liquor ammonia in cm^3	4%EDTA in cm^3	0.005% Dithizone In cm^3	$CHCl_3$ in cm^3
01	Blank	50	20	7.5	17.5
02	Increasing concentration of Pb	↓	↓	↓	↓

Cadmium and Lead is analyzed in alkaline medium by using Dithiozone, Spectrophotometrically [1, 7].

Results and discussion:

The following heavy metals were determined in two different industrial effluents:

Table 3: Analysis of Industrial Effluent I

Sr. No.	Parameters	Amount in ppm
01	Cadmium	1.0
02	Lead	0.250

Table 4: Analysis of Industrial Effluent II

Sr. No.	Parameters	Amount in ppm
01	Cadmium	1.0
02	Lead	0.100

Determination of Cadmium

Cadmium was determined by calibration curve method spectrophotometrically.

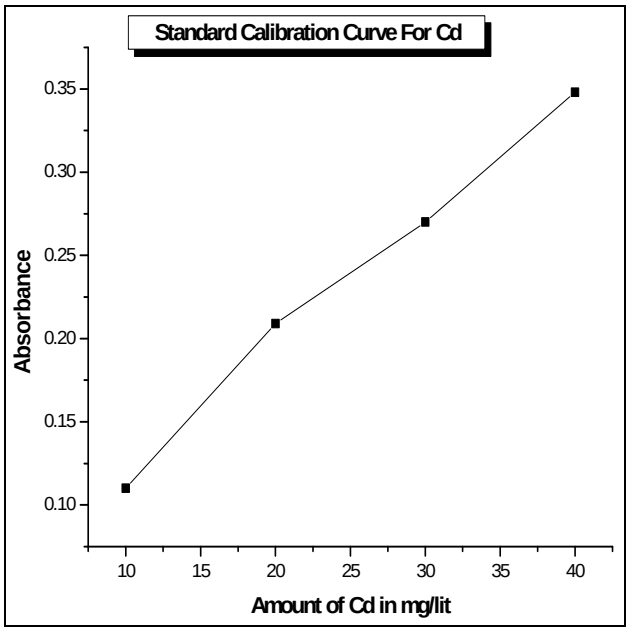

Fig 1: Graph of Absorbance against amount of Cadmium in mg/lit

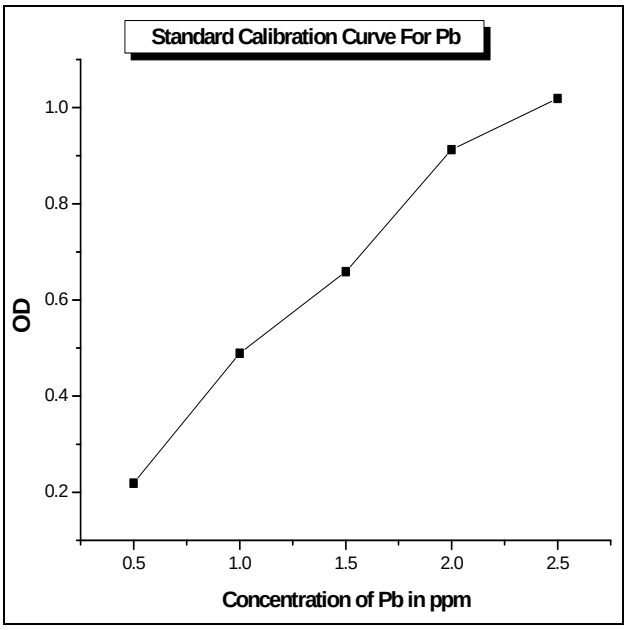

Fig 2: Graph of OD Vs Concentration of Pb in ppm

Table 5: Amount of Cadmium

Sr. No	Dyeing Industrial Effluents	Concentration of Cadmium (ppm)
01	Effluent I	1.0
02	Effluent II	1.0

Maximum permissible limit of Cadmium in industrial water is not more than 0.03ppm according to Pollution Control Board. The amount of cadmium in both the industrial effluents is found to be greater than the standard values. As this water gets mixed in the water body, it causes cadmium pollution in water. This in turn leads to various diseases in human beings who consume this water and fish caught from this water reservoir [5].

Lead: Lead was determined quantitatively by calibration curve method.

Table 6: Amount of Lead

Sr. No	Dyeing Industrial Effluents	Concentration of Pb (ppm)
01	Effluent I	0.250
02	Effluent II	0.100

The amount of Lead in the industrial effluent water samples were found to be greater than the standards provided for PCD (Not more than 0.2ppm). The amount of lead in both the industrial effluents is greater than the standard values. As this water gets mixed in the water body, it causes lead pollution in water. This in turn leads to various diseases in human beings who consume this water and fish caught from this water reservoir

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

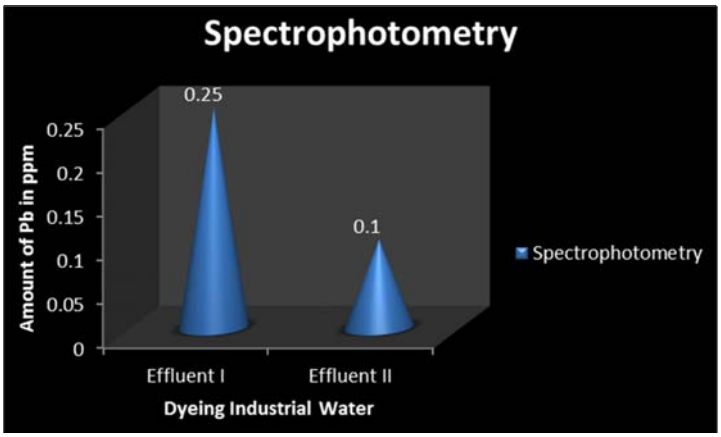

Fig 3: Concentration of Lead

Table 7: Quality of Industrial Effluent and the Techniques used with the Standard Limits and Guidelines.

Sr. No	Parameters	Technique used	PCD Standards
1	Lead	Spectrophotometry	Not more than 0.2 mg/l
2	Cadmium	Spectrophotometry	Not more than 0.03 mg/l

Table 8: Quality of Industrial Effluent with the Standard Limits and Guidelines

Sr. No.	Parameters	Central Government, Environment Protection Rule 1986, for Dye Industry			
		In ppm Unit			
		Disposal in surface water	Disposal in Marine water	On Land for Irrigation	Public Sewer
02	Lead	0.1	2.0	--------	1.0
03	Cadmium	0.2	2.0	--------	1.0

Conclusion

It is important to carry out such heavy metal analysis as it concerns with the health of human beings. By carrying out such analyses, we have confirmed that industries released the effluents containing the heavy metals directly into the water bodies.

It was found that effluent water samples collected from Dyeing industry in Bhiwandi city was contaminated. Industrial activities deteriorated the aqua quality rendering water not fit for the use by human being, when it is discharged in to the water reservoir. These Industrial activities cannot be stopped completely but awareness could be generated regarding reduction in pollution. With respect to concentration of cadmium and lead, both industrial effluent water samples are not safe for irrigation purpose. It also indicates increase in the cadmium and lead toxicity in the water reservoirs in which this effluent water get mixed. This leads to various water borne diseases in the human population.

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