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Study of Vanadium as Peroxy Complex Spectrophotometically

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Abstract

There are different textile and dyeing industries in the Bhiwandi city, District Thane, Maharashtra. The Bhiwandi city is famous for fabrication, dyeing and bleaching, printing, finishing of cloths and fabrics due to which textile and dyeing industries are very famous in this city. Textile industries consume large quantity of water and in turn generate huge amount of waste water which are saturated with different types of pollutant and heavy metals. In present study the vanadium which is a heavy metal is analyzed spectrophotometrically by forming peroxy complex with hydrogen peroxide. The current experimental work yielded a higher level of this metal than the typical value. As a result, it was determined that textile effluents are not suitable for disposal into water reservoirs without treatment in terms of Vanadium metal pollution.

Keywords: Vanadium, Industrial Waste Water, Spectrophotometer.

Introduction

Waste water discharged from the textile industries contain many heavy metals, chlorine, toxic contaminants that leads to decrease in the level of micro organisms stabilizing the waste in the water and destroy the characteristics of these micro organisms which are responsible for cleanliness by some biological processes in water and thus decreasing the level of oxygen which is called as oxygen depletion. This result in destroy of aquatic ecosystem and self purifying tendency of water reservoirs. These all things are due to discharge of untreated textile waste effluent unconsciously in to water bodies causing dangerous environmental damages[1].

Large quantities of water and energy are consumed in the textile finishing and dyeing industry. Textile industries utilizes huge quantity of dyes around one lakh and produces seven lakh of product. But around 15% of the dyes goes as a waste every year through textile dyeing and finishing industries. Large amount of water is required for dyeing, finishing and other different processes that takes place in textile industries , in turn huge amount of water are discharged as a waste which contain dyes which are left or not properly absorbed, adsorbed or reacted with the fabrics. This effluent water contain many organic and inorganic contaminants that are detrimental along with this, heavy metals are also present in effluent water. This all contaminants are either non biodegradable or undergoing very slow biodegradation, they are persistent to light, temperature microbial attack and detergent. So they remain persistent in water and they damage whole ecosystem and environment. They have a tendency to get accumulated in living organisms called as bioaccumulation and causes long term damage that is chronic toxicity in human being, those who comes in contact with this contaminated water which are discharged in to big water reservoir.

Maximum quantity of water is been consumed by the cotton substances. The printing and dyeing industries which uses cotton as substrate generally utilizes the reactive and active dyeing reagents. Out of total consumption of dye nearly 18 to 28% consumption is represented by these dyes[2,3]. The dye reacts chemically with the fibre, forming a covalent link with oxygen, nitrogen, or sulphur atoms in the fibre in the form of amino, hydroxyl, or thiol groups. In the dyeing industry, due to the parallel hydrolysis process, a large percentage of non-reactive dyes are not fixed to the fibres. The reaction between the dye and the fibre is a competitive process in this reaction. As a result, once the dyeing process is completed, the residual bath has a specific concentration of dye in its hydrolyzed form, which is no longer able to react with the fibre and is washed away[4].

Vanadium (V) is an essential trace element in both humans and animals, and it plays a role in increasing the level of blood plasma and cell function, lowering glucose levels in blood, protecting islet cells, reducing blood cell dyeing functions. However, too much vanadium in the body can be harmful to the respiratory, circulatory, urinary, blood, and digestive systems. Vanadium overexposure has been linked to reproductive and developmental toxicity, as well as cancer. However, the impact of long-term vanadium exposure from potable water on the inner nervous structure is not known. Vanadium is extensively utilised in the chemical industry, refining and smelting, weld machine, medium, dye, batteries, and for preservation due to its unique physical and chemical qualities. During mining and metal manufacturing, compounds of vanadium will be taken in body via the process of respiration, cutaneous, and/or digestion systems. Pollution of the environment is caused by the release of waste gas, residue, and industrial waste water.

As a result of waste gas, residue, and industrial waste water discharge, large amounts of vanadium are discharged into the water, land and air. In our daily lives, we add to the environmental vanadium load by using gasoline, coal, and other fuels, resulting in vanadium-related pollution and occupational dangers. Vanadium exposure has been linked to cognitive deficits, altered neurobehavioral function, and a decrease in spatial learning ability, according to new findings. The mechanisms that cause these adjustments, on the other hand, are unknown. The striatum, as a major component of the basal ganglia, not only regulates voluntary movement but also receives a wide range of sensory and cognitive input, which influences learning and memory[5].

Materials and methods

Three sampling area that is the dyeing industries selected for this research work and sampling of effluent water done during afternoon period. Sample stored in a plastic container which is previously washed, rinsed and completely dried in order to prevent the contamination of samples[6,7]. This sample is then used for analysis of Vanadium metal. Vanadium is estimated spectrophotometrically by forming a complex with H_2O_2 at two different wavelengths.

Statistical Analysis: Statistical analysis is been done with respect to determination of various statistical parameters which are mentioned in result and discussion.

Results and discussion

From Table-4 it is clear that obtained value from present experiments are in the range of 3.315mg to 3.321mg but no any specific values are provided by the NSDQW and WHO for Vanadium metal concentration. From Table-5 it is clear that obtained value from present experimental work (3.315mg to 3.321mg) are greater than the standard values (permissible value) provided for discharge in to Inland surface water, Public Sewers and Marine coastal areas that is 0.2ppm. From Table-6 it is clear that obtained value from present experimental work (3.315mg to 3.321mg) are greater than the recommended maximum concentration (mg/L) as per FAO guidelines (0.10ppm).

From Table-7 it is clear that obtained value from present experimental work (3.315mg to 3.321mg) are greater than the Jordanian Standard Ground water discharge (0.1ppm). From Table-8 it is clear that Obtained value from present experimental work (3.315mg to 3.321mg) are greater than the maximum permissible value set by Jordanian Standard (0.1ppm). From Table-9 it is clear that the amount of Vanadium obtained by present research work is very greater than the amount of vanadium required by human body. From Table-10 it is clear that Amount of Vanadium obtained are further greater than the standard values for discharge in to fresh water and sea water.

Table-1: Vanadium Estimation.

Vanadium metal in ppm	Amount of sulphuric acid in (cm^3)	Amount of hydrogen peroxide in (cm^3)	Total dilution(cm^3)	Absorbance at	
				410 nm	460 nm
2.0	25.0	3.0	100.0	0.048	0.042
3.0	25.0	3.0	100.0	0.049	0.043
4.0	25.0	3.0	100.0	0.050	0.044

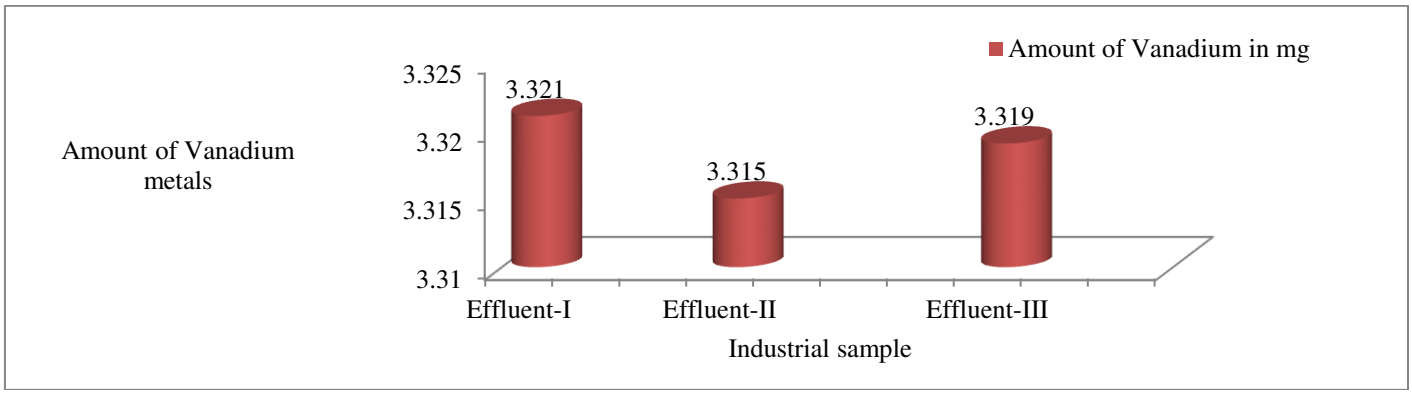

Figure-1: Amount of Vanadium Metals.

Table-2: Analysis of Statistical Parameters.

Dyeing Effluent	Amount of V in mg	Mean	Median	Mode	Max	Min	Error	SD	Avg. Deviation	Variance
I	3.3328	3.321467	3.3275	NA	3.3328	3.3041	5.35137 E-07	0.015272	0.011577778	0.000233
	3.3275									
	3.3041									
II	3.4401	3.315333	3.3512	NA	3.4401	3.1547	6.99749 E-06	0.146041	0.107088889	0.021328
	3.1547									
	3.3512									
I	3.3604	3.319867	3.2996	NA	3.3604	3.2996	1.05521 E-06	0.035103	0.027022222	0.001232
	3.2996									
	3.2996									

Table-3: Level of Heavy Metals in Textile Sample Water.

Sr. No.	Sample	Concentration of Vanadium in mg
1	Effluent-I	3.321467 ± 0.015272
2	Effluent-II	3.315333 ± 0.146041
3	Effluent-III	3.319867 ± 0.035103

Table-4: Adopted from (WHO) and (NSDQW) water quality guidelines for Vanadium[8].

Acceptable limit for drinking water		Acceptable limit for discharge into stream		Obtained value
NSDQW standard ppm	WHO standard ppm	NSDQW standard ppm	WHO standard ppm	
Not specified	Not specified	Not specified	Not specified	3.315mg to 3.321mg

Table-5: Standard value of Vanadium[6,9].

Standard value of Vanadium				Obtained value
Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas	
0.2ppm	0.2ppm	----	0.2ppm	3.315mg to 3.321mg

Table-6: FAO guideline[10].

Recommended maximum concentration	
Suggested Upper Limit	Comment
0.10ppm	Toxic to many plants at relatively low concentrations

Table-7: Jordanian Standard[10].

Discharge to streams, Wadis and water storage areas	Ground water discharge
0.1ppm	0.1ppm

Table-8: Jordanian Standard[10].

(Value in milligrammes per litre (mg/L) (prescribed value)
0.1

Table-9: Standard values of Vanadium Metal[11].

Consumption from meals on a daily basis	Concentrations in tap water per 2 litres of water consumed/day	Consumption from tap water for people on a daily basis
0.01 to 0.02 mg	0.001 mg/L	0.002 mg

Table-10: Standard values of Vanadium[12].

In fresh water	In sea water
0.2 to more than 100 µg/litre	0.2 to 29 µg/litre

Conclusion

The level of vanadium in water depends on the geographical position and ranges. In the global circulation, the main source of vanadium metal is ocean floor but due to discharge of these textile industrial effluent the concentration of Vanadium metal further get increased in ocean that get the water from different water bodies. The values of Vanadium obtained by present research work in effluent waste water which are going to be discharged in to water reservoir, contaminating whole water bodies. The amount of Vanadium metal in textile effluent waste water is greater than permissible value set by various standard bodies for discharge in to inland water, surface water, ground water. The obtained values are also greater than the quantity of Vanadium which is required for normal functioning of human physiology.

Therefore these dyeing industries are not safe with respect to vanadium metal pollution and when such effluent water through drainage or by any other way find their way in to the lake, pond, river, sea or any other water reservoir then it contaminate the whole water bodies, if this water reservoirs are used for the drinking purpose or if it provides the source of edible fishes then the consumer of this contaminated water and fish get affected by this metal contaminants and it leads to various disease and disorder in human being or any other living organisms.

Therefore it is recommended that before discharge of textile dyeing effluents in to water bodies it should be treated carefully so that there will be less chances of contamination and heavy metal pollution. Awareness should also be created among the people regarding the harmful effect of heavy metal pollution and the necessary precaution which are required to get rid of this pollutants.

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