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Dispersion of heavy metals in textile effluent and pond environment in Panipat industrial area

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Abstract

The Panipat region is well known textile industrial zone of Northern India and have a large number of dye houses and textile processes units. The dyeing house industries uses a large volume of water for wet dip coloring process and draine most of the waste water as effluent. The effluent containing composite mixture of different pollutant in terms of heavy metals. Metal accumulation in sediments provides a record of the spatial and temporal history of pollution from surface water to ground water. The dispersion of heavy metals from textile effluents to adjoining pond system ultimately affect quality of water. The present study revealed that pond sediment found highly polluted regarding heavy metals load. Transfer factor for Fe, Mn, Ni and Pb was found very high in pond through open effluent drainage system.

Keywords :– *Textile effluent, Heavy metals, Pond sediment, Aquatic environment*

Introduction

Textile industries consume large volume of water of high purity and discharge large quantities of effluent that normally exhibit polluting characteristics. Approximately, 40,000 different dyes and pigments are used in the industry and over 7×10^5 tons of these dyes are produced annually worldwide (Zollinger, 1987). 10-15% of the dyes used in textile processing were lost in the effluent during the dying processes (Vaidge and Datye, 1982). The effluents from dye industries contain high amount of cation, anion, organic pollutants in the form of colour and heavy metals. Both natural processes and anthropogenic activities are responsible for introducing metals in to the aquatic system. Many contaminants discharged into surface water rapidly become associated with the particulate matter and incorporated in sediments. Metal contaminated sediments may release heavy metals back to the overlying water column and, thus, pose risk to aquatic life and ecosystems (Forstner and Wittman, 1981).

Composite effluents from textile industries and dyeing houses of Panipat industrial area normally discharged openly into a common effluent drain without any adequate treatment and commences in a large pond near Binjhole village near to industrial area, which may change the quality of bottom sediments of drain and pond sediment and the physico-chemical characteristics. Sediments reflect the current quality of the water system and can be used in detecting the presence of contaminants that do not remain soluble after discharge into surface water (Forstner, 1985). As a result of complex physical, chemical and biological processes a major fraction of heavy metals are found to be associated with bottom sediments (Baruah *et al.,* 1996). Metal accumulation in sediments provides a record of the spatial and temporal history of pollution. Hence, sediment monitoring can provide important information on various pollution events.

Materials and Method

Geographically, Panipat city is situated between 29º 09' 50" and 29º 50' North latitude and 76° 31' 15" and

77° 12' 45" East longitude with altitude of 255 msl. Panipat town is located on the National Highway no.1 about 90 km toward north of Delhi has a population of about 0.27 million. Study point (Textile Dye houses) in Panipat city is situated on Jatal road in industrial area near GT Road. The effluent samples were collected from common effluent drain and surface water samples were collected from a pond of village Binjhole situated near industrial area, where the effluent drain ends up and delay for a long time. Sediment samples were collected from the bottom of pond. All the samples were collected and preserved for further analytical work. All samples were analyzed by the standard methods (APHA, 1995) and Trivedi and Goel (1984). Transfer factor between textile effluents and surface water was calculated for each metal according to Lokeshwari and Chandrappa (2006).

Results and Discussion

The concentrations of heavy metals in water samples from effluent drain, pond water and pond sediment are presented in Tables-1, 2 and 3 respectively.

Table-1: Seasonal variations of heavy metals in textile effluents (in ppm)

Heavy metals	Pre-monsoon		Monsoon		Post-monsoon	
	Mean	SD	Mean	SD	Mean	SD
Cd	0.052	0.042	0.025	0.037	0.012	0.008
Cu	0.440	0.085	0.343	0.058	0.165	0.066
Fe	0.527	0.093	0.253	0.130	0.266	0.079
Mn	0.153	0.050	0.127	0.047	0.224	0.072
Ni	0.037	0.016	0.016	0.015	0.031	0.013
Pb	0.500	0.207	0.250	0.085	0.422	0.133
Zn	0.173	0.059	0.110	0.012	0.238	0.132

Table-2: Seasonal variations of heavy metals in pond water (in ppm)

Heavy metals	Pre-monsoon		Monsoon		Post-monsoon	
	Mean	SD	Mean	SD	Mean	SD
Cd	0.009	0.001	0.001	0.002	0.004	0.002
Cu	0.427	0.045	0.397	0.136	0.252	0.084
Fe	9.700	3.035	4.233	1.450	4.820	2.961
Mn	0.530	0.061	0.463	0.070	0.172	0.062
Ni	0.127	0.025	0.073	0.033	0.054	0.045
Pb	1.800	0.557	0.610	0.412	0.504	0.364
Zn	0.156	0.031	0.110	0.020	0.158	0.066

Transfer factor values of all metals are depicted in Table-4. Cadmium concentrations in textile effluent (0.005-0.052 ppm) and pond water (0.001-0.012 ppm) turn down in rainy season due to the dilution factor. Cadmium slightly fluctuated and remains mostly constant in pond sediment (4.0-5.7 ppm). Cadmium transfer is due to some other non-point sources of cadmium pollution. During the last decade, the industrial use of Cd has increased and can create both acute and chronic cases of clinically identifiable

Table-3: Seasonal variations of heavy metals in pond sediments (in ppm)

Heavy metals	Pre-monsoon		Monsoon		Post-monsoon	
	Mean	SD	Mean	SD	Mean	SD
Cd	5.717	0.451	4.780	0.455	4.054	0.595
Cu	51.520	5.098	43.880	6.877	43.834	7.332
Fe	5640.333	2179.050	4312.667	463.092	6013.400	856.579
Mn	942.000	48.135	724.000	56.471	836.400	38.708
Ni	63.667	8.083	52.333	9.074	52.800	3.768
Pb	69.000	6.245	55.333	9.292	44.000	5.385
Zn	240.000	92.601	142.333	59.341	123.200	42.032

Table-4: Transfer factor for heavy metals from textile effluent to pond water

Heavy metals	Pre-monsoon	Monsoon	Post-monsoon
Cadmium (Cd)	0.17	0.05	0.32
Copper (Cu)	0.97	1.16	1.53
Iron (Fe)	18.42	16.71	18.12
Manganese (Mn)	3.46	3.66	0.77
Nickel (Ni)	3.39	4.52	1.74
Lead (Pb)	3.60	2.44	1.19
Zinc (Zn)	0.90	1.00	0.66

toxicity in humans (Mani *et al.*, 2005). When the animal kept on contaminated feed along with the industrial polluted environment for long time, they suffer from its toxicity symptoms which may be sub clinical or clinical. The retention time of Cd is quite high (half life being 40 years). Bordas and Bourg (1998), Vazquez *et al.,* (2007) and Korfali and Davies (2004) observed the similar Cd concentrations in sediments.

Concentrations of copper in textile effluent are due to the residues of some dyes especially used for blue or green colours. Copper concentrations in textile effluent (0.16-0.44 ppm) were found parallel or sometimes higher than iron. Most of the part of copper content reaches in pond water (0.25-0.43 ppm) and rest settle down in drain sediment. Copper in pond sediment (38.6-52.4 ppm) also settled down after some time. Copper may accumulate in living organisms and their various body parts (Kudesia, 1992). High amount of heavy metals like Cu and Zn may harm the living organism of existing ecosystem (Aslam *et al.,* 2004). The Cu concentration level in study area has been compared with those observed by Korfali and Davies (2004) in sediments. Iron is one of the most abundant heavy metal in rocks and soil, ranking fourth by weight. However, iron was not found in high concentration in textile effluents (0.24-0.54 ppm), but the high concentrations of iron was observed in effluent drain sediment (5656.00-8467.70 ppm) due to the continuous settlement. Iron was present in high quantity in pond sediment (3803.5-6013.4 ppm). Iron's transfer factors were found very high from textile effluent to pond water up to 25.00. Manganese was found as a second abundant element in the effluent drain and pond sediment after iron. However, manganese was comparatively low in textile industrial effluent (0.11-0.31 ppm). Transfer factor of Mn from textile effluent to pond water was noticed from 1to 4 almost in all seasons, while below 1 in winter season. Nickel is one of the second trace elements of the present study after cadmium. As it is very toxic to plants and animals, even in low concentrations and has a tendency to get accumulated in different body parts. However Ni was presented in very low concentration in textile effluent (0.007-0.067 ppm) but in pond water (0.047-0.13 ppm), it was found comparatively high due to the regular input. Ni concentration in pond water was noticed higher during the summer season due to the loss of water by vaporization from pond system. Ni was found very high like other metals due to the settling of metals on bottom in pond sediment (49.0-63.7 ppm). Highest transfer factor of Ni from textile effluent to pond water was found in monsoon seasons.

The observations of the study reveals that Ni never reflected the pollution load in drain or pond sediment through the geo-accumulation index because it was found always below than 1. Nickel may accumulate in aquatic life but its presence is not magnified along food chains. This trend of Ni concentration in present study has been supported on the basis of recommendation of Nasr *et al.,* (2006) in sediment. It may be pointed out that the builds up of heavy metal like Cr, Pb, Ni warrant toward continuous monitoring and suitable measures are needed before these become toxic.

Lead was found highest in textile effluent. Lead mostly remained in effluent (0.25-0.50 ppm) and fluctuated in pond (0.5-1.8 ppm). Rest quantity of lead settled down on bed sediment of pond. Lead was the second most abundant metal species after iron. Pb was found slightly higher in pond water (0.50-1.8 ppm). It should not be more than 0.01 mg/l for health views, while it should be less than 0.1 mg/l generally in drinking water (WHO, 2006).

Zinc was not found so high in textile effluent (0.11-0.34 ppm) in comparison to lead. Similarly, it was found in less quantity in pond water (0.11-0.2 ppm) and accumulated in very high quantity in bed sediment (116.2-240.0 ppm) of pond. Zinc concentration was fluctuated in pond sediment (116.2-240.0 ppm) season to season. High amount of Zn may harm to living organism of that ecosystem (Aslam *et al.,* 2004).

The presence of heavy metals in the aquatic environment has been of great concern to scientists and biologist because of their toxic nature (Bharti, 2007). Heavy metals travel from one level to another in the ecological system by being accumulation in abiotic and biotic components. In the studied area, basically anthropogenic source of heavy metals are the dye houses in textile industrial area. Heavy metals reach in effluent drain and also its bottom sediment and further into pond and bed sediment of pond near village Binjhole adjoining to textile industrial area of Panipat. Heavy metals percolate slowly from the bed sediment of Binjhole pond towards the ground water table and there may be a threat to deep aquifers also by leaching process of metals. Heavy metals have a tendency to accumulate and store in different trophic levels. The storage of heavy metals has created harmful effects for biotic components. Heavy metals in pond water were observed slightly lower than textile industrial effluents, whereas the heavy metal concentrations in effluent drain were higher than pond sediment.

The present study reveals that there was heavy metals pollution in pond water and sediment. Due to the regular discharging of metals residues in the textile industrial area, a threat have been appear on plant vegetation, livestock and human beings of the region (Malik *et al.,* 2006). It is therefore obvious that scientific treatment is necessary to minimize the pollution effects before textile industrial effluent is discharge on the land. There is a need to take effective steps for improving wastewater use efficiency through renovation and modernization of recycling treatments of wastewater.

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