

Studies on Pollution due to discharge of effluent from Pharmaceutical Industries of Dombivali Industrial Belt of Mumbai, India

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ABSTRACT

The paper deals with monitoring of pollution arising due to pharmaceutical based industries located along the Dombivali industrial belt of Mumbai, India. The study was carried for the period of one year from June, 2012 to May, 2013 to study the level of toxic heavy metals and the physico-chemical properties of waste water effluents discharged from the above industries. The concentration level of majority of toxic heavy metals like Cu, Cr, Pb, Fe and Zn were found to be maximum of 14.06, 0.57, 0.42, 18.93 and 3.31 ppm respectively in the month of February, while Ni concentration was found to be maximum of 0.43 ppm in the month of June. The pH and BOD values were reported to be maximum of 12.54 and 546 ppm respectively in the month of October. The conductivity and total solid content was found to be maximum of 27400 μ mhos/cm and 9401 ppm respectively in the month of June. The cyanide content was maximum of 0.13 ppm in the month of April. The alkalinity, hardness, salinity, chloride, phosphate and COD content was reported maximum of 852, 694, 10.36, 4821, 46.32 and 1271 ppm respectively in the month of February. The DO content was found to be minimum of 3.00 ppm in the month of February. It was observed that the level of many of these toxic heavy metals except Zn and various physico-chemical parameters were above the tolerable limit set for inland surface water. From the results of the present investigation it seems that the time has come to move towards ecosystem specific discharge standards to maintain the health and productivity of natural resources on which the majority of Indians are dependent.

Keywords: industrial pollution; waste water effluent; physico-chemical analysis; toxic heavy metals; pharmaceutical industries; Dombivali industrial belt; Mumbai

1. INTRODUCTION

Over the last decade, more than 100 different drugs have been found as environmental contaminants in effluents of sewage treatment plants, surface water, sediments, sludge, soils, groundwater and even drinking water sources [1-7]. The widespread detection of pharmaceuticals in environmental samples as a result of improved analytical capabilities and focused field surveys has led to concern over the potential risks associated with releases of pharmaceuticals into the environment. This concern has been driven by surface water

sampling programs in the US, Europe and elsewhere that have all shown the presence of many different classes of pharmaceuticals. The high polarity and low volatility of most pharmaceuticals means that they are likely to be transported to and by the water compartment. In recent years it has been clear that pharmaceuticals released into the environment are an important group of environmental pollutants [8]. Many reports have been published that proves the widespread occurrence of these pollutants in waste water, ground water and surface water [6, 9-13]. Pharmaceuticals that are made to interact with living organisms can also have acute effects on fauna and flora, but due to low concentrations this will not be the biggest concern [14]. Synthetic and semisynthetic pharmaceuticals and pesticides are known to pollute the aquatic, terrestrial, and atmospheric environment alike, and they usually find their way into the drinking water as a dilute cocktail of varied drugs in varied concentrations. About 26 metric tons of pharmaceutical waste is disposed annually down the drain, and another 26 tons are disposed annually with municipal solid waste in landfills in North America alone [15]. North American [16], Canadian [17], Japanese [18], Korean [19], and across the Europe, waterways [20] contain traces (in nanograms/L to micrograms/L) of antibiotics, painkillers, hormones, tranquilizers, anti-inflammatory, chemotherapeutic, antiepileptic and hypolipidemic drugs [3,7,9,21,22].

When such wastewater is used for irrigation pharmaceuticals may also be released to soils [23]. Use and misuse of pharmaceuticals, by man is causing havoc with nature, as they persist as such or as their toxic metabolites. These pollutants bioaccumulate in environment, and they ultimately reach man through various means. They are hazardous because of potential toxicity, mutagenicity, carcinogenicity, and genotoxicity [24]. Considering the environmental impact of pollution arising from pharmaceutical based industries at global level, in the present investigation attempts was made to carry out the extensive monitoring of effluents released from such industries located in Dombivali MIDC industrial belt which is considered to be one of the most polluted industrial belts of Mumbai.

2. EXPERIMENTAL

2. 1. Study area

The Dombivali industrial area was established by Maharashtra Industrial Development Corporation (*M.I.D.C*) in 1964. The industrial belt occupies an area of about 347.88 hector, is located in south of Ulhas River and about 45.00 km from Mumbai international airport.

There are about 30 highly polluting small/ medium/ large scale chemical industries located in this industrial belt. Quantity of industrial effluent generated in the industrial area is about 14 MLD, which is finally discharged into the creek through open drainages which was passing through residential area [25].

2. 2. Climatic condition

Dombivali enjoys a tropical climate with mean annual temperature of 24.3 °C (min) to 32.9 °C (max). The hottest and driest part of the year is April-May, when temperature rises to 38.0 °C. The humidity is usually in the range of 58 to 84 % and sea breeze in the evening hours is a blessing to combat the high temperature and humidity during summer months. The average southwest monsoon rainfall is in the range of 1850 mm to 2000 mm. The average annual rainfall in the region is the range from 1286 to 1233 mm [25].

2. 3. Requirements

All the chemicals and reagent used for analysis were of analytical reagent grade. The glasswares used in the analysis were washed with distilled de-ionized water; the pipettes and burette were rinsed with the experimental solution before final use.

2. 4. Industrial Effluent Sampling and Preservation

The industrial waste water effluent samples were collected randomly twice in a month in morning, afternoon and evening session from three representative pharmaceutical manufacturing units of Dombivali industrial belt of Mumbai. The samples were collected every month from June, 2012 to May, 2013. Polythene bottles of 2.5 L and 2.0 L were used to collect the grab water samples (number of samples collected, $n = 20$). The bottles were thoroughly cleaned with hydrochloric acid, washed with tap water to render free of acid, washed with distilled water twice, again rinsed with the water sample to be collected and then filled up the bottle with the sample leaving only a small air gap at the top. The sample bottles were stoppered and sealed with paraffin wax.

2. 5. Physico-chemical Study

The samples were collected were analyzed for pH, conductivity, alkalinity, hardness, salinity, chloride, cyanide, phosphate content, Total Dissolved Solids (*T.D.S*), Total Suspended Solids (*T.S.S*), Total Solids (*T.S*), Dissolved Oxygen (*D.O*), Bio-chemical Oxygen Demand (*B.O.D*) and Chemical Oxygen Demand (*C.O.D*) values. The techniques and methods followed for collection, preservation, analysis and interpretation are those given by Rainwater and Thatcher [26], Brown et al. [27], *I.C.M.R* [28], Hem [29] and *A.P.H.A* [30].

2. 6. Heavy Metal Analysis by AAS Technique

Water samples (500 mL) were filtered using Whatman No. 41 (0.45 μm pore size) filter paper for estimation of dissolved metal content. Filtrate (500mL) was preserved with 2mL nitric acid to prevent the precipitation of metals. The samples were concentrated on a water bath depending on the suspected level of the metals [31]. The analysis for the majority of the trace metals like copper (*Cu*), nickel (*Ni*), chromium (*Cr*), lead (*Pb*), iron (*Fe*) and zinc (*Zn*) was done by Perkin Elmer ASS-280 Flame Atomic Absorption Spectrophotometer.

The calibration curves were prepared separately for all the metals by running different concentrations of standard solutions. A reagent blank sample was run throughout the method, and the blank readings were subtracted from the samples to correct for reagent impurities and other sources of errors from the environment. Average values of three replicates were taken for each determination.

3. RESULTS AND DISCUSSION

The experimentally measured pollution data on heavy metal content and physico-chemical properties of industrial waste water effluents released from pharmaceutical based industries located along the Dombivali industrial belt of Mumbai is presented in Tables 1 and 2.

Trace elements are those elements which are present in relatively low concentration of less than few ppm. Among the special group of trace elements are the heavy metals which are having the potential to create health hazards among humans, plants and other aquatic biological life. Under the group of heavy metals are *Cr*, *Ni*, *Zn*, *Cu*, *Pb* and *Fe*.

Table 1. Physico-chemical properties of the effluents released from Pharmaceutical industries located along Dombivali Industrial Belt of Mumbai, India.

Physico-chemical Parameters	June 2012	July 2012	August 2012	September 2012	October 2012	November 2012	December 2012	January 2013	February 2013	March 2013	April 2013	May 2013
pH	9.08	10.21	9.00	11.33	12.54	12.50	12.01	11.32	7.80	8.25	9.03	7.96
Conductivity ($\mu\text{mhos/cm}$)	27400	25630	20500	15480	1343	1445	1603	1987	27000	27200	26078	25760
Alkalinity (ppm)	276	431	201	191	154	234	465	683	852	650	657	439
Hardness (ppm)	248	145	126	214	88	150	345	569	694	654	362	376
Salinity (ppm)	4.80	4.64	4.89	4.39	4.36	6.56	7.70	9.43	10.36	10.26	8.80	9.54
Cl ⁻ (ppm)	2049	2026	1572	1295	616	775	1245	1786	4821	3243	3037	2025
CN ⁻ (ppm)	0.02	0.04	0.03	0.05	0.05	0.08	0.09	0.06	0.10	0.09	0.13	0.10
Phosphates (ppm)	10.23	13.20	15.54	12.25	12.23	15.25	20.13	25.67	46.32	43.30	40.24	42.67
TDS (ppm)	8741	6500	3545	1783	900	1100	1432	1564	1611	2312	3033	4436
TSS (ppm)	660	435	358	257	200	400	879	2570	2980	2679	1450	953
TS (ppm)	9401	6935	3903	2040	1100	1500	2311	4134	4591	4991	4483	5389
D.O (ppm)	3.50	4.50	3.70	4.00	4.40	4.60	4.30	4.00	3.00	4.70	3.90	4.50
B.O.D (ppm)	106	137	370	459	546	530	524	510	508	348	215	270
C.O.D (ppm)	834	549	396	375	363	643	753	950	1271	971	1045	894

They are classified under the group of heavy metals because in metallic form they have the densities higher than 4 g/cm^3 . The Cu content was found to vary in the range of 0.17 ppm in the month of June to 14.06 ppm in the month of February. The values reported were above the permissible limit of 0.05 ppm set by *W.H.O* and 1.0 ppm as per the USPH standards. The Ni content was found to be minimum of 0.21 ppm in the month of July to maximum of 0.43 ppm in the month of June. The overall experimental observed Ni concentration was above the maximum limit of 0.1ppm set by *W.H.O*.

The Cr content was found to vary in the range of 0.40 ppm in the month of October to 0.57 ppm in the month of February. The Cr values reported were above the maximum permissible limit of 0.05ppm set by *W.H.O* [32]. The Pb content was found to vary in the range of 0.31 ppm in the month of September to 0.42 ppm in the month of February. The values of Pb were extremely above the general standard limit of 0.1 ppm lead set for effluents discharge in inland surface water [33]. The Fe content was found to vary in the range of 0.29

ppm in the month of June to 18.93 ppm in the month of February. The reported level of *Fe* from the month of November to May were very much above the permissible limit of 3.0 ppm iron set for effluents discharge in inland surface water [33]. The Zn content was found to vary in the range of 0.76 ppm in the month of October to 3.31 ppm in the month of February.

Table 2. Heavy Metal content in the effluents released from Pharmaceutical industries located along Dombivali Industrial Belt of Mumbai, India.

Heavy Metals (ppm)	June 2012	July 2012	August 2012	September 2012	October 2012	November 2012	December 2012	January 2013	February 2013	March 2013	April 2013	May 2013
Cu	0.17	0.29	0.23	0.19	0.79	0.78	0.75	0.80	14.06	12.40	10.30	11.50
Ni	0.43	0.21	0.35	0.33	0.35	0.30	0.25	0.36	0.31	0.34	0.42	0.41
Cr	0.48	0.49	0.56	0.53	0.40	0.49	0.54	0.47	0.57	0.49	0.53	0.55
Pb	0.33	0.39	0.34	0.31	0.33	0.35	0.37	0.41	0.42	0.40	0.38	0.32
Fe	0.29	0.57	1.83	1.79	2.51	4.65	6.36	9.80	18.93	15.9	12.32	17.26
Zn	1.28	1.00	1.20	1.13	0.76	0.89	0.95	1.50	3.31	2.38	2.00	1.05

The reported level of *Zn* in the effluent samples collected for different months were within the general standard limit of 5.0 ppm Zn set for effluents discharge in inland surface water [33]. In any environmental monitoring study related to pollution of surface water, physico-chemical parameters gives valuable information regarding the pollution load. It is found that most of the industries in India are located near the water bodies because of their extensive requirement of water for various industrial activities.

The industrial waste water is generally discharged in drainages which finally enter the nearby water bodies creating extensive pollution creating threat to the aquatic life and health of surrounding human population. The most common physico-chemical parameters are pH, conductivity, hardness, alkalinity, suspended and dissolved solids, BOD, COD and DO. These parameters generally decide the extent of pollution and help in planning the waste water treatment technology which is to be adopted. In the present investigation it was observed that the pH of collected effluents was found to vary in the range of 7.80 in the month of February to maximum of 12.54 in the month of October. During major assessment period, the pH values recorded were above the permissible pH range of 5.5 to 9.0 as set for inland surface water subjected to pollution load [33-43].

The conductivity values recorded was found to be minimum of 1343 $\mu\text{mhos/cm}$ in the month of October to maximum of 27400 $\mu\text{mhos/cm}$ in the month of June. The majority of physic-chemical parameters like alkalinity, hardness, salinity, and chloride content were found to be minimum of 154, 88, 4.36, 616 ppm respectively in the month of October and

maximum of 852,694, 10.36 and 4821 ppm respectively in the month of February. The CN^- content was found to vary in the range of 0.02 ppm in the month of June to maximum of 0.13 ppm in the month of April.

The phosphate content in the effluent samples was found to be minimum of 10.23 ppm in the month of June to maximum of 46.32 ppm in the month of February. The total solid (TS) content was found to vary in the range of 1100 ppm in October to maximum of 9401 ppm in the month of June. The DO content was in the range of 3.00 ppm which was minimum in the month of February to 4.70 ppm which was maximum in in the month of March. The minimum BOD and COD content was found to be 106 ppm and 363 ppm in the month of June and October respectively, while the maximum values reported were 546 ppm and 1271 ppm in the month of October and February respectively.

4. CONCLUSION

Around the world as countries are struggling to arrive at an effective regulatory regime to control the discharge of industrial effluents into their ecosystems, Indian economy holds a double edged sword of economic growth and ecosystem collapse. As India progresses towards strict regulation of industrial effluents to control water pollution, greater efforts are required to reduce the risk to public health as colourless and odourless toxic pollutants are released into the ecosystems. Hence there is a need that each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise 'Polluter pays' principle should be implemented.

The current regulatory system in India for control of industrial discharges needs a complete improvement in terms of standards setting, monitoring and enforcement. The monitoring system for water quality needs to be strengthened both in terms of parameters monitored, water resources coverage and timely reporting to public domain.

These steps are important in order to avoid irreparable ecological harm in the long term well masked by short term economic prosperity due to extensive industrial growth.

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