

Pollution Scenario due to discharge of effluent from Agrochemicals and Pesticides Manufacturing Industries of Dombivali Industrial Belt of Mumbai, India

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ABSTRACT

The paper deals with monitoring of pollution arising due to agrochemicals and pesticides manufacturing 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 average concentration of Cu, Ni, Cr, Pb and Zn was found to be maximum of 29.86, 0.90, 1.16 and 1.19 ppm respectively in summer season, while average Fe concentration was maximum of 51.10 ppm in winter season. The average pH value of the effluent was found to be maximum of 12.95 in summer season, while average conductivity value was maximum of 21085 $\mu\text{mhos/cm}$ in rainy season. The majority of physico-chemical parameters like alkalinity, hardness, salinity, chloride, cyanide, phosphate, total solid, BOD and COD content were found to be maximum in summer season having the average values of 1918, 186, 4, 11.20, 0.07, 81, 6391, 685 and 2556 ppm respectively. The average DO content was found to be low of 4.5 ppm in winter season. It was observed that the concentration level of majority of the toxic heavy metals and physico-chemical properties were above the tolerable limit set for inland surface water. The results of present study indicates that the existing situation if mishandled can cause irreparable ecological harm in the long term well masked by short term economic prosperity due to extensive industrial growth.

Keywords: industrial effluents; physico-chemical properties; heavy metals; agrochemicals; pesticides; Dombivali industrial belt; Mumbai

1. INTRODUCTION

The production of pesticides started in India in 1952 with the establishment of a plant for the production of *BHC* near Calcutta, and India is now the second largest manufacturer of pesticides in Asia after China and ranks twelfth globally [1]. There has been a steady growth in the production of technical grade pesticides in India, from 5,000 metric tons in 1958 to

102,240 metric tons in 1998. The pattern of pesticide usage in India is different from that for the world in general. In India 76 % of the pesticide used is insecticide, as against 44% globally [1]. The use of herbicides and fungicides is correspondingly less heavy. The main use of pesticides in India is for cotton crops (45 %), followed by paddy and wheat. It is estimated that about 380000 tons of pesticides and other halogenated hydrocarbons are used each year in India, of which 55000 tons are used in agriculture. The total of 107000 tons of DDT and its isomers are consumed per year [2]. According to one report, consumption of pesticide in the Indian Ocean region and neighbouring countries are as follows: 11000 tons in Pakistan, 3000 tons in Bangladesh and 28000 tons in Sri Lanka [3]. These chemicals are used as pesticides, herbicides and fungicides in agriculture and for controlling vector-borne diseases as malaria. It is recognized that a large portion of the pesticides used on land reaches the oceans through atmospheric transport and river discharge in India [4]. Groundwater pollution due to pesticides is a worldwide problem.

According to the USGS, at least 143 different pesticides and 21 transformation products have been found in ground water, including pesticides from every major chemical class. During one survey in India, 58 % of drinking water samples drawn from various hand pumps and wells around Bhopal were contaminated with Organo Chlorine pesticides above the *EPA* standards [5]. Once ground water is polluted with toxic chemicals, it may take many years for the contamination to dissipate or be cleaned up. Cleanup may also be very costly and complex, if not impossible [6-8]. Pesticide/Agrochemical manufacturing industry wastewater poses pollution problems due to the toxic components, high chemical oxygen demand (*COD*), biochemical oxygen demand (*BOD*); high Total dissolved solids (*TDS*) and high alkaline pH in the range of 12-14. The most important portion of contamination due to this wastewater is observed in agricultural areas and in surface waters that come from agricultural areas. Major quality of pesticide pollution is released during pesticide manufacturing. Pesticide, usually have direct adverse effects on the living organisms.

Pesticides are highly toxic and carcinogenic in nature even at picogram loads [9]. Moreover it persists in nature for long period of time. The process of pesticide removal from the industrial wastewater is of great importance because of well-known pesticide resistance to microbial degradation and has tendency to bio-accumulate in the soil fauna and flora. Pesticides are carcinogenic and mutagenic in nature [10]. Pesticide wastewater distinguishes itself because of its toxic and persistent nature in the environment. This wastewater depicts wide variation in its characteristics based on the pesticide production; raw materials used and water consumption and wastewater flow [11,12]. Considering the environmental impact of agrochemicals and pesticides at global level, in the present investigation attempts was made to carry out the comprehensive survey of pollution arising due to 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 [13].

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 [13].

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 agrochemicals and pesticides 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 [14], Brown et al. [15], *I.C.M.R* [16], Hem [17] and *A.P.H.A* [18].

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 (500 mL) 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 [19].

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 agrochemicals and pesticides manufacturing industries located along the Dombivali industrial belt of Mumbai is presented in Tables 1 and 2.

Table 1. Heavy metal content in the effluents released from agrochemical industries located along Dombivali industrial belt of Mumbai, India.

Heavy Metals (ppm)	Rainy Season					Winter Season					Summer Season				
	June 2012	July 2012	August 2012	September 2012	Average	October 2012	November 2012	December 2012	January 2013	Average	February 2013	March 2013	April 2013	May 2013	Average
Cu	0.68	0.78	0.96	1.87	1.07	5.88	8.35	14.45	19.54	12.06	30.58	29.67	28.68	30.52	29.86
Ni	0.48	0.46	0.38	0.57	0.47	0.6	0.86	0.67	0.75	0.72	0.87	0.98	0.88	0.86	0.90
Cr	0.52	0.5	0.37	0.54	0.48	0.55	0.76	0.99	1.09	0.85	1.12	1.2	1.16	1.15	1.16
Pb	0.49	0.65	0.54	0.74	0.61	0.73	0.76	0.95	1.14	0.90	1.15	1.19	1.25	1.18	1.19
Fe	0.2	0.97	1.45	3.4	1.51	59.21	40.45	50.42	54.3	51.10	41.59	44.69	41.29	42.9	42.62
Zn	0.59	0.87	1.06	0.95	0.87	2.58	4.54	5.23	3.86	4.05	6.27	5.59	6.74	6	6.15

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*. They are classified under the group of heavy metals because in metallic form they have the densities higher than 4 g/cm³.

Table 2. Physico-chemical properties of the effluents released from agrochemical industries located along Dombivali industrial belt of Mumbai, India.

Physico-chemical Parameters	Rainy Season					Winter Season					Summer Season				
	June 2012	July 2012	August 2012	September 2012	Average	October 2012	November 2012	December 2012	January 2013	Average	February 2013	March 2013	April 2013	May 2013	Average
pH	8.65	8.90	9.32	9.03	8.98	11.93	12.40	13.58	11.06	12.24	13.70	12.76	11.54	13.80	12.95
Conductivity (µmhos/cm)	29300	25500	20450	9090	21085	5486.6	6600	6206.9	7243.23	6384	7700	7995.9	9508.24	7200	8101
Alkalinity (ppm)	1	387	439.5	443.9	318	1	984.5	1095.8	1595	919	2044.8	2065.9	1867.45	1695.3	1918
Hardness (ppm)	148.5	138.7	99.65	129.4	129	88.27	158.9	176.54	197.5	155	198.16	167.23	190.9	187.34	186
Salinity (ppm)	2.25	3.54	3.98	2.5	3	4	4.56	4.98	4.29	4	4	3.3	4.24	5.9	4
Cl ⁻ (ppm)	542.4	546.87	674.24	629.34	598	689.85	890.3	789.7	1156.75	882	1311.65	1249	1029.43	890	1120
CN ⁻ (ppm)	0.02	0.04	0.06	0.05	0.04	0.05	0.06	0.09	0.07	0.07	0.05	0.06	0.08	0.07	0.07
Phosphates (ppm)	ND	10.4	12.23	13.87	12	14.88	20.65	25.85	32.21	23	85.6	87.3	85.38	65.6	81
TDS (ppm)	3210	654.87	879	1564.34	1577	4230	4978.9	5276	4998	4871	5310	4507	4450	5209	4869
TSS (ppm)	106	208.6	650.3	457.9	356	750	954.7	1540.9	1210.46	1114	1620	1498	1348	1622.3	1522
TS (ppm)	3316	863.47	1529.3	2022.24	1933	4980	5933.6	6816.9	6208.46	5985	6930	6005	5798	6831.3	6391
D.O (ppm)	5.3	4.3	5.1	4.4	4.8	3.33	5	4.9	4.9	4.5	5.52	4.32	4	5	4.7
B.O.D (ppm)	80	95.87	148.94	450.6	194	575.9	585.6	689.8	713.8	641	730.78	607.8	680.3	720.35	685
C.O.D (ppm)	1722	1660	1725	1675.9	1696	1681.7	1756.8	2189.7	2540.6	2042	2666.56	2598	2350	2609.6	2556

The average *Cu* content in the effluent samples collected was found to be minimum of 1.07 ppm in rainy season which increases to 29.86 ppm in summer season. 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 average *Ni* content in the waste water samples was found to vary between 0.47 ppm in rainy season to 0.90 ppm in summer. The overall experimental observed *Ni* concentration was above the maximum limit of 0.1 ppm set by *W.H.O*. The average *Cr* content in the industrial effluent samples was found to vary between 0.48 ppm in rainy season which was minimum to maximum of 1.16 ppm in summer, which was higher than the maximum permissible limit of 0.05 ppm set by *W.H.O* [20].

The steady increase in concentration of *Pb* in the effluent samples was observed from 0.61 ppm in rainy season to 1.19 ppm in summer, which was extremely higher than the general standard limit of 0.1 ppm lead set for effluents discharge in inland surface water [21]. The drastic increase in *Fe* concentration in the industrial waste water effluent was observed from 1.51 ppm in rainy season to 51.10 ppm in winter season, while in summer the *Fe* concentration was found to be 42.62 ppm.

The observed level of *Fe* in summer and winter seasons were above the permissible limit of 3.0 ppm iron set for effluents discharge in inland surface water [21]. The concentration of *Zn* in the industrial waste water effluent samples was in the range of 0.87 ppm in rainy season to 6.15 ppm in summer season, while in winter the concentration of *Zn* was found to be 4.05 ppm. The level of *Zn* in the effluent samples collected in summer season was extremely higher than the general standard limit of 5.0 ppm *Zn* set for effluents discharge in inland surface water [21].

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 waste water from such industries are 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 value was minimum of 8.98 in rainy, 12.24 in winter and 12.95 in summer season which was maximum. It is important here to note that the permissible pH range of inland surface water subjected to pollution load is 5.5 to 9.0 [21-31]. The average conductivity of the industrial waste water effluent was found to vary in the range of 6384 $\mu\text{mhos/cm}$ in winter to 21085 $\mu\text{mhos/cm}$ in rainy season.

The majority of physico-chemical parameters like alkalinity, hardness, salinity, chloride, cyanide, phosphate, total solid, BOD and COD content in summer season were found to be maximum having the values of 1918, 186, 4.0, 11.20, 0.07, 81, 6391, 685 and 2556 ppm respectively. The values of the above physico-chemical parameters were found to be minimum of 318, 129, 3.0, 598, 0.04, 12 1933, 194 and 1696 ppm respectively in rainy season. The DO content was found to be low of 4.5 ppm in winter and high of 4.8 ppm in rainy season.

4. CONCLUSION

The ecological and human health safety due to discharge of heavily polluted industrial effluents are undoubtedly under threat. The present experimental data on environmental risk assessment studies due to agrochemical and pesticides manufacturing industries may be regarded as an aid towards a better understanding of the problem arising due to such industries.

There is a need to convey the message that prevention of adverse health effects and promotion of health are profitable investments for employers and employees as a support to a sustainable development of economics. 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. These are possible by proper treatment of effluent water and enforcement of pollution control by the regulatory authority on the indiscriminate discharge of industrial wastewater into water bodies should be carried out.

Educating the urban as well as the rural mass is another major step to put a check on such industrial pollution. Masses should be made aware of the drastic consequences of such industrial pollution on their lives, both directly and indirectly. The existing situation if mishandled can cause irreparable ecological harm in the long term well masked by short term economic prosperity due to extensive industrial growth.

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