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Studies on pollution discharge scenario of effluents released from fine chemicals manufacturing industries along Dombivali industrial belt of Mumbai, India

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ABSTRACT

The paper deals with monitoring of pollution arising due to fine chemicals 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 concentration levels of heavy metals like Cu, Ni, Cr, Pb, Fe and Zn was found to be maximum of 45.94, 1.05, 7.50, 4.76, 145.87 and 21.96 ppm respectively in the effluents released during the months of February to April. The majority of physco-chemical parameters like alkalinity, salinity and chloride content were found to be maximum in the month of October having the concentration values of 1482, 4.91, 2710 ppm respectively, while the DO content in the effluents released in the same month was reported to be very much low having the value of 2.90 ppm. The effluents released during the month of June were reported to have high hardness, total solid (TS) content and COD values of 3713, 13638 and 6951 ppm respectively. The cyanide content (0.08 ppm), phosphate content (131.32 ppm) and BOD content (631 ppm) were found to be maximum in the months of December, February and May respectively. From the results it appears that as India moves towards stricter regulation of industrial effluents to control water pollution, greater efforts are required to reduce the risk to public health as toxic pollutants which are mainly colourless and odourless can be expected to be released into the ecosystems.

Keywords: industrial effluents; physico-chemical analysis; heavy metals; fine chemicals industries; Dombivali industrial belt; Mumbai

1. INTRODUCTION

Industries are the major sources of pollution in all environments. Based on the type of industry, various levels of pollutants can be discharged into the environment directly or indirectly through public sewer lines. Wastewater from industries includes employees' sanitary waste, process wastes from manufacturing, wash waters and relatively uncontaminated water from heating and cooling operations [1].

High levels of pollutants in river/ creek /lake water systems causes an increase in biological oxygen demand (*BOD*), chemical oxygen demand (*COD*), total dissolved solids (*TDS*), total suspended solids (*TSS*), toxic metals such as *Cd*, *Cr*, *Ni* and *Pb* and fecal coliform and hence make such water unsuitable for drinking, irrigation and aquatic life [2-7].

Industrial wastewaters range from high biochemical oxygen demand (*BOD*) from biodegradable wastes such as those from human sewage, pulp and paper industries, slaughter houses, tanneries and chemical industry [8-15]. Others include those from plating shops and textiles, which may be toxic and require on-site physiochemical pre-treatment before discharge into municipal sewage system [16-18].

Considering the environmental impact due to industrial pollution at global level in general and India in particular, we have carried out the comprehensive survey of pollution arising due to fine chemicals manufacturing 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 [19].

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 [19].

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 fine chemicals 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 tape 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 stoppard 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 [20], Brown et al. [21], *I.C.M.R* [22], Hem [23] and *A.P.H.A* [24].

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 [25].

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 in the industrial waste water effluent released from fine chemicals manufacturing industries located along Dombivali industrial belt of Mumbai, India 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*. 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 in the industrial effluent was found to be minimum of 0.68 ppm in the month of June and maximum of 45.94 ppm in the month of February.

Table 1. Physico-chemical properties of the effluents released from fine chemical manufacturing 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	8.46	8.47	9.30	8.50	7.90	7.40	7.45	8.75	7.50	7.43	8.34	7.15
Conductivity (µmhos/cm)	20000	15647	13490	19570	12990	12401	10986	9562	6100	7860	14531	13991
Alkalinity (ppm)	244	544	481	890	1482	1399	1237	1120	1193	1250	1150	1135
Hardness (ppm)	3713	3251	2541	1743	1370	1271	1165	1181	1189	1231	1579	2055
Salinity (ppm)	4.65	4.28	4.80	4.70	4.91	4.50	4.59	4.00	4.06	4.20	4.29	4.10
Cl^- (ppm)	1296	1564	2350	2550	2710	1784	1461	1420	1418	1351	1287	1410
CN^- (ppm)	0.01	0.04	0.05	0.04	0.05	0.06	0.08	0.07	0.06	0.05	0.03	0.04
Phosphates (ppm)	8.35	9.43	10.74	9.80	11.95	19.35	23.65	12.40	131.32	120.23	99.50	89.60
TDS (ppm)	13190	12500	10000	9541	9000	6573	5983	4211	4450	6452	8590	4520
TSS (ppm)	448	549	661	955	1350	1539	1439	1590	1630	1620	1595	1480
TS (ppm)	13638	13049	10661	10496	10350	8112	7422	5801	6080	8072	10185	6000
D.O (ppm)	4.80	3.35	4.40	3.33	2.90	4.40	3.32	3.99	5.00	4.80	4.20	3.99
B.O.D (ppm)	319	432	547	498	581	587	585	590	591	605	594	631
C.O.D (ppm)	6951	5680	3540	2568	2846	4500	3540	5120	5231	6050	5380	5230

Table 2. Heavy metal content in the effluents released from fine chemical manufacturing 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	0.68	0.87	0.95	1.32	6.15	13.84	20.50	12.45	45.94	40.90	35.93	44.65
Ni	0.51	0.60	0.66	0.52	0.59	0.60	0.78	0.80	0.97	0.98	1.05	0.95
Cr	0.98	1.43	0.89	1.05	5.97	6.89	6.54	5.87	6.53	7.50	6.55	6.60
Pb	0.83	0.78	0.67	0.80	0.55	0.90	0.98	1.32	3.71	4.76	3.35	2.26
Fe	0.62	0.80	0.90	1.50	13.72	16.80	23.67	8.95	140.16	145.87	120.00	140.70
Zn	2.17	2.50	2.26	2.10	2.27	3.57	5.78	9.69	21.96	20.60	19.30	21.69

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 in the effluent released was in the range of 0.51 ppm in the month of June and 1.05 ppm in the month of April. The overall experimental observed *Ni* concentration was above the maximum limit of 0.1 ppm set by *W.H.O*. The Cr content in the industrial effluent was found to be minimum of 0.89 ppm in the month of August and maximum of 7.50 ppm in the month of March.

The values of *Cr* reported here were found to be higher than the maximum permissible limit of 0.05 ppm set by *W.H.O* [26]. The *Pb* content in the effluent released was in the range of 0.55 ppm in the month of October and 4.76 ppm in the month of March. The overall concentration of *Pb* was above the general standard limit of 0.1 ppm lead set for effluents discharge in inland surface water [27].

The *Fe* content in the industrial effluent was found to be minimum of 0.62 ppm in the month of June and maximum of 145.87 ppm in the month of March. The observed levels of *Fe* in the effluents released during the month of October to May were above the permissible limit of 3.0 ppm iron set for effluents discharge in inland surface water [27]. The *Zn* content in the effluent released was in the range of 2.10 ppm in the month of September and 21.96 ppm in the month of February. The levels of *Zn* in the effluents discharged during the month of December to May were above 5.0 ppm limit set for effluents discharge in inland surface water [27]. 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 7.15 in the month of May to maximum of 9.30 in the month of August. The overall pH values recorded were found to be within the permissible pH range of 5.5 to 9.0 set for inland surface water subjected to pollution load [27-37].

The conductivity of the industrial waste water effluent was found to vary in the range of 6100 µmhos/cm in the month of February to 20000 µmhos/cm in the month of June. The majority of physco-chemical parameters like alkalinity, salinity and chloride content were found to be maximum in the month of October having the concentration values of 1482, 4.91, 2710 ppm respectively, while the DO content in the effluents released in the same month was reported to be very much low having the value of 2.90 ppm. The effluents released during the month of June were reported to have high hardness, total solid (TS) content and COD values of 3713, 13638 and 6951 ppm respectively. The cyanide content (0.08 ppm), phosphate content (131.32 ppm) and BOD content (631 ppm) were found to be maximum in the months of December, February and May respectively.

4. CONCLUSION

With the rapid industrialization in the country, environment pollution by industrial waste has increased tremendously. The discharge of waste water from industries such as tanneries, pulp and paper, textile, petroleum, fine chemical industries etc. pollute water bodies. Nature has an amazing ability to cope up with small amount of water wastes and pollution, but it would be hazardous or harmful if billions of gallons of waste water produced everyday are not treated before releasing them back to the environment. It is therefore recommended that the careless disposal of industrial wastes without pretreatment should be discouraged. Here the right way forward will be to empower the local communities to ensure their right to a healthy environment and ultimately their survival. 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 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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