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Pollution discharge Scenario of Metallurgical Industries along Dombivali Industrial Belt of Mumbai, India

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ABSTRACT

The paper deals with monitoring of pollution arising due to metallurgical 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 Cu, Ni, Cr, Pb, Fe and Zn were found to be maximum of 41.00, 1.47, 5.97, 2.55, 46.86 and 12.97 ppm respectively during winter and summer seasons starting from December to May. The pH value was found to be maximum of 10.30 in the month of February, while the conductivity was found to be maximum of 25067 μmhos/cm in the month of July. The majority of physco-chemical parameters like salinity, chloride content, and total solids (TS) were observed to be maximum in the month of June having values of 6.32, 2411 and 20738 ppm respectively. The high cyanide (0.09 ppm), phosphate (117.21 ppm), COD (13640 ppm) and low DO content of 5.79 ppm were observed in the effluents released during the month of February. The alkalinity content in the effluent was maximum of 1395 ppm in the month of May. The hardness and BOD values of the effluents were reported maximum of 490 and 557 ppm in the month of October. From the results of the present investigation it seems that the time has come to implement proper effluent water treatment techniques and enforcement of pollution control by the regulatory authority on the indiscriminate discharge of industrial wastewater into water bodies.

Keywords**:** industrial effluents; physico-chemical analysis; heavy metals; metallurgical industries; Dombivali industrial belt; Mumbai

1. INTRODUCTION

India, being a rapidly growing economy, has to resolve massive environmental problems. The direct consequences of the process of development and the range of issues categorized as environmental problems include industrial pollution (i.e. pollution of air, water and soil) vehicular emission, hospital waste and domestic sewage disposal etc. Water pollution has emerged as one of the gravest environmental threats to India. In India, every year, approximately, 50,000 million litres of waste water both industrial and domestic, is generated in urban areas. A significant number of industries (for example, metal processing industries, Oil Refineries, Coal & Lignite, Chemical industries, Distilleries, Manmade fibre, Paints & Dye, Leather, Textiles, Paper, Fertilisers, Milk & Milk Products) in India are producing water pollution above MINAS by several times.

These industries do not exist in isolation from each other, rather are inter dependent. This inter dependence arises from the fact that the output of an industry is generally required as an input by another industry. Though some industries do not produce pollution directly but these industries produce pollution indirectly in a significant way. Water pollution caused by industrial effluent discharges has become a worrisome phenomenon due to its impact on environmental health and safety [1]. Industrial effluent contamination of natural water bodies has emerged as a major challenge in developing and densely populated countries like India [2-9]. These effluents from industries have a great deal of influence on the pollution of the estuarine and surface water bodies, by altering the physical, chemical and biological nature of the receiving water bodies [10-15].

Therefore in the present investigation attempts were made to carry out the comprehensive survey of pollution arising from metallurgical 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 [16].

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 [16].

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 metallurgical industries located along 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 [17], Brown et al. [18], *I.C.M.R* [19], Hem [20] and *A.P.H.A* [21].

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 2 mL nitric acid to prevent the precipitation of metals. The samples were concentrated on a water bath depending on the suspected level of the metals [22].

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 metallurgical 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*.

They are classified under the group of heavy metals because in metallic form they have the densities higher than 4 g/cm^3. The concentration of Cu was found to be minimum of 0.60 ppm in the month of October to maximum of 41.00 ppm in the month of February.

Table 1. Physico-chemical properties of the effluents released from metallurgical 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	8.95	9.30	8.40	8.36	8.19	9.67	10.20	8.95	10.30	9.59	10.06	10.29
Conductivity (μmhos/cm)	9800	25067	21570	17940	4949	5289	5978	6056	6640	6541	8096	7630
Alkalinity (ppm)	101	275	560	759	815	929	1132	1278	1306	1384	1230	1395
Hardness (ppm)	396	429	457	395	490	329	246	436	198	341	296	326
Salinity (ppm)	6.32	5.20	4.80	5.29	4.90	4.38	5.00	4.35	4.36	5.90	5.40	4.32
Cl^- (ppm)	2411	2106	981	816	838	1343	1659	1774	1985	1895	1946	1990
CN^- (ppm)	0.05	0.04	0.06	0.07	0.06	0.08	0.07	0.06	0.09	0.07	0.08	0.06
Phosphates (ppm)	2.97	4.60	6.89	5.27	7.19	8.94	12.43	15.76	117.21	101.4	80.35	71.98
TDS (ppm)	20050	15641	8946	7894	3400	4101	3885	4327	4640	5439	6985	4975
TSS (ppm)	688	900	1543	1431	1600	1505	1596	1608	1510	1380	1464	1506
TS (ppm)	20738	16541	10489	9325	5000	5606	5481	5935	6150	6819	8449	6481
D.O (ppm)	2.67	3.39	4.00	4.10	4.40	4.49	5.00	4.53	5.79	3.90	4.48	3.92
B.O.D (ppm)	356	440	528	548	557	436	440	521	445	406	396	446
C.O.D (ppm)	1816	2055	3242	3200	3450	5696	7885	987	13640	8794	7648	11235

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 concentration of Ni was found to vary in the range of 0.36 ppm in the month of August to 1.47 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 concentration of *Cr* was found to be minimum of 0.39 ppm in the month of June to maximum of 5.97 ppm in the month of April. The reported concentration of *Cr* was higher than the maximum permissible limit of 0.05 ppm set by *W.H.O* [23].

Table 2. Heavy Metal content in the effluents released from metallurgical 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	2.75	1.98	1.56	0.99	0.60	0.97	1.57	2.50	41.00	39.95	40.57	35.60
Ni	0.50	0.49	0.36	0.49	0.55	0.59	0.54	0.87	0.84	0.98	1.47	0.90
Cr	0.39	0.55	0.53	0.49	0.58	0.79	1.49	2.50	3.35	4.64	5.97	3.98
Pb	1.04	0.99	0.65	1.01	0.67	1.09	2.55	2.05	2.43	2.40	2.12	2.08
Fe	1.24	1.56	1.70	1.75	1.76	1.90	3.54	5.98	46.86	30.65	40.21	35.67
Zn	2.05	2.00	1.55	1.05	0.59	0.65	0.80	0.96	12.93	12.00	10.6	12.97

The concentration of *Pb* was found to vary in the range of 0.65 ppm in the month of August to 2.55 ppm in the month of December.

The concentration values of *Pb* as observed here were extremely higher than the general standard limit of 0.1 ppm lead set for effluents discharge in inland surface water [24]. The concentration of *Fe* was found to be minimum of 1.24 ppm in the month of June to maximum of 46.86 ppm in the month of February. The observed levels of *Fe* from December to May were above the permissible limit of 3.0 ppm iron set for effluents discharge in inland surface water [24]. The concentration of *Zn* was found to vary in the range of 0.59 ppm in the month of October to 12.97 ppm in the month of May. The levels of *Zn* in the effluent released in the period of February to May were extremely higher than the general standard limit of 5.0 ppm *Zn* set for effluents discharge in inland surface water [24].

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 8.19 in the month of October to maximum of

10.30 in the month of February. 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 [24-29]. The conductivity of the industrial waste water effluent was found to vary in the range of 4949 µmhos/cm in the month of October to 25067 µmhos/cm in the month of July. The majority of physco-chemical parameters like salinity, chloride content, and total solids (TS) were observed to be maximum in the month of June having values of 6.32, 2411 and 20738 ppm respectively.

The high cyanide (0.09 ppm), phosphate (117.21 ppm), COD (13640 ppm) and low DO content of 5.79 ppm were observed in the effluents released during the month of February. The alkalinity content in the effluent was maximum of 1395 ppm in the month of May. The hardness and BOD values of the effluents were reported maximum of 490 and 557 ppm in the month of October.

4. CONCLUSION

The effluents also have considerable negative effects on the water quality of the receiving water bodies and as such, they are rendered not good for human use. It is therefore recommended that the careless disposal of industrial wastes without pretreatment should be discouraged. Imposition of direct charges on industrial effluents by the regulating agency, as well as continuous monitoring and surveillance is imperative in order to ensure the protection of water resources from further degradation.

References

[1] V. J. Odjegba, N. M. Bamgbose, *African Journal of Environmental Science and Technology* 6(11) (2012) 438-445.

[2] R. S. Lokhande, P. U. Singare, D. S. Pimple, *International Journal of Ecosystem* 1(1) (2011) 1-9.

[3] R. S. Lokhande, P. U. Singare, D. S. Pimple, *World Environment* 1(1) (2011) 6-13.

[4] R. S. Lokhande, P. U. Singare, D. S. Pimple, *Resources and Environment* 1(1) (2011) 13-19.

[5] R. S. Lokhande, P. U. Singare, D. S. Pimple, *The New York Science Journal* 4(9) (2011) 66-71.

[6] Rajaram T., Das A., *Futures* 40(1) (2008)56-69.

[7] Pachpande B. G., Ingle S. T., *Orient J Chem* 20(1) (2004) 117-23.

[8] P. U. Singare, R. S. Lokhande, A. G. Jagtap, *International Journal of Global Environmental Issues* 11(1) (2011) 28-36.

[9] P. U. Singare, R. S. Lokhande, A. G. Jagtap, *Interdisciplinary Environmental Review* 11(4) (2010) 263-273.

[10] Modak D. M., Singh K.P., Ahmed S., Ray P. K., *Chemosphere* 21 (1-2) (1990) 275-87.

[11] J. S. Menon, S.V. Mahajan, *Our Nature*, 8 (2010) 170-179.

[12] P. U. Singare, R. M. Mishra, M. P. Trivedi, *Interdisciplinary Environmental Review* 13(4) (2012) 245-268.

[13] P. U. Singare, M. P. Trivedi, R. M. Mishra, D. V. Dagli, *Interdisciplinary Environmental Review* 13(2/3) (2012) 220-243.

[14] P. U. Singare, M. P. Trivedi, R. M. Mishra, *Science and Technology* 2(4) (2012) 87-97.

[15] P. U. Singare, R.M. Mishra, M.P. Trivedi, *Frontiers in Science* 2(3) (2012) 28-36.

[16] Action Plan for Industrial Cluster "Dombivali", Maharashtra Pollution Control Board, November 2010. http://www.mpcb.gov.in

[17] Rainwater F. H., Thatcher L. L., *U.S. Geol. Surv. Water Supply Papers* 1454 (1960) 1-301.

[18] E. Brown, M. W. Skougstad, M. J. Fishman, 'Methods for collection and analysis of Water samples for dissolved minerals and gases', *Techniques of Water Resources Investigations of the U.S. Geological Survey,* Vol. 160, Book 5, Chapter A1 (1970).

[19] Indian Council of Medical Research (ICMR) Manual of Standards of Quality for Drinking Water Supplies, (1975).

[20] J. D. Hem, '*Study and Interpretation of Chemical Characteristics of Natural Water'*, 3rd ed., U.S. Geological Survey, Washington (1985).

[21] American Public Health Association (APHA). Standard Methods for Estimation of Water and Wastewater, 19th ed., American Water Works Association, Water Environment Federation, Washington, (1995).

[22] Chen M., Ma L. Q., *Soil Science Society of American Journal* 65(2) (2010) 491-499.

[23] A. K. De, Environmental Chemistry, pp. 232-272, 4th ed., New Age International (P) Ltd., New Delhi, India (2002).

[24] The Environment (Protection) Rules (1986) Available at: http://www.cpcb.nic.in/GeneralStandards.pdf (assessed on November 2011).

[25] P. Daniszewski, *International Letters of Chemistry, Physics and Astronomy* 4 (2012) 112-118.

[26] E. Cyrania, P. Daniszewski, B. Draszawka-Bołzan, *International Letters of Chemistry, Physics and Astronomy* 5 (2012) 96-103.

[27] E. Cyraniak, P. Daniszewski, B. Draszawka-Bołzan, *International Letters of Chemistry, Physics and Astronomy* 5 (2012) 88-95.

[28] P. Daniszewski, R. Konieczny, *International Letters of Chemistry, Physics and Astronomy* 4 (2013) 91-97.

[29] P. Daniszewski, R. Konieczny, *International Letters of Chemistry, Physics and Astronomy* 4 (2013) 98-104.

[30] P. U. Singare, M. S. Talpade, D. V. Dagli, V. G. Bhawe, *International Letters of Chemistry, Physics and Astronomy* 8(2) (2013) 94-104

[31] P. U. Singare, M. S. Talpade, D. V. Dagli, V. G. Bhawe, *International Letters of Chemistry, Physics and Astronomy* 8(2) (2013) 105-112

[32] P. Daniszewski, *International Letters of Chemistry, Physics and Astronomy* 8(3) (2013) 269-278.

[33] P. Daniszewski, *International Letters of Chemistry, Physics and Astronomy* 8(3) (2013) 279-287.

[34] P. Daniszewski, *International Letters of Chemistry, Physics and Astronomy* 10(2) (2013) 218-226.

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