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PHYSICO-CHEMICAL ANALYSIS OF SOME INDUSTRIAL EFFLUENTS FROM VAPI INDUSTRIAL AREA, GUJARAT, INDIA

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ABSTRACT

Physicochemical characteristics of some industrial effluents collected from various industries in and around Vapi Industrial Area. Industrial effluents were studied for five months intervals during Sep 2008-Jan 2009, however in this paper data is presented for the month of Jan 2009. In all 17 parameters were studied. These includes Colour, temperature, pH, electrical conductivity, TDS, TSS, BOD, COD, Chloride, sulphate, Nitrate, Phosphate, Calcium, Magnesium, Sodium and Potassium ions. The pollution levels from these industries were found to be very high and alarming and hence proper care must be taken for the treatment of these effluents before they are released to the sewage. Many big industries have their own effluent treatment plants, but small scale industries are not following the guidelines prescribed for the industrial effluents. The study has shown that almost all the parameters are on the higher levels than the prescribed limit and hence proper treatment methods are needed.

Key words: Industrial effluents, physicochemical properties, WHO, Vapi GIDC, Gujarat.

INTRODUCTION

The need to control toxic materials from the effluents is currently increasing which may cause serious health problems like cancer and diseases. Water is the most vital resource for all kinds of life on this planet, but it is being adversely affected both quantitatively and qualitatively by all kinds of life. Today most of the rivers receive millions of litre sewage domestic waste and industrial effluents containing varying in characteristics from simple nutrient to highly toxic substances. In recent years, increasing industrialization, urbanization and developmental activities with the population explosion leads to generation of large amount of waste water from domestic, commercial, industrial and other sources. Industrial waste waters directly discharged in to river, lake, nallas, and khadi and created new pollution problem[1]. Industrial pollution is found in large amount in some industrial areas like, Surat, Vapi and Ankleshwar of Gujarat. The data collected by various agencies like CPCB, Greenpeace Research Laboratories, and Center for Science and Environment (CSE) revels that, in these area deteriorating the quality of the ground water[2]. Therefore an attempt has been made to study the physic-chemical characteristics of effluents of various industries located in Vapi GIDC. The pollution level of each effluent is compared with the guidelines as prescribed by WHO and Indian Standard Institution.

EXPERIMENTAL

Study Area

Vapi GIDC in District Valsad, Gujarat, is one of the large industrial areas in Asia. There are about 832 industries of which around 759 are the polluting ones. Of these 653 are in the red-category list of Central Pollution Control Board (CPCB). Seventy per cent of the 759 factories include those manufacturing fine chemicals, Pharmaceuticals, dyes, dye intermediates, pesticides, agrochemicals, textiles, various metals, alloys and many more. The remaining are mostly Pulp & paper mills, plastic, and food processing units.

Several times, factories in Vapi dump their spoilt batches, and waste material in open places. These materials contain chemicals that are highly toxic. Large quantities of partially treated but highly polluted effluents are discharged into Damanganga and Kolak river. Industrial effluents having large amount pollutant load and if not treated properly, discharge it river and nullas and pollute the ground water. People who live near the area use the water from the river or open wells and bore wells for domestic purposes.

Sampling

Industrial effluents were studied for five months intervals during Sept. 2008-Jan 2009. However in this paper data is presented for the month of Jan 2009. The 24 different industrial effluents were collected for the physico-chemical analysis. The sampling and analysis of industrial effluents require greater care and attention. Considering the above mentioned points, the collected samples were not only representative but also homogeneous and quite sufficient to provide required data. Samplings of industrial effluents were carried out in previously dried polythene containers of 2 litres capacity. Every sample was labeled appropriately and brought back to the laboratory for the chemical analysis[3].

Analytical Procedures

The effluents were studied for physical, chemical, biological parameters. All the chemicals used were AR grade and were purchased from S.D. Fine chemicals Ltd. PH and temperature of the effluents were measured in the field itself. Dissolved oxygen was also fixed in the field itself Electrical conductivity and TDS were determined by Elico model Conductivity TDS analyzer. Total suspended solids, Total Hardness, Biological Oxygen Demand, Chemical Oxygen Demand, Chlorides, Nitrate, Sulphate, and phosphates were determined as per standard procedures[3]. Na^+, K^+, Ca^{+2}, and Mg^{+2} were determined by Flame Photometer (Model Elico CL-178).

RESULTS AND DISCUSSION

The present study was carried out to find the suitability of industrial effluents for irrigation purpose and to study the physico- chemical characteristics during a period of five months from Sep 2008-Jan2009, however in this paper; data is presented for the month of Sept 2008. Overall all the parameters were found on the higher side and the pollution levels and hence proper treatment methods are advised before the industrial effluents are released to the sewage[4]. The data of different physicochemical and biological parameters are presented in Table-1 andTable-2.

Temperature

Temperature affects chemical, biological reactions in water. In the present study, it varies from 28 to 29.5 ^{0}C, but there are cases where that temperature has been reported more than 40 ^{0}C due to reactions in the plants (nuclear and thermal power plants).Generally the effluents are suitably diluted before they are released to the sewage[5].

pH

The pH values are in the range 6.5-8. This is in accordance with the WHO permissible limit (6.0-8.5). But two samples E_{10} and E_{16} show very high acidic range (pH1.17 to 1.55).The extreme pH of wastewater are generally not acceptable, as lower pH cause problems to survival of aquatic life. It also interferes with the optimum operation of wastewater treatment facilities. Water with high or low pH is not suitable for irrigation. At low pH most of the metals become soluble in water and therefore could be hazardous in the environment. At high pH most of the metals become insoluble and accumulate in the sludge and sediments. The toxicity of heavy metals also gets enhanced at particular pH[6].

Electrical conductivity

The electric conductivity of water is a measure of the ability of a solution to conduct an electric current; this ability depends upon the presence of ions, their total concentration, mobility and temperature of

water. The conductivity of the water is one of the important parameter used to determine the suitability of water for irrigation. It is useful indicator for salinity or total salt content of waste water[7]. In present study, only two samples E7 and E22 shows EC within limits prescribed by WHO(1400µS/cm) and other samples exceeds limits, and hence they are unfit for irrigation .Thus suitable treatments are required before they are released to the sewage.

Table -1: Physico-chemical parameters of industrial effluent. (Sample E_1 to E_{12})

Sample No.	Temp O^oC	pH	EC µS/cm	TDS	TSS	DO	BOD	COD	Cl^-	$S04^{2}$	NO^{3-}	$PO4^{3}$	Ca^{2+}	Mg^{2+}	Na^+	K^+
E_1	28	7.11	5140	3447	257	0.8	320	1770	364	200	2.9	7	398	112	912	4
E_2	28.1	8.05	5130	3439	281	1.0	260	1470	690	288	3.8	41	178	324	954	0
E_3	28	7.08	2900	1943	184	0.0	170	4368	200	488	2.0	4	302	346	399	0
E_4	27.9	5.04	16850	11298	227	0.0	210	8220	2886	213	11	56	652	456	2205	7
E_5	28	6.98	12200	8174	234	0.0	218	5600	870	650	234	46	3650	1134	1172	29
E_6	28	6.32	22600	15142	212	0.99	210	1236	249	1700	430	87	1510	334	1928	8
E_7	28.9	7.01	14900	9983	82	1.6	90	167	156	144	3.8	10	103	65	75	73
E_8	29	7.14	59130	39643	712	0.9	678	1238	3863	2789	88	23	3307	554	5446	18
E_9	29	7.16	17120	11521	890	1.3	892	1770	564	2300	345	21	185	340	3289	5
E_{10}	29.5	1.17	20100	13467	121	0.0	129	2390	4400	1200	123	47	212	2340	806	8
E_{11}	28.4	6.76	15000	10050	670	0.0	568	4368	3400	234	66	70	952	456	2528	74
E_{12}	28.5	6.29	7670	5171	148	1.1	128	450	1232	125	43	74	1725	989	778	38

(All values are expressed in mg/L, except Temp. EC)

Total dissolved solids

Total dissolved solid is the measure of total inorganic salts and other substances that are dissolved in water**.** The effluents with high TDS value may cause salinity problem if discharged to irrigation water[8]. The total dissolved solids in various industrial effluents ranged from 1557- 39643 mg /L. The effluent samples from paper and pulp mill, fine chemical, agrochemical, Textile and dyes industries samples show higher TDS values compared to WHO and hence treatments are needed.

Total Suspended solids

In the present Study, the total suspended solid were found in the range of 82 to 4410 mg/L, which was very higher value compare to limit set by WHO.

Nitrates and Phosphates

20-50 mg/L of nitrates and 0-20mg/L of phosphates are permissible for irrigation. More than 75% of the samples are having higher concentration levels; they are unfit for irrigation without proper treatments.

Dissolved Oxygen (DO)

Dissolved oxygen levels are found to be very low and hence a lot of oxygen has been used up. It shows the increased concentration of organic matter. More than 4 mg/L is desirable but all the samples show very negligible amount of DO. The presence of free oxygen in water is an indication of the ability of that water to support biological life. Low value of DO may be due to higher water temperature and increased activity of microorganisms in the water which consumes a lot of oxygen due to metabolic process and the decomposition of organic material[9].

BOD and COD

BOD measure the amount of oxygen requires by bacteria for breaking down to simpler substances from the decomposable organic matter present in any water and COD test is useful in pinpointing toxic

condition and presence of biological resistant substances[10]. In the present study BOD and COD values were found in the range of 90 -1213mg /L and 167 – 8220 mg/L respectively which goes higher side than the limit WHO.

Table-2 : Physico-chemical parameters of industrial effluent. (Sample E_{12} to E_{24})

Sample No.	Temp O^o_C	pH	EC µS/cm	TDS	TSS	DO	BOD	COD	CI^-	$S04^{2-}$	NO^{3-}	$PO4^{3-}$	Ca^{2+}	Mg^{2+}	Na^+	K^+
E_{13}	28	8.49	15970	10731	590	0.3	610	2789	427	778	90	59	427	445	2028	71
E_{14}	28.1	7.12	2920	1958	223	0.7	241	1000	526	764	23	45	526	765	445	5
E_{15}	28	6.4	11200	7504	884	0.0	879	4459	975	3489	87	14	975	1267	1389	16
E_{16}	27.9	1.55	16630	11143	462	2.0	382	822	6750	5467	46	41	6750	1250	500	41
E_{17}	28	5.12	13020	11730	671	0.0	658	4890	6450	1290	89	12	6450	3246	1445	11
E_{18}	28	6.8	3590	2405	783	0.2	811	3567	1942	669	36	47	1942	1200	108	10
E_{19}	28.9	6.75	2320	1557	463	0.12	453	3123	302	124	5.0	9	302	34	96	14
E_{20}	29	7.41	5140	3447	920	1.0	998	1457	298	289	9.0	45	298	1560	639	23
E_{21}	29	7.77	7020	4705	575	2.34	677	678	1012	349	31	23	1012	327	1028	10
E_{22}	29.5	7.67	13200	8846	1013	0.03	1213	3456	921	545	22	42	921	654	2168	13
E_{23}	28.4	7.24	3090	2008	230	0.8	272	179	421	234	45	49	421	374	189	24
E_{24}	28.9	6.8	3130	2098	441	1.2	378	1238	2256	346	37	56	2256	957	5693	5
Mean	28.4	6.47	11780	14788	635.0	0.68	476.8	2491	2239	1028	83	141	1477	855.3	1509	21

(All values are expressed in mg/L, except Temp. EC)

Chlorides and Sulphates

Concentration of Chloride varied from 200-600 mg/L and that of sulphate varied from 200-400 mg/l. More than 95% of samples show higher amount of Chlorides and Sulphates compared to WHO limits. (250 mg/L). Highcontration of Chlorides and Sulphates may due to use Chlorine compounds, like Hydrochloric acid, Hypochloric acid, chlorine gas and sulphate compounds like Sulphuric acid, Sodium sulphate, Aluminium sulphate etc. are used as a raw materials in various process[11],.

Sodium and Calcium

Sodium concentration was found in the range 65 to 5693 mg/L. and Calcium was in the range of 103 to 6470 mg/L which exceeds the limit set by WHO. The concentration of sodium and calcium in effluent may due to use large amount sodium and calcium compounds used in various manufacturing process[12].

Magnesium and Potassium

Magnesium concentration varies in the range of 34 to 3246 mg/L. 90% of samples exceeds the standard limit of WHO. Potassium concentrations were in the range of below detection limit to 74 mg/L.

CONCLUSION

From the result of physico-chemical analysis of industrial effluents, it has been concluded that EC, TDS, Chlorides, Sulphates, BOD, COD, Sodium and Calcium are very high in concentration compared to the standards prescribed by WHO. Few samples show negligible amount of DO. Such effluent should not be discharged in to the nearby water body or soil without treatment. They are unfit for irrigation. The high level pollution of the industrial effluents cause's environmental problems which will affect plant, animal and human life.[7-13]

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