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STUDY ON THE PHYSICO-CHEMICAL PARAMETERS OF DYE INDUSTRY EFFLUENTS FROM INDUSTRIAL ESTATE VATVA, AHMEDABAD, GUJARAT.

Suriyaprabha R [a] M H Fulekar [b]

[a]*School of Nanosciences;* [b]*School of Environment & Sustainable Development, Central University of Gujarat, Gandhinagar- 382030*

Abstract – *Physicochemical characteristics of some industrial effluents collected from various industries in and around Vatva Industrial Estate located in Ahmedabad. The study reveals that the effluents from industrial estate need to be treated properly to avoid the pollution in water and soil. Chemicals, dyes & textile industries are some of the major industries responsible for polluting surrounding aquatic environment. It was observed that pH values of effluent samples collected from dyes and textile industries shows extremely high total dissolved solid content. Besides this various other parameters were also calculated for waste water samples like Colour, Temperature, Electrical Conductivity, TDS, TSS, BOD, COD, Chloride, Sulphate, Nitrate, Phosphate, Calcium, Magnesium, Sodium and Potassium ions. The result of the present investigation points out the need to implement advances and improvement in waste water treatment methods and implementation of various compatible policies and objectives.*

I. Introduction

With the rapid industrialization in the country, environment pollution by industrial waste has increased tremendously [1]. The discharge of waste water from industries such as dyeing, tanneries, paper and pulp, textile, petroleum, chemical industries etc. pollute water bodies. Wastewaters contaminated by dyes represents a relevant issue associated with several industries. Dyes, even at very low concentrations, reduce wastewater transparency and oxygen solubility and are often toxic and recalcitrant; moreover, these chemicals are toxic, carcinogenic or mutagenic for various organisms [2]. In addition, coloured streams are characterized by large fluctuations of composition, pH and temperature [3]. Central Pollution Control Board has listed the dye and dye intermediates industry as one of the heavily polluting industries [4].

These industries use a variety of chemicals and azo dyes (direct, reactive, rapid, mordant and premetalised etc.) during processing and finishing of raw materials. The workers in these industries are exposed to such dyes with no control over the length and frequency of exposure. Further, a huge volume of untreated textile dye wastewater is released into surface waters through the drainage systems, that seep into the ground water and adjoining water bodies. Industrial effluents contain dyes, aniline, caustic soda, acids, bleaching powder, heavy metal ions etc. Most of the heavy metals are essential for growth of organisms but are only required in low concentrations [5].

Several studies have been conducted by different scientists on adverse effects of textile effluents on soil and water environment [6]. Untreated or incompletely treated textile effluent can be harmful to both aquatic and terrestrial life by adversely affecting on the natural ecosystem and long term health effects [7]. Considering the environmental impact of pollution arising due to dyeing industries at global level and in India the present investigation attempts was made to carry out the comprehensive survey of pollution monitoring of the effluents released from such industries located in Vatva Industrial Estate, Ahmadabad, Gujarat.

II. Materials and Methods

A. Study Area

Vatva Industrial Estate, Ahmedabad started in the year 1968, when Gujarat Industrial Development Coporation (GIDC) took steps to initialize the industrial revolution of Gujarat. Vatva is one of the oldest and largest industrial estates in the state, spread over an area of about 537 hectares and has over 2500 industrial units in four phases. This estate is a part of Ahmadabad Municipal Corporation (AMC).

B. Sample Collection and Analysis

The industrial waste water effluent were collected from six representative dyeing units of Vatva Industrial Estate of Ahmadabad and named as Site-1, Site-2, Site-3, Site-4, Site-5 and Site-6.

The samples were collected and analysed for the following parameters (Table1). The techniques and methods followed for collection, preservation, analysis and interpretation are those given by APHA, 2002 [8].

Table 1. List of Parameters

Physical Parameters	pH, Colour, Odour, Temperature, Electrical Conductivity, Total Suspended Solids, Total Dissolved Solids, Total Solids, Turbidity and Salinity
Chemical Parameters	Phenolphthalin Alkalinity, Total Alkalinity, Carbonates, Bicarbonates, Chloride, Sodium, Potassium, Total Hardness, Calcium Hardness, Magnesium Hardness, calcium, Magnesium, Total Organic Carbon, Phosphate, Sulphate, Sulphide, Nitrite and Nitrate
Organic Parameters	Dissolved Oxygen, Biological Oxygen Demand and Chemical Oxygen Demand

III. Results and Discussion

The experimentally measured data on physico - chemical properties of industrial waste water effluents released from dyeing industries located in Vatva Industrial Estate, Ahmadabad, India is presented in Tables 2, 3 and 4.

Table 2: Physical Parameters of Dye Effluent

Parameters	Unit	Site -1	Site -2	Site-3	Site -4	Site-5	Site-6
pH	-	7.22	7.45	6.41	7.44	5.87	7.74
Colour	Hazan	Above 50	Above 5	Above 50	Above 20	Above 20	Above 50
Odour	-	O	UO	O	O	O	O
Temp	(°C)	27	28	27	29	27	30
EC	(µs/cm)	19700	13600	26100	31800	24000	23100
TSS	(mg/L)	555	300	450	550	320	280
TDS	(mg/L)	12850	8840	16965	20670	15600	15015
TS	(mg/L)	13405	9140	17415	21220	15920	15295
Turbidity	(NTU)	175.5	42	158	70	84	131
Salinity	(mg/L)	108.36	74.97	138.75	174.16	132.71	127.00

pH

The acidic and basic nature of the effluent can be identified by the pH value and it also determines the presence or absence of various ionic species of the textile effluent. From table 2 it was found that the pH values ranged from 5.80 to 7.80, which varies from slight acidic to slight basic condition, indicating the presence of both acidic and basic dye. The pH of the effluents was found to be within the permissible limit (5.5 – 9.0). pH of effluents affects physical and chemical properties of water which in turn adversely affects aquatic life, plants and humans. This also changes soil permeability which results in polluting underground resources of water [9].

Colour

Colour of the effluent is one of the major problems in textile industry and it is widely accepted primary pollutant in wastewater. In fact colour in the effluent is easily visible to human eyes even at very low concentration and no one likes the appearance of dirty water.

Temperature

Chemical and Biological reactions of water is affected by temperature is common. Temperature of waste water evolving from manufacturing area may affect soil texture and if released straight on to the land it may increase the microbial activity and it decreases the fertility of soil [10].The temperature of samples varies from 27.0^{o}c to 30.2 ^{o}c as showed in Table.2

Electrical Conductivity (EC)

Electrical Conductivity shows the concentration of ions in the water. In samples it varies from 13600- 31800(µs/cm) given in table 2. 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. In present study, samples shows the higher EC than the limits prescribed by WHO (1400µS/cm), and hence they are unfit for irrigation. Thus suitable treatments are required before they are released to the sewage. [11]

Total dissolved solids (TDS)

Total dissolved solids are the measure of total inorganic salts and other substances that are dissolved in water**.** The effluents with high TDS value will cause salinity difficulties if discharged to irrigation water. The total dissolved solids in different industrial effluents ranged from 8840-20670 mg /L. The effluent samples taken from Textile and dyes industries showed higher TDS values compared to WHO (2,000 mg/L),) and hence treatments are needed.

Total Suspended solids (TSS) and Total Solids (TS)

In the present study, the total suspended solids were found in the range of 280 to 550 mg/L, and TS values ranges between 9140-21220 (mg/L) which were very higher values comparing to the limit set by WHO.

Turbidity& Salinity

As there is high level of total solids present in the samples there is increase in the turbidity i.e., reducing the clarity of water and the rate of photosynthesis also decreases. The samples showed the high turbidity level of 42- 175.5(NTU). Salinity also increases when the total solids are high. A large number of salts present in the water lowers the density and reduces the solubility of gases such as oxygen. The sample depicts varying salinity level from 74.97- 174.16 (mg/L)

Table 3: Chemical Parameters of Dye Effluent

Parameters	Unit	Site -1	Site -2	Site-3	Site -4	Site-5	Site-6
Total Alkalinity	(mg/L)	2000	4800	2400	2800	1400	3200
Chloride	(mg/L)	5998	4150	7680	9640	7346	7030
Sodium	(mg/L)	3891.02	2692.20	4982.84	6254.32	4766.85	4561.64
Potassium	(mg/L)	995.52	688.80	1274.69	1600.00	1219.26	1166.81
Total Hardness	(mg/L)	3900	3100	3400	6000	5400	4000
Ca Hardness	(mg/L)	2200	1700	2000	3400	3200	2300
Mg Hardness	(mg/L)	1700	1400	1400	2600	2200	1700
Calcium	(mg/L)	881.76	681.36	801.6	1362.72	1282.56	921.84
Magnesium	(mg/L)	413.1	340.2	340.2	631.8	534.6	413.1
Phosphate	(mg/L)	4.92	3.88	4.41	6.48	3.77	2.61
Sulphate	(mg/L)	12800	10400	16300	20800	16400	17000
Nitrate	(mg/L)	0.73	0.45	0.61	0.88	0.42	0.33

Total Alkalinity:

Table 3 shows high Alkalinity in all the samples. The change in alkalinity depends on carbonates and bicarbonates, which in turn depends upon the release of CO_2. Change in carbonates and bicarbonates is also depends upon the release of CO_2 through respiration of living organisms. The amount of total alkalinity in the samples ranges between 1400 to 4800 mg/l .The addition of large amount of organic pollutant in the lake also effect photosynthesis rate, which also result in death of plants and living organism. The degradation of plants, living organism and organic waste might also be one of the reasons for the increase in carbonate and bicarbonate, resulting in increase in alkalinity value. [12].

Total Hardness:

Hardness of water is mainly due to the presence of calcium and magnesium ions, and it is an important indicator of the toxic effect of poisonous elements. [13]. The hardness of water is the measure of the capacity of water to react with soap. Total hardness recorded in the samples ranges between 3100-6000 (mg/L) which is the total of Calcium Hardness (1700-3400mg/L) and the Magnesium Hardness 1400-2600(mg/L).

Nitrates and Phosphates

20-50 mg/L of nitrates and 0-20mg/L of phosphates are permissible for irrigation. Samples possess the values in permissible limit as shown in table 3.

Chlorides and Sulphates

Concentration of Chloride varied from 4150 - 9640mg/l and that of sulphate varied from 10400-20800 mg/l. More than 95% of samples show higher amount of Chlorides and Sulphates compared to WHO limits. (250 mg/L). High concentration of Chlorides and Sulphates may be 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[14].

Sodium and Calcium

Sodium concentration was found in the range 2692.20-6254.32 (mg/L) and Calcium was in the range of 681.36-1362.72 (mg/L) which exceeds the limit set by WHO. The concentration of sodium and calcium in effluent may be due to use of large amount of sodium and calcium compounds in various manufacturing process [15].

Magnesium and Potassium

Magnesium concentration varies in the range of 340.2 -631.8 (mg/L). 90% of samples exceed the standard limit of WHO. Potassium concentrations were in the range of 688.80-1600.00(mg/L).

Table 4: Organic Parameters of Dye Effluent

Parameters	Unit	Site -1	Site -2	Site-3	Site -4	Site-5	Site-6
Dissolved Oxygen	(mg/L)	7.8	6	9.3	7.2	7.4	9.5
BOD (mg/L)	(mg/L)	1600	36	1900	2200	1000	480
COD (mg/L)	(mg/L)	7600	160	8300	10500	4500	2400
TOC	(mg/L)	41.32	55.83	38.87	11.83	7.5	10.31

Dissolved Oxygen(DO)

The dissolved oxygen amount in waste water sample was very less, due to high amount of BOD and COD. The samples showed values ranging between 6-9.5(mg/L)

Biological Oxygen Demand (BOD)

BOD may be defined as rate of removal of oxygen by microorganisms in aerobic degradation of the dissolved organic matter in water over a 5-day period. Increase in BOD can be due to heavy discharge of industrial waste water effluent, which contains enormous amount of organic matter. Maximum permitted BOD content is <100 to 300 mg/L. The experimental data reveals Industrial effluents from the dye industry has BOD 480-2200 (mg/L) respectively as showed in table4. The grater is the BOD lesser will be the dissolved oxygen in water.

Chemical Oxygen Demand (COD)

From table 4, the maximum COD value was recorded as 160-10500 (mg/L). Commonly, organic strength of the effluent can be identified by COD values. Increases in COD can be due to huge amount of industrial wastes such as detergents, softeners, non-biodegradable dyeing chemicals, formaldehyde based dye fixing agents etc. Higher concentration of COD in water implies toxic conditions and the presence of biologically resistant organic substances [16]. Hence the effluent is incompatible for the survival of the aquatic living organisms due to the reduction of DO content.

Total Organic Carbon (TOC)

In table 4 the Total organic carbon (TOC) ranges between 7.5 -55.83 (mg/L) indirectly measures the total amount of organic substances present in water. This also correlates with the values of BOD and COD.

IV. Conclusion

According to the results of physico-chemical analysis of Dyestuff 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. Such effluent should not be discharged in to the nearby water body or soil without treatment. They are unfit for irrigation. The high levels of TDS and TSS are of major cause of concern due to increased incidences of cancer. The experimental data suggests a need to implement common objectives, compatible policies and programmes for improvement in the industrial waste water treatment. The high level pollution of the industrial effluents cause's environmental problems which will affect plant, animal and human life.

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