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ORIGINAL ARTICLE

STUDY OF PHYSICO-CHEMICAL INVESTIGATION FOR ASSESSMENT OF POLLUTION IN AND AROUND INDUSTRIAL AREA

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ABSTRACT:

For this investigation we have selected Palghar and Tarapur MIDC areas. The industrial effluent samples have been collected from both the industrial areas. Some nearby soil and ground water samples were also collected for correlation and comparison. Under this investigation we have analyzed the industrial sample for the parameters like pH, conductivity, TS, TSS, TDS, chlorides, sulphides and nitrates etc. For the impact assessment of industrial wastes some nearby soil and ground water samples have been analysed for the same parameters.

Keywords- Industrial effluent, assessment, correlation.

INTRODUCTION:

The technological advancements have sustained our industrialized society. The explosive development of chemical industries has produced a great variety of chemical compounds, led to the modernization of our life-style. Large-scale production of variety of chemical compounds however has caused global descent of environmental quality. The large volume of water has been consume by Indian industries for various processes and discharged nearly equal volume of water as an effluent in to surface water or on to land. As far as pollution from industries is concern effluent in most of the cases are discharged in to rivers, streams, pits, open ground or open unlined drains near the factories thus allowing it to move to low line depressions resulting in severe ground water pollution. The magnitude of damaged caused to our water resources can be estimated from the fact that about 70% of rivers and streams in India contain polluted water (1).

A considerable amount of water is used in industrial sector of the various purposes such as preparation of solutions, dilutions and other chemical process. More than 50% of water supply used in chemical plant is utilized for cooling purposes that is to carry heat by warming or by evaporation. Thus quality and quantity of water available are important in location of chemical plant. Worldwide, industry accounts for about ¼th all water used ranging from 70% of withdrawal in some European countries such as Germany, to 5% in less industrialized country. Cooling water for power plant is for the largest single industrial use of water typically accounting for 50-100% of industrial withdrawal (2).

Many of the industries like electroplating, metal finishing, tanneries, textile dying and printing, pulp and paper, distilleries wastewaters contains heavy metals, dyes and organic chemicals. Pesticides and chemical fertilizers are major sources of pollution followed by industrial processes waste and wastewater, sludge-disposal and accidental release. The environmental contamination by toxic heavy metals from industrial effluents is considered to be one of the serious problems, which get aggravated due to their accumulation in the food chain, adverse effect on human and aquatic system. Due to the non-biodegradable nature of the heavy metals, their concentrations in the environment increases continuously (3).

For this investigation the samples were collected from the Palghar and Tarapur MIDC areas. These areas are one of the important industrial belts situated nearby Mumbai

MATERIAL AND METHODS:

The experimental sites of industrial areas of Palghar and Tarapur MIDC were selected. These areas are well connected to the other part of the country by roads, railways and air transport etc. Basically this is an urban region, but most of the people living in this region are occupied with agriculture and depending on the ground water for various purposes. Due to rapid growth of population, industrialisation and urbanisation this region is facing a serious problem of pollution. In view of this problem, the industrial wastewater amended soil and ground water samples from above industrial areas were collected for the present study.

COLLECTION OF THE SAMPLES:-

a) Industrial wastewater samples:

The Industrial wastewater samples from different experimental sites were carefully collected as per standard methods (4-5). These samples were stored in polythene cans and brought to the laboratory and analysed by following standard methods (6-8).

b)Amended soil samples:

To investigate the effect of the sewage on soil properties, the sewage amended soil samples were collected carefully by following procedure recommended by United States, Department of agriculture (9). Some soil samples were also collected from agricultural farm, which was irrigated, by well water for comparison (i.e. control site). These soil samples were dried, crushed and sieved through 2 µm and stored in polythene bags for analysis.

c) Ground water samples:

To investigate the effect of industrial wastewater on ground water resources, the ground water samples (i.e. open well and hand pumps) near the experimental areas were collected and analyzed by standard methods. For comparison some ground water samples remote from industrial area (i.e pollution free zone) were also collected and analyzed for the study.

Methods for the determination of physico-chemical characteristics:

During the course of present study, some salient physico chemical characteristics of industrial wastewater, amended soil and water samples (i.e open well, bore well,) have been determined by using following standard methods.

pH :

The pH of the sewage and all water samples were measured immediately at the time of sampling by using electronic pen type pH meter, model pH ep/HANNA, Mauritius. The amended soil pH was measured in 1:5 soil/amended soil water extract.

Conductivity:

The conductivity of all the samples were measured by a ‘chemito’ digital conductivity meter having a cell constant of 1.04 cm^{-1}. For the industrial wastewater, 1:5 amended soil-water extract (11) was used to measure conductivity. It is measured in µmhos/cm.

Total Dissolved Solids (TDS) :

50 ml of filtered sample (Industrial wastewater or ground water) was boiled in clean and preweighed beaker upto dryness. The beaker was cooled and weighed. The amount of total dissolved solids was then calculated (5) by using the following formula.

$$\text{Total Dissolved solids, mg/l} = \frac{A - B \times 1000 \times 1000}{(v) \text{ ml of sample}}$$

where, A – Final weight of beaker in gm
B - Initial weight of beaker in gm.
V – volume of sample taken in ml.

Total Solids:

50 ml of unfiltered sample (Industrial wastewater or ground water) was boiled in a clean and preweighed beaker upto dryness. The beaker was cooled and weighed. The amount of total Suspended solids was then calculated (5) by using the following formula.

$$\text{Total solids, mg/l} = \frac{A - B \times 1000 \times 1000}{(v) \text{ ml of sample}}$$

where, A – Final weight of beaker in gm
B - Initial weight of beaker in gm.
V – volume of sample taken in ml.

Total Suspended Solids:

Total Suspended Solids are determined by difference between the total solids and total dissolved solids.

$$TSS = TS - TDS$$

Chloride:

The concentration of chloride was determined by titrating 50 ml of sample (1:5 soil-water extract in case of soil) against 0.02N $AgNO_3$ by using potassium chromate as an indicator. The concentration of chloride was calculated by using the following relationships:

i) Industrial wastewater and ground water samples:

$$\text{Chloride, mg/l} = \frac{(\text{ml} \times \text{N}) \text{ of } AgNO_3 \times 35.5 \times 1000}{\text{ml of sample}}$$

ii) For amended soil samples:

$$\text{Chloride, mg/g} = \frac{(\text{ml} \times \text{N}) \text{ of } AgNO_3 \times 35.5 \times 10^4}{\text{ml of soil solution} \times 2}$$

Sulphate:

Sulphate was estimated gravimetrically. A suitable volume of sample (100 – 150 ml in case of industrial wastewater and ground water or 50 ml 1:5 soil-water extract in case of amended soil) was boiled with con.HCl (0.5 ml) for five minutes followed by drop wise addition of 20 ml of 5 % barium chloride (AR) solution. After allowing the solution to stand for about half an hour, the precipitate of

barium sulphate was filtered through a Whatman No. 42 filter paper and washed with hot distilled water. The precipitate was then dried, ignited and weighed. The concentration of sulphate ions has been calculated by using following formula:

i) For industrial wastewater and ground water samples:
ii)

$$\text{Sulphate, (mg/l)} = \frac{\text{mg } BaSO_4 \text{ x } 411.5}{\text{ml of sample}}$$

iii) Amended soil samples:
iv)

$$\text{Sulphate, } (\mu g/g) = \frac{\text{mg of } BaSO_4 \text{x } 411.5 \text{ x } 10^4}{\text{ml of sample x } 2000}$$

Nitrate-nitrogen (NO_3 – N) :

The phenol disulphuric acid (PDA) method (2,5) was used for the determination of NO_3-N. Methods used for the preparation of standard calibration graph and detection procedure are being described below:

i) Preparation of standard solution :

A solution containing 100 mg/l of nitrate-nitrogen was prepared by dissolving 0.722 gm of potassium nitrate (AR) in 1000 ml of deionised water. 50 ml of the above solution was taken in a porcelein dish and evaporated to dryness. The porcelein dish was cooled and the residue was dissolved in 2 ml of PDA and transferred to a 500 ml measuring flask and diluted upto to the mark. This diluted solution contains 10 mg/l of NO_3-N.

RESULTS AND DISCUSSION:

The results thus obtained are being described and discussed under individual headings:

pH:

pH range 6-7.5 has been generally found to be optimum for biological environment under natural condition. The nitrification in soils takes place vigorously in this range and the intake of nutrients in the plants is found to be highly conductive. The availability of nutrients like phosphorous, calcium, magnesium and iron etc to the plant is controlled by the pH of the soil. The activity of the bacteria in soil considerably decreases when pH falls below 5.5. pH has no direct adverse effect on health. High pH in water bodies induces the formation of trihalomethanes which are toxic (12).

During the present study, the pH of Palghar and Tarapur industrial effluents varies between 4.1-8.2 and 6.5-9.1 respectively (Table-1). The pH of some of the industrial wastewater samples is more or less neutral and most of the samples are alkaline.

Conductivity:

Conductivity is a measure of the current carrying capacity of substance or solution, thus gives a clear idea of a soluble salts present in soil. In water it is the property caused by the presence of various ionic species. It is generally measured with the help of a conductivity meter having conductance cell containing electrodes of platinum coated with Pt. black or carbon. Conductivity

has got no health significance as such. However, it is an important criterion for determining suitability of water and wastewater for irrigation.

The Conductivity (Table-1) of Palghar and Tarapur industrial effluents varies between 1470-1960 and 1070-1940 μmhos/cm^{-1} respectively. The high conductivity value in ground water is because of percolation of water-soluble species from industrial wastewater through the soil bed.

Solutions of most inorganic acids, bases and salts are relatively good conductors. Conversely, molecules of organic compounds those do not dissociate in aqueous solution conducts current poorly (13). The presence of salts affects crops.

TDS, TSS, TS:

Total dissolved solid is a quantitative measurement of dissolved salts in water and wastewater. The dissolved solid concentration can be directly related to the conductivity. Total dissolved solids denote mainly various kinds of minerals present in the water and wastewater. Dissolved solids do not contain any gases and colloids.

In natural waters,dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron and manganese etc. In the polluted waters the concentration of other substances increases, depending upon the type of pollution. Concentration of dissolved solids as an important parameter in drinking water. They give a particular taste to the water of higher concentration and also reduce its potability (14).

The TSS of Palghar and Tarapur industrial effluents varies between 960-1808 mg/l and 1260-2320 mg/l respectively. A perusal of the table - 2, indicates the concentration of TDS. The TDS of Palghar and Tarapur industrial effluents varies between 1420-2600 and 560-3640 mg/l respectively. The TS of Palghar and Tarapur industrial effluent varies between 1628-3360 mg/l and 1340-4960 respectively.

Chlorides:

Chloride is also known to influence photosynthesis and root growth and suffers if it is absent. Sometimes, equipment failure or damage of chlorine container leads to leakage of chloride into the atmosphere and it is added to soil in considerable quantities each year through rain water. The presence of chlorine in soil gives rises the formation of some chlorocomplexes (15). Chloride ion concentration bear a conjugational relationship with mineral content of the respective water samples; During the present study, The concentrations of chloride in industrial effluents at Palghar and Tarapur MIDC was found to be in the ranges of 208-4793 and 106-5545 mg/l, respectively.

Sulphate:

Like chlorides, most of the sulphate salts are soluble in natural as well as in wastewater and in combination with calcium and magnesium it induces hardness in water. Sulphate can arrive from several sources such as dissolution of gypsum and other mineral deposits containing sulphates, from oxidation of sulphides, sulphites and thiosulphates in well aerated surface water and from industrial effluents where sulphate and sulphuric acid have been used in process. Also sulphurous fuel gases discharged into atmosphere in industrial area often result in acidic rain water containing appreciable level of sulphate. The adverse effect of acid rain on the micro-organisms, plants and fishes of river and lakes have been well documented. When sulphuric acid is added to the soil, the sulphate (SO_4^{-2}) of the acid can displace the calcium and magnesium ions.

A perusal of tables-3 indicates the presence of sulphate ion concentration in industrial wastewater.The concentrations of sulphate in industrial effluents at Palghar and Tarapur MIDC was found to be in the range of 1004-2296 and 982-2861 mg/l, respectively.

Nitrate- nitrogen (NO_3-N):

Nitrate-nitrogen (NO_3-N) (Table-3) content of industrial wastewater samples collected in Palghar and Tarapur MIDC was found to be in range 28.2-92.6 and 40.6-102.6 mg/l respectively. This high concentration is because of nitrification processes (16). It is a characteristic property of nitrates that they do not form any sparingly soluble salts in soil and due to high solubility, nitrates are quite mobile and migrates down with ease through the soil in presence of water.

Nitrification is a process of enzymatic oxidation of ammonia to nitrate by certain microorganisms in the soil. It takes place in two co-ordinated steps. The first step is production of nitrite (NO_2) ions by one group or organism (Nitrosomonas) apparently followed by further oxidation to nitrate (NO_3) form by another organism (Nitrobacter).

Table 1 - pH and EC of Industrial wastewater.

Sample No	pH		EC	
	Palghar	**Tarapur**	**Palghar**	**Tarapur**
1	8.1	6.6	1690	1070
2	7.8	7.1	1850	1800
3	4.1	7.5	1960	1940
4	4.2	7.7	1900	1460
5	7.8	6.5	1610	1260
6	8.2	9.1	1470	1400

EC is expressed in µmhos/cm.

Table 2 -The concentration of TS, TDS, and TSS mg/l in Industrial wastewater.

Sample No	TS		TDS		TSS	
	Palghar	**Tarapur**	**Palghar**	**Tarapur**	**Palghar**	**Tarapur**
1	2380	1340	1420	1040	960	1300
2	1628	1580	1188	1320	1440	1260
3	3360	4960	2600	3640	1760	2320
4	3008	2248	2200	1720	1808	1578
5	2320	1640	2160	560	1260	1720
6	1947	1720	1680	580	1468	1340

Table 3 - The concentration of Chloride, Sulphate and Nitrate (mg/l) in industrial Wastewater.

Sample No	Chloride		Sulphate		Nitrate	
	Palghar	**Tarapur**	**Palghar**	**Tarapur**	**Palghar**	**Tarapur**
1	208	1365	1052	1002	28.2	52.0
2	2670	5545	1165	1692	46.5	40.6
3	2542	3283	2296	2861	71.4	102.6
4	1473	2158	1712	1473	38.2	76.2
5	1592	106	1630	982	42.6	92.2
6	4793	1333	1004	1226	92.6	68.6

Table 4 - The Physico-chemical characteristics of GW samples collected from Palghar and Tarapur MIDC.

	Palghar MIDC							
Sample No	**PH**	**EC**	**TS**	**TDS**	**TSS**	**Cl^-**	**SO^-_4**	**NO_3-N**
1	8.0	300	460	420	40	36	402	28.0
2	8.1	670	580	528	52	97	516	57.2
	Tarapur MIDC							
Sample No	**PH**	**EC**	**TS**	**TDS**	**TSS**	**Cl^-**	**SO^-_4**	**NO_3-N**
1	8.1	340	260	200	60	47	162	21.0
2	7.9	720	280	240	40	58	614	23.2

All values are expressed in mg / l except pH and EC.

CONCLUSION:

The results obtained during the course of present investigation, it was found that effluents are very much polluted in all respect. The effluents are either acidic or basic in nature and constantly effluents are coming out from these industries at considerable high rate, which affect the soil and underground resources of these areas. It was found that it also affects underground water and makes it polluted. Peoples living in these areas are consuming hand pump water for household purpose. Due to the soil pollution fertility of soil decreased significantly. An effluent gives toxicity to the soil after repeated use on the same part of land.

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