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Study on the Waste Water Quality and Sediments of the Industrial Area and It's Effect, Raigarh (C.G.) India

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Abstract: ***The present aim of the investigatory work is to determine the concentration and effect of the effluent or contaminant absorbed by the industrial waste water and sediments nearer to the industrial area (pond) of the Raigarh (C.G.) India. Samples of waste water and sediments collected in the month of December, January and February in the year 2019. The average range of physico-chemical parameter of waste water recorded are as follows– PH – 7.56, TDS – 613 ppm and Hardness – 264.4 g/L are higher in December. Cl – 89.8 g/L & BOD – 7.44 higher in January. Alkalinity 254.4 g/L higher and DO – 4.94 lower in February. Some values are within permissible limit of the drinking water standards (IS : 10500), some values are above the limits. The average range of measured concentrations in the total sediments are – PH – 8, EC – 677.4 µs/cm, Alkalinity – 3.37 mg/gm, N – 206 kg/hac (lowest), K – 151.544 kg/hac, OC – 0.02% (lowest), S – 68.802 kg/hac, Zn – 0.928 mg/kg, Fe – 31.616 mg/kg, Mn – 20.38 mg/kg, Cu – 1.624 mg/kg. The highest concentration of the metals or elements were found in the sediments due to higher adsorption of sediments which causes contaminations, pollution and diseases.***

Keywords: Industrial waste water, Pollution, Sediment, Effluent, Concentration, Contamination, Nutrients, Physico-Chemical Analysis

1. Introduction

a) Water

Water is an essential need of all living beings. Until the mid 18th century water pollution was essentially limited to small localized areas, then came the industrial revolution the development of the internal combustion engine with the rapid development of various industries, a huge amount of fresh water is used as a raw material as a means of production and for cooling purpose. Many kinds of raw materials, intermediate products and wastes are brought into the water, when water passes through the industrial process. So infact the waste water is an essential by product of modern industry and it plays a major role as a pollution sources in the pollution of water environment. The metal working industries discharge Cr, Ni, Zn, Cd, Pb, Fe, Ti compounds. Generally industrial based water can be divided into two types-

1) Inorganic Industrial waste water
2) Organic Industrial waste water

Inorganic Industrial waste water is produced mainly in the coal and steel industries. Water absorbs fine particles of ore, iron and coke which do not easily settle. Waste water is produced in addition to solid substances and oils and also contains extremely harmful solutes. The industrial waste water discharged directly from different industries affects the water quality and soil. (Sediment)

As we know the steel industry & power plant is one of the most important industry of the present and future. It is asset of nation. Steel plants use a tremendous amount of water for waste transfer, cooling, and dust control. Steel plants have sintering mills, coke plants, blast furnaces, chemical by products and chemical processes water cooled rolls, pumps, extrusion experiment, transfer lines for sludge's and slurries. All these plants use a tremendous amount of water to cool the products and flush the impurities away from the finished stock. Approximately more than 73% of power can be produced from the steam of industrial waste water than normal water. The 12 W batteries can be charged from 100 liters of waste water. This is an advantage, but on the other hand industrialization leads to spoil the water for agricultural purposes, for drinking purpose and also spoils the soil quality. According to WHO organization about 80% of all the diseases in human beings are caused by water.

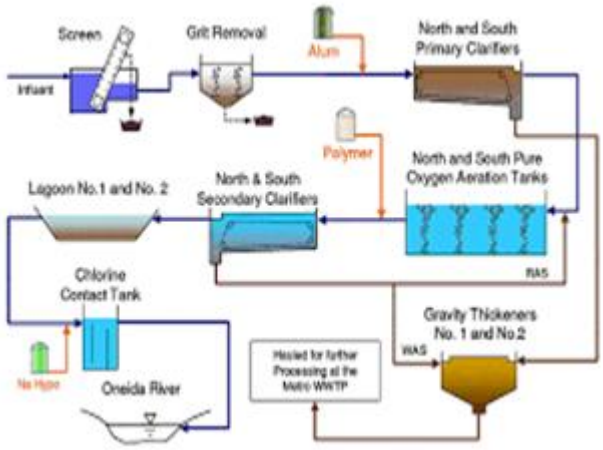
b) Sediment

Sediments are solid materials that settle at the bottom of the water bodies. Soil is defined as the weathered layer of the

earth's crust with living organisms and their products of decay intermingled. The trace elements and heavy metals are introduced into sediments by industrial waste. Contaminated sediments kill benthic organisms in fact almost all industrial processes that produce waste water discharges are potential sources of heavy metals to the aquatic environment. The livestock systems are prone to general problem of pollution emanating from industrial activity.

c) Industrial Waste Water Treatment

It covers the mechanisms and process used to treat waste water that is produced as a byproduct of industrial activities after treatment the treated industrial waste water may be reused or released to a sanitary sewer or to a surface water & soil.



2. Types of Waste Water Treatment Process

1) ETP – Effluent Treatment Plant
2) STP – Sewage Treatment Plant
3) CETP – Common and combined Effluent Treatment Plant

About a hundred years ago since the emergence of the relationship between the effect of pathogenic bacteria and microbes in out breaks and transmission of diseases, the man thought to cleanse and purify the polluted waters. In other words, water and waste water treatment technology in its current trend has arisen mostly due to advances in biology and medicine. This technology came to the consideration since gradual banning of waste water discharge into the natural resources of water, primarily to the rivers (Ahmed et al, 2001). Such preventions and restrictions led to the need for waste water treatment and development of its methodologies.

Glance at Raigarh – Raigarh is thickly populated city, many small & big industries are here. Industries like JSPL, Nalwa, and Monet etc. Industrial effluence treated and untreated discharge in dam, canal, fields, ponds, rivers, forest etc. Due to increasing industrialization on one hand and exploding population on the other hand, the demands of water supply have been increasing tremendously. The soil (sediments) also been affected by the effluent discharged from industries. Soil pollution is the contamination of the earth by any range of pollutants that are derived from industrial based. Industrial development in Raigarh has resulted an increase in metal contamination of local waters & sediment & caused environmental pollution. Therefore fresh water and soil (sediment) which are precious and limited vital resources needs to be protected conserved and used wisely by man.

3. The Study Area (Selection of Sampling Sites)

My study area is centralized to Raigarh, the industrial area of steel and power plant from where treated and untreated waste water is discharged to small ponds & canals and from there it reaches to fields & forest. Samples were collected from original site of the effluent discharge and other sites of the pond where the effluent is passed. The effluent passed to the pond, where it is stagnant and little by little discharged to the canal & other areas. Sample was collected from this area to know the variation in the quality and amount of elements deposited in the water and sediments by industrial process at different season. Samples were collected at the end of first week of December, January and February 2019.

4. Material and Methods

1) Treatment of Containers

Before sample collection new plastic bottles were bought and rinsed with 1% HNO_3 (Nitric acid) and washed with distilled water to make it decontaminated and dried well.

2) Collection of waste water sample & its preservation for analysis

Previously treated 1 liter airtight plastic bottles were used for the collection of samples. Waste water samples were collected from very close to the discharging place and other sites of the pond between 12: am. to 12:30 pm., as per instruction given. The samples were collected with the help of mug. Some of the physico-chemical analysis of water was done in the sample collection site itself, rest of the analysis were done in the laboratory. Each container was clearly marked with the name and date of sampling. 500 ml. water samples were prepared for metal analysis by adding 5 ml. of con. HNO_3 or $AgNO_3$ and preserved in the refrigerator.

3) Collection of sediments and its preservation for analysis

Sediments (Soil) were collected from same sites of the waste water collection with the help of dust pan and bottles. Sediments were decanted off and were left 2 days for drying. The air drying and freeze drying are satisfactory techniques, which enable preservation of sediment as representatives of the environment (Bordas and Bourg 1988) the air dried sediments were grounded and sieved; the fine powdered sample was taken to soil analysis laboratory in Raigarh for physico-chemical analysis and to detect the elements present in the sediments. Some sample was preserved in refrigerator for heavy metal analysis by adding con. HNO_3 or $AgNO_3$.

5. Results and Discussions

5.1 General parameters for waste water analysis

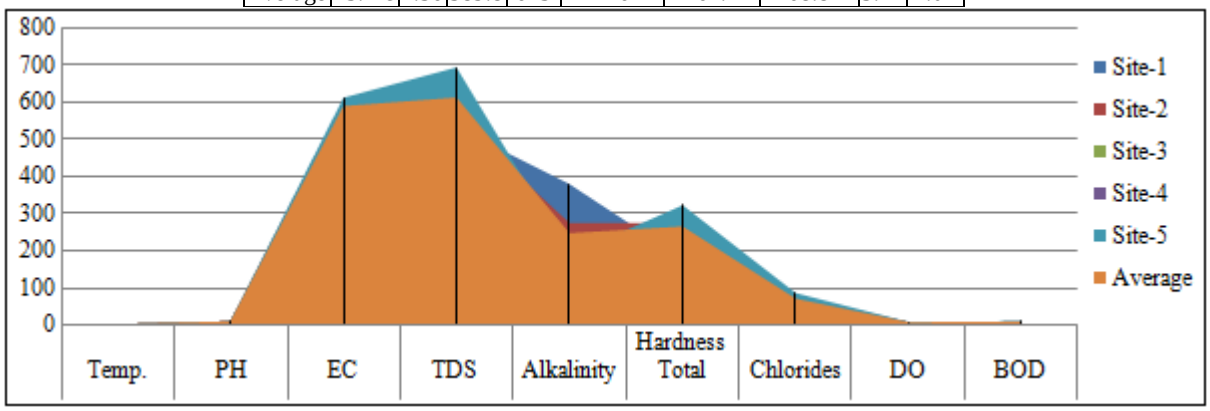
S.No.	Parameters	Apparatus & Methods	Unit
1.	Temperature	Thermometer	^{o}c
2.	PH	Digital PH meter (HI96107CE)	PH scale
3.	EC	Digital EC meter	µs/cm.
4.	TDS	Digital TDS meter	ppm
5.	Total Hardness	Titrimetric (EDTA)	g/L.
6.	Alkalinity	Titrimetric	g/L.
7.	Chlorides	Argentometric Titration	g/L.
8.	DO	Titrimetric	g/L.
9.	BOD	Titrimetric	g/L.

5.2 Drinking Water Standards (IS:10500)

S.No.	Parameters	Units	Desirable	Permissible
1.	PH	PH Scale	7.0 – 8.5	6.5 – 9.2
2.	TDS	g/L	500	1500
3.	EC	µs/cm.		
4.	Alkalinity	g/L	200	600
5.	Total Solids	g/L	500	1500
6.	Total Hardness	g/L	100	500
7.	Chlorides	g/L	250	600
8.	DO	g/L	4 – 6	4.0 – 6.0
9.	BOD	g/L	5	5
10.	COD	g/L	20	20
11.	Iron (Fe)	g/L	0.1	1.0
12.	Cu (Copper)	g/L	0.05	1.5
13.	Cr (Chromium)	g/L	0.05	0.05

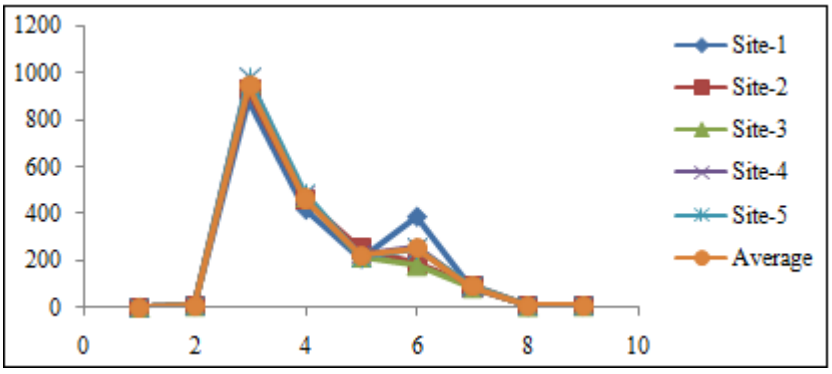
3. (a) Physico-Chemical Analysis of Industrial Waste Water in December

	Temp.	PH	EC	TDS	Alkalinity	Total Hardness	Chlorides	DO	BOD
Site-1	24°c	7.8	0577	0534	380	178	57	4.9	6.5
Site-2	23 °c	7.6	0573	0558	275	276	68	5.2	6.9
Site-3	23 °c	7.5	0582	0612	198	234	59	5.4	7.1
Site-4	23 °c	7.5	0604	0666	190	312	76	5.1	7.3
Site-5	24 °c	7.4	0613	0695	187	322	84	5.5	7.4
Average	23.4°c	7.56	589.8	613	246	264.4	68.8	5.22	7.04



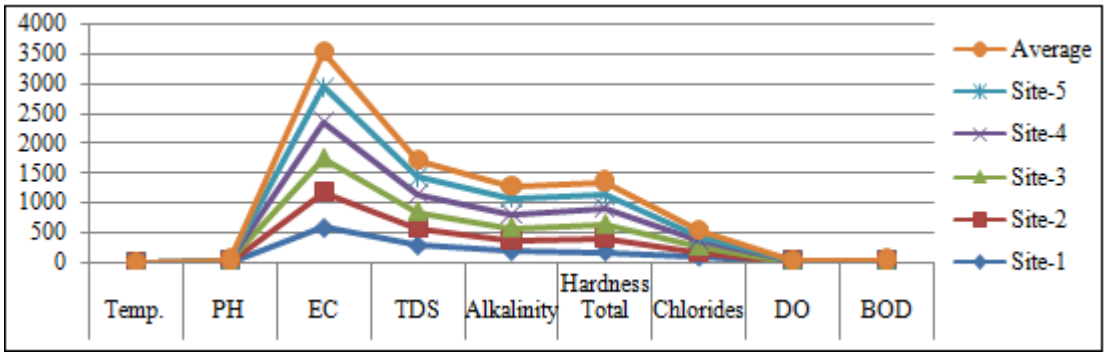
(b) Physico-Chemical Analysis of Industrial Waste Water in January

	Temp.	PH	EC	TDS	Alkalinity	Total Hardness	Chlorides	DO	BOD
Site-1	23 °c	7.4	0884	0417	209	387	87	5.7	7.5
Site-2	24 °c	7.2	0931	0464	253	190	95	5.3	7.2
Site-3	24 °c	7.3	0952	0469	215	179	85	5.8	7.4
Site-4	25 °c	7.2	0981	0477	227	256	87	5.6	7.6
Site-5	25 °c	7.3	0979	0487	213	250	95	4.8	7.5
Average	**24.2** °c	**7.28**	**945.4**	**462.8**	**223.4**	**252.4**	**89.8**	**5.44**	**7.44**



(c) Physico-Chemical Analysis of Industrial Waste Water in February

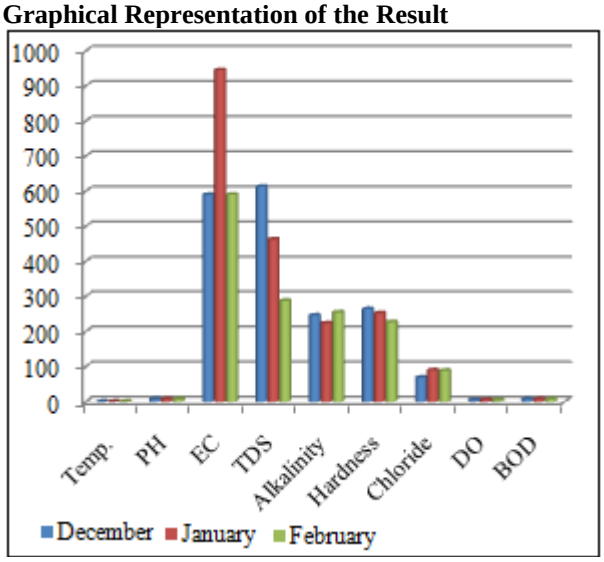
	Temp.	PH	EC	TDS	Alkalinity	Total Hardness	Chlorides	DO	BOD
Site-1	25 °c	7.3	0585	0283	187	178	90	5.1	6.8
Site-2	25 °c	7.2	0588	0288	190	231	89	4.9	6.7
Site-3	25 °c	7.1	0589	0289	213	234	95	4.7	7.1
Site-4	25 °c	7.2	0604	0290	209	276	86	4.5	7.5
Site-5	25 °c	7.1	0587	0292	275	215	82	5.5	6.9
Average	**25 °c**	**7.18**	**590.6**	**288.4**	**214.8**	**226.8**	**88.4**	**4.94**	**7**



4.Average Values of Physico-Chemecal Analysis of Water Observed

	December	January	February
Temp.	23.4^{O}C	24.2 ^{O}C	25 ^{O}C
PH	7.56	7.28	7.18
EC	589.8	945.4	590.6
TDS	613	462.8	288.0
Alkalinity	246	223.4	254.4
Hardness	264.4	252.4	226.8
Chloride	68.8	89.8	88.4
DO	5.22	5.44	4.94
BOD	7.04	7.44	7

5. Graphical Representation of the Result



6. Description

1) **PH** – PH value of natural water changes due to biological activity and industrial contamination. PH of different water samples are in the range of 7.1 – 7.8. The highest PH value was observed in December month. Higher PH value imparts bitter taste.
2) **EC** – It indicates that the content of soluble and high conducting salts are present in the water sample & sediments. It is also a measure of ions present in the sample. The conductivity of solution increases with the increase in the amount of ions. Conductivity is affected by temperature, the warmer the water higher its conductivity in water. It is also affected by the presence of inorganic solids dissolved in it. In the present study EC of waste water ranges from 0573 µs/cm – 0981 µs/cm.
3) **TDS** – Total dissolved solid represents the total concentration of dissolved substances in water. The degree to which these dissociates into ions. The TDS values are within the permissible limit. The high value may be due to the addition of solids from industrial effluents. The range of TDS is 0283 ppm – 0695 ppm.
4) **Alkalinity** – alkalinity of waste water in December, January & February months were observed. The values ranging from 187 g/L to 380 g/L within permissible limit.
5) **Hardness** – Hardness is determined by the concentration of multivalent cautions in the water. Common cations found in hard water include Ca^{2+} and Mg^{2+}. Hardness is expressed as g/L of $CaCO_3$. Variation in the values are observed in various seasons. The range is 178 g/L – 387 g/L.
6) **Chloride (Cl^-)** – The high concentration of Cl^- is considered to be an indication of high organic waste. The range of Cl^- ion is less than the desirable and permissible limit that is 57 g/L to 95 g/L. There is a variation in values of different samples. According to U.S. council of environmental quality - the cancer risk for people who drink chlorinated water is up to 93% higher than for those whose water does not contain chlorine. (Aug. 10, 2017)

7) **DO** – Dissolved oxygen is present in water, which is essential element for the working of aerobic bacteria in the biological treatment systems. It is important that the waste water have maximum DO level, when these are discharged. Oxygen is a poorly soluble gas in water having a solubility of 9.1 g/L of 20^{o}C. DO is minimum when the BOD rates are maximum. Water temperature and the volume of moving water can affect dissolved

oxygen level. Oxygen dissolves easier in cooler water than warmer water. If DO level is below 5.0 g/L causes stress to aquatic life. Range of DO in waste water is 4.5 g/L to 5.8 g/L.

8) BOD – BOD is the amount of O_2 required for microbial metabolism of organic compounds in water. Higher the BOD value the greater the amount of organic matter or food available for O_2 consuming bacteria. Low BOD is an indicator of good quality water while high BOD indicates polluted water. Dissolved Oxygen is consumed by bacteria when large amount of organic matter from swage or other discharge are present in the water. The range of BOD is 6.5 g/L to 7.6 g/L

[B] 1- General Parameters for Physico-Chemical Analysis of Industrial Sediments

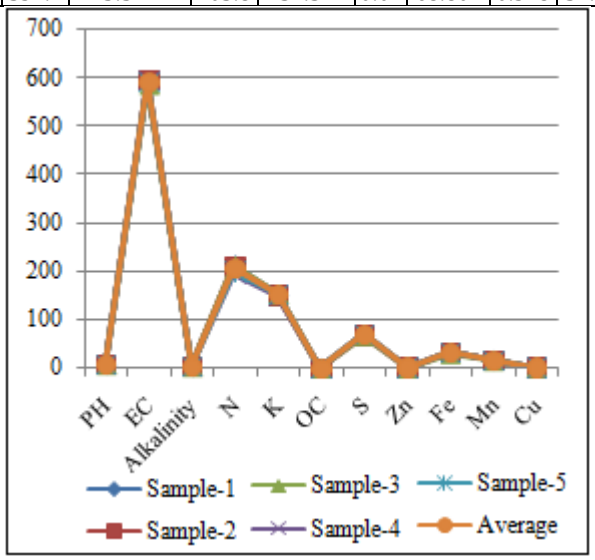
No.	Parameters	Apparatus & Methods	Units
1.	PH	Digital PH Meter	
2.	EC	Digital EC Meter	µs/cm.
3.	Alkalinity	Titrimetric	mg/gm
4.	N	Kjeldhal (method)	kg/hac
5.	K	Flame photometer	kg/hac
6.	OC	Titrimetric	%
7.	S	Spectrophotometer	kg/hac
8.	Zn	AAS (Atomic absorption spectrophotometric)	mg/kg
9.	Fe		
10.	Mn		
11.	Cu		

2- Range of Elements in Sediments

S.No.	Elements	Minimum Range	Medium Range	Higher Range
1	OC	0.5	0.5 – 0.75	0.75 and above
2	N	280	280 – 560	560 and above
3	K	135	135 -335	335 and above
4	S	22	22 – 35	35 and above
5	Zn	0.6	-	-
6	Fe	4.5	-	-
7	Mn	3.5	-	-
8	Cu	0.2	-	-

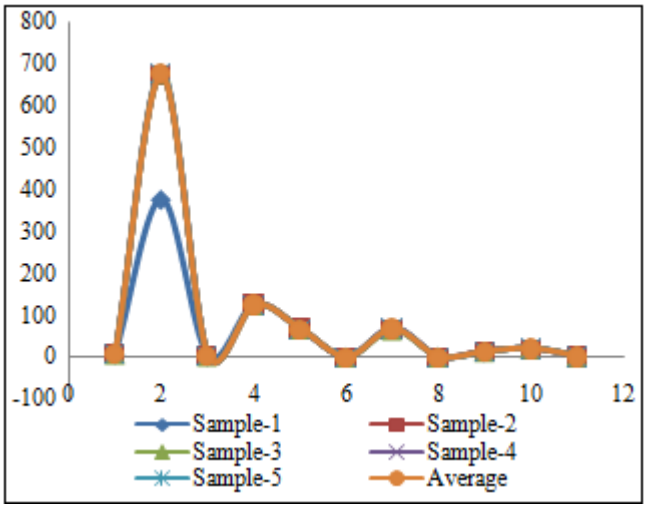
3- (a) Analysis Result of Industrial Sediments in December

	PH	EC	Alkalinity	N	K	OC	S	Zn	Fe	Mn	Cu
Sample-1	7.8	0590	3.395	213	152.14	0.03	69.21	0.96	32.43	16.49	1.34
Sample-2	7.6	0595	3.365	211	150.1	0.01	68.1	0.89	31.23	16.47	1.44
Sample-3	7.5	0585	3.355	210	152.13	0.02	67.2	0.92	30.5	15.59	1.36
Sample-4	8.0	0595	3.375	195	151.15	0.01	71.0	0.95	31.42	16.25	1.34
Sample-5	7.9	0592	3.365	200	152.1	0.03	68.5	0.90	32.5	16.55	1.32
Average	7.76	591.4	3.371	205.8	151.524	0.02	68.802	0.928	31.616	16.27	1.36



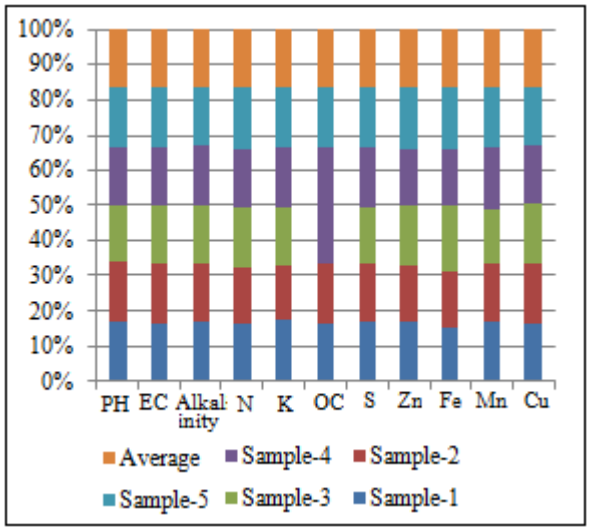
(b) Analysis Result of Industrial Sediments in January

	PH	EC	Alkalinity	N	K	OC	S	Zn	Fe	Mn	Cu
Sample-1	8.2	0378	3.31	125.4	67.48	0.01	67.5	0.52	13.10	20.50	1.68
Sample-2	7.8	0675	3.30	126.0	68.12	0.01	68.0	0.51	14.0	19.5	1.57
Sample-3	7.6	0677	3.33	125.2	67.51	0.02	65.2	0.55	13.2	20.5	1.66
Sample-4	8.0	0678	3.35	125.1	66.2	0.01	70.0	0.52	13.2	20.5	1.66
Sample-5	7.9	0679	3.38	125.4	67.36	0.02	68.1	0.55	12.1	21.0	1.68
Average	**7.9**	**677.4**	**3.334**	**125.42**	**67.334**	**0.014**	**67.76**	**0.53**	**12.98**	**20.38**	**1.624**



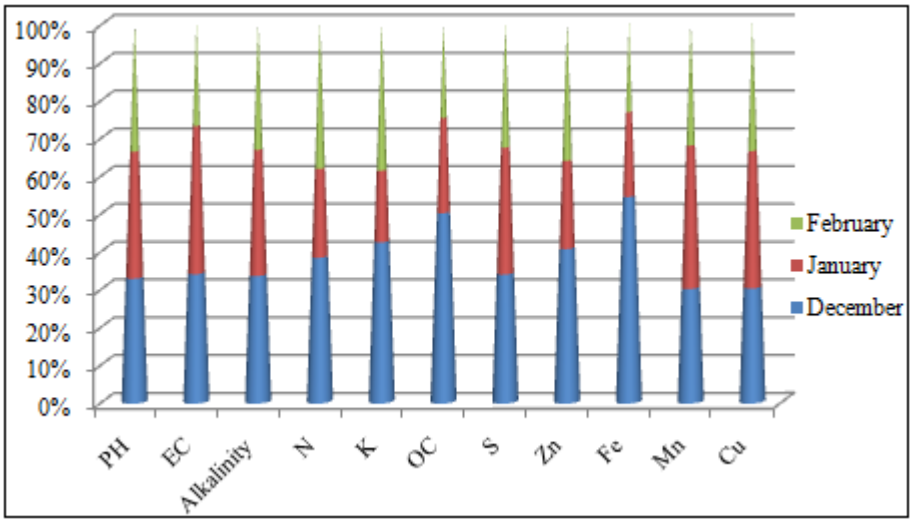
(c) Analysis Result of Industrial Sediments in Fabruary

	PH	EC	Alkalinity	N	K	OC	S	Zn	Fe	Mn	Cu
Sample-1	8.3	0471	3.39	201	145.2	0.01	68.2	0.85	12.35	17.52	1.50
Sample-2	8.0	0475	3.34	198	127.5	0.01	65.1	0.78	13.44	17.22	1.59
Sample-3	7.7	0470	3.36	209	140.1	0.0	64.5	0.84	15.12	16.59	1.55
Sample-4	7.9	0472	3.38	210	142.2	0.02	67.1	0.80	12.98	18.21	1.52
Sample-5	8.1	0469	3.32	212	139.5	0.01	67.5	0.87	14.45	17.51	1.51
Average	8	471.4	3.358	206	138.9	0.01	66.48	0.828	13.668	17.41	1.514



4- Average Values of Physico-Chemical Analysis and Element Observed

	December	January	February
PH	7.76	7.9	8
EC	591.4	677.4	471.4
Alkalinity	3.371	3.334	3.358
N	205.8	125.42	206
K	151.524	67.334	138.9
OC	0.02	0.01	0.01
S	68.802	67.76	66.48
Zn	0.928	0.53	0.828
Fe	31.616	12.98	13.668
Mn	16.27	20.38	17.41
Cu	1.36	1.624	1.514



Graphical Representation of the Result

Descriptions

(i) **PH** – PH of the sediments is a measure of their acidity or alkalinity and one of the stable measurements. The PH range of the sediments are 7.5 – 8.3. There are variations in the values in different seasons. PH value of sediments are higher than waste water. The sediments are more basic in condition which is measured by digital PH meter.

(ii) **EC** – Conductivity is a measure of the ability of water or solution to carry an electrical current. According to present study the EC in industrial sediments varies with temperature in different months. The EC ranges from 0469µs/cm to 0679 µs/cm.

(iii) **Alkalinity** – it is a measure of the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate. Alkalinity include hydroxide, phosphate, silicate, nitrate, dissolved ammonia the conjugate bases of some organic acids and sulfide. Alkalinity raging from 3.30 mg/gm – 3.395mg/gm.

(iv) **N** – N is a primary macronutrient for plant. It is found in sediments as nitrated, ammonia, organic nitrogen. However excessive levels of nitrate in soils & sediments can produce negative health impacts on humans and animals. N content sediment ranging from minimum 125.1kg/hac to maximum 213kg/hac.

(v) **K** – Potassium is not integral part of any major plant component. But plays a key role in a vast array of physiological process vital to plant growth from protein synthesis to maintenance of plant and water balance. Presence of K ranges from 66.2 kg/hac – 152.14 kg/hac . The highest value is at medium range which is observed in December month (winter).

(vi) **OC** – The organic carbon represents the organic matter in the sediments. The percentage of OC in sediments in the study area ranged from 0.0% - 0.03%. It is evident that there is low or no OC in the sediment due to industrial effluent.

(vii) **S** – Sulphur concentration – Sulfur is present in the organic compounds excess of S soil produce sulphuretted gases like H_2S and So_2 which cause musty and putrid smell in soil. Present study shows that the range of S in the sediments is 64.5 kg/hac – 71.0 kg/hac. The sediment is highly toxic or polluted due to the high level of S present in the sediments.

(viii) **Zn** – Zn plays a biochemical role in the life processes of all aquatic plants and animals. So they are essential in trace amount. But at elevated levels it is toxic. Zn is potentially hazardous and excessive concentrations in soil lead to phytotoxicity. It is used in galvanizing steel and iron products. In industrial sediments the range of Zn is found to be 0.51 mg/kg – 0.96 mg/kg. Thus sediments are highly polluted.

(ix) **Fe** – Iron is one of the essential elements in human nutrition however its presence at elevated concentration in aquatic ecosystems, poses, serious pollution and health problems. Toxicity of iron in human has been found to bring about vomiting, diarrhea, cardio vascular, while iron deficiency may lead to failure of blood clotting. In the present study the concentration of iron is in the range of 12.1 mg/kg – 32.43 mg/kg. It is the evident that iron steel industries discharge lots of waste, due to which the people of Raigarh are badly affected.

(x) **Mn** – Manganese occurs in industrial effluents and there by enters water bodies. It imparts objectionable and tenacious stains to laundry plumbing fixtures. According to present study the sediment contains Mn ranging from 16.25 mg/kg – 21.0 mg/kg. The sediment is polluted due to high level of Mn.

(xi) **Cu** – Copper is an essential substance to human life, however in high concentrations it can cause anemia, liver and kidney damage, stomach and intestinal irritation. The present study of the sediment proves that the sediment contains Cu ranging from 1.32 mg/kg – 1.68 mg/kg. Sediments are heavily polluted by Cu.

7. Conclusion

The result of the investigatory work of the physico-chemical analysis of industrial waste water and sediments provide valuable information that quality of water and sediment (soil) is very poor (polluted). There are variations in the values in the month of December, January and February. On the bases of above result it can be concluded that near industrial area water and sediments are highly polluted. It cannot be used by human, animal and plants, unless it is treated and channalized well. The spectro : : lyser titanium pro and the spectro : : lyser industrial are especially designed for heavy duty applications. Spectro : : lyser industrial is safe to be used in areas with an explosive atmosphere according to RL 2014/34/EU, TUV-A16 ATEX and therefore the ultimate solution for industrial waste water is done.

8. Acknowledgement

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