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The Investigation of Pollutants of Different Waste Water Effluents in Thoothukudi, Tamil Nadu, India

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Abstract

This study investigated the level of pollutants by analyzing the physicochemical parameters of waste water collected at five different stations including sewage water from house, farmland water, salt yard water and industrial outlet points. Organic and inorganic compounds, heavy metals and biogenic compound have been analyzed by using volumetric, gravimetric and colorimetric (spectrophotometric) methods. The parameters such as pH, electrical conductivity, hardness, E-coli, chloride content, phosphate, sulphate, iron, sodium, alkalinity, chemical oxygen demand, biological oxygen demand, dissolved oxygen. The pH values of the sample between the values from 6.0 to7.6. The conductivity was measured by using conductivity meter the values of the sample between the values from 460 µs – 113000 µs. In E-coli content was positive for domestic waste water sample. The TDS value varies from 0.0037 to 0.04 mg/L The chloride content of waste water samples was determined by volumetric method. The turbidity of the sample is measured by using turbidity meter. The turbidity values between <1-248 NTU. The sulphate content of the sample is measured by using turbidity method by barium sulphate precipitation. The sulphate content of the sample from 3400 to 48000 g/l as SO_4^{2-}. The phosphate content of the sample values between 30-1400 ppm as PO_4^{3-} using colorimetric method. The iron content of the waste water is determined by using spectrophotometer. Most important parameters of biological oxygen demand and chemical oxygen demand were measured. The results of various physicochemical parameters studied in this work are varied from places to place and which was compared with limits of State Pollution Control Board and World Health Organisation and revealed that this study recommended the further development and the necessary steps to take before discharging this wastewater.

Keywords*: Waste water, E-coli, conductivity, chloride, turbidity, sulphate, phosphate*

1. INTRODUCTION

Water is an indispensible natural resource essential for the existence of man and the ecological system. Water is crucial for sustaining life on the production of a large amount of wastewater. Waste water encompasses liquid wastes discharged from domestic residences, commercial properties, industry and agricultural activities and can contain a wide range of potential contaminants (Suklieman *et al*., 2010). These pollutants could exhibit toxic and hazardous effects in aquatic life and the public leading to a less suitable environment, poor health, a less flourishing economy, and ultimately, a poor quality of life (Odjadjare & Okoh, 2010). Therefore , it is necessary to know details about different physicochemical properties such as pH, electrical conductivity, E Coli, total solids (TS), total suspended solid (TSS), turbidity, chlorine and chloride content, sodium content phosphate and sulphate content, and total dissolved solid (TDS) which are used for evaluating waste water quality (Hassan et al., 2017). Most of the industries are situated along the river banks for easy availability of water and also disposal of the wastes. These wastes often contain a wide range of contaminants. All these chemicals are quite harmful or even fatally toxic to fish and other aquatic populations (Charavarty *et al*.,). The objectives of this research were aimed to determine the physicochemical characteristics of wastewater effluent from five different stations of Thoothukudi town and to investigate the quality of water. The disposal, management and proper utilization of waste products has become a concern for the scientists and environmentalists (Clara & Sugirtha, 2015)

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2. MATERIALS AND METHODS

2.1 Description of study area & Collection of samples

Wastewater samples were collected from about 40-50 cm below the surface, to avoid surface impurities. Before sampling, 2L polythene bottles were rinsed with 0.1N chromic acid, and then washed twice with distilled water and hand gloves were used for safety. The water samples were analyzed to determine their physicochemical characteristics. This analysis was done according to APHA.

For the present study five differently polluted waste water stations were fixed.

Station 1 (Latitude 8.8266728, longitude 78.1477136)

Effluents from salt processing unit, Ayanarpuram, Thoothukudi

Station 2 (Latitude 8.8949296, Longitude 78.1701064)

Plastic polluted waste water, Tharuvaikulam

Station 3 (Latitude 8.8494988, longitude 78.1313215)

Fish processing unit effluent, Samathuvapram**.**

Station 4(Latitude 8.814940, Longitude 78.150550)

Stagnant polluted water, Krishnarajapuram

Station 5 (Latitude 8.792990, Longitude 78.142420)

Sewage Effluent, Arockiyapuram

The physicochemical analysis was done for the following characteristics and analyzed using standard methods given in Table1.

Table1: Analytical methods for physicochemical parameters of different areas.

Parameter	Methods For Laboratory Analysis
pH	Digital pH Meter.
Electrical Conductivity	Conductivity Meter.
Total Suspended Solid	Gravimetric oven at 100 degree celcius.
Total Dissolved Solid	Gravimetric oven at 100 degree celcius.
Turbidity	Nephelometer.
Total Hardness	EDTA method
Calcium & Magnesium	EDTA method
Iron content	Spectrophotometer.
Sodium Content	Spectroflamephotometer.
Chloride Content	Titration Method.
Sulphate	Spectrophotometer.
Phosphate	Spectrophotometer.
Alkalinity	Titration using phenolphthalein & methyl orange indicator
Biological Oxygen demand	Winkler's method
Chemical oxygen demand	Dichromate method

Sodium metal is determined by using spectro flame photometer. Phosphate content of the sample is determined by using Spectrophotometer at 700nm. In this method the sample is mixed with 14% sulphuric acid, 2.6 g of ascorbic acid, 4% Ammonium molybdate and 0.27% of Potassium amyl tartarate mixture. Then the different sample readings are taken in the spectrophotometer. E coli are an abbreviation form of Eschirtieacoli. It comes waste of human and animal. E Coli content is determined by the BOD Incubator using the e coli test kit. 100ml of the each wastewater sample taken in six bottles and adding the e coli food test kit. These bottles are placed in the BOD incubator at 37^0C. After 3 days take the bottles to the incubator to view the colour of the water sample. If the colour of the bottle is blue it confirms the presence of E coli content. Chloride content of water can be determined by using Argentometric Method (MOHR'S Method). Iron is usually present in water as soluble ferrous ions (Fe^{3+}). Ferric iron is not significantly soluble in water, in the absence of complex

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forming ions or unless the pH is very low. Iron content of water is determined calorimetrically at 500 nm using phenanthroline method.

3. RESULTS AND DISCUSSION

S. NO	Parameters	S 1	S 2	S3	S 4	S 5
1.	pH	7.3	7.6	7.5	6.8	6.3
2.	Conductivity (µs)	113000	750	17300	1360	460
3.	E Coli	Negative	Negative	Negative	Negative	Positive
4.	Total suspended Solid (TSS) (mg/L)	0.0025	0.00493	0.0053	<1	<1
5.	Total Dissolved Solid (TDS) (mg/L)	0.04	0.0037	0.0107	0.009	0.00486
6.	Calcium hardness As Ca (ppm)	188	20	85	73	28
	(b) as $CaCO_3$ ppm	470	50	212	182	72
7.	Magnesium hardness (a)As Mg ppm (b)As $CaCO_3$ ppm	1615 6730	16 70	223 938	80 19	48 12
8.	Chloride content (a) As Cl ion ppm (b) as NaCl ppm	117 1845	794 1309	3276 5407	1052 1754	308 507
9.	Turbidity (NTU)	<1	8	248	139	231
10.	Sulphate content as SO_4^{2-} as g/l	48000	4120	15000	32000	3400
11.	Phosphate content ppm as PO_4^{3-}	65	33	1466	456	240
12.	Iron content ppm	Nil	0.05	0.14	0.34	2.256
13.	Alkalinity ppm as $CaCO_3$ (a) OH- (b) CO_3^{2-} (c) HCO_3^-	N/A N/A 86	N/A N/A 68	N/A N/A 450	N/A N/A 218	N/A N/A 166
14.	Total hardness as $CaCO_3$ ppm	6700	120	1140	262	120
15.	Biological oxygen demand (BOD)as O_2 /L	100ml N/A	75ml N/A	50ml N/A	25ml N/A	12.5ml 368 as O_2
16.	Chemical Oxygen Demand O_2 /L	120	8	440	N/A	N/A

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17.	Sodium as ppm	9990	0.519	6	4	3

3.1 Colour and Odour of waste water

3.2 pH

pH was measured immediately after its collection using pH meter. Normally waste water showing slightly acidic nature. The pH varies from 6.3-7.6. The pH value is very high in station 2 that shows basic nature of water and all the samples shows pH of within the limit. Sewage waste water is little acidic in nature due to toilet waste. The result is shown in the Table 1 and the Fig 1.

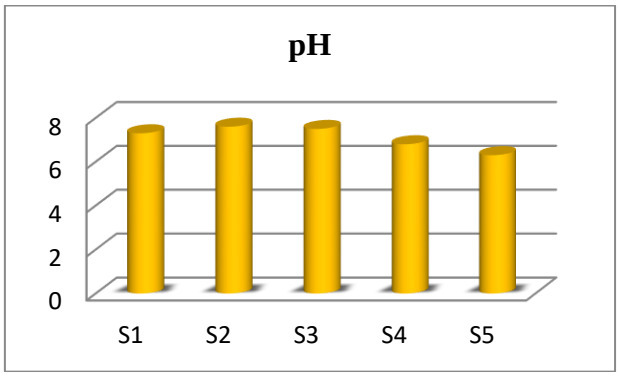

Fig. 1 pH of different stations

3.3 Electrical Conductivity

Electrical conductivity was determined and the values were ranges from 460 µs – 113000 µs and the results is shown in Table 1. The conductivity is mainly due to the presence of dissolved solids. Station 1 was found to contain high value than other states due to the presence soluble salts from salt processing unit.

3.4 E Coli

Station 5 showed positive result for E Coli bacteria (Table 1). Station 5 containing sewage water effluents showed pathogenic bacteia due to domestic loads and the decaying process**.** Disease-causing microbes (pathogens) in these wastewaters lead to diarrhea, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, children, and people with severely compromised immune systems.

Fig.2 Positive result for E Coli bacteria

3.5 Total Suspended Solids (TSS)

TSS is a measure of suspended solids in the waste water and showed the presence of pollutants level. The values were ranges from 0.0025 to <1 mg/L. Station 1 showed low value of TSS.

3.6 Total Dissolved Solids (TDS)

In this study the TDS value varies from 0.0037 to 0.04 mg/L and the results are shown in the Table 1. TDSs are composed mainly of bicarbonates, carbonates, chlorides, phosphates, and nitrates of calcium, magnesium, sodium, and potassium. The value of station 1 is very high due to soluble salts from effluents of salt processing unit.

3.7 Calcium Hardness (as calcium)

Generally hardness is due to the presence of calcium and magnesium in the salts. In this study hardness due to calcium was estimated. It was ranged from 20-188 ppm. Station 2 showed lower

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value and station 1 showed higher value. The higher value was due to the soluble salts of salt water from salt processing unit.

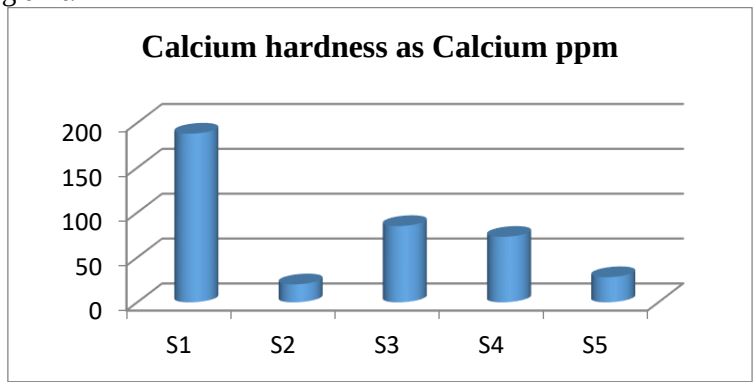

Fig. 3 Calcium hardness as calcium

3.8 Magnesium Hardness

The hardness of waste water was measured as magnesium hardness and ranges from 16 ppm to 1615 ppm. Station 2 showed very low value and station 1 showed high value. The hardness of waste water was also found as $CaCO_3$ and ranges from 12 to 6730 ppm. Sewage water showed lowest value and station 1 showed high value was due to the effluents from salt processing unit.

3.9 Total hardness

In this study the total hardness ranges from 120 to 6700 ppm. Station 1 showed high value of hardness in waste water. According to Indian Standard the value exceeds the limit.

3.10 Chloride

The Chloride Content of the waste water samples ranges from 117 ppm to 3276 ppm. The chlorides are generally present as NaCl, $MgCl_2$, and $CaCl_2$. They enter in water by solvent action of water on salts present in soil or from polluting materials like trade wastes containing chloride used in manufacturing. When present at concentrations above 250 ppm, chlorides impart an unacceptable taste to waters although no adverse effects have been recorded on human. Station 3 showed much higher value of chloride content effluents from factory. The results are shown in Table 1. Chloride was also calculated as NaCl in ppm.

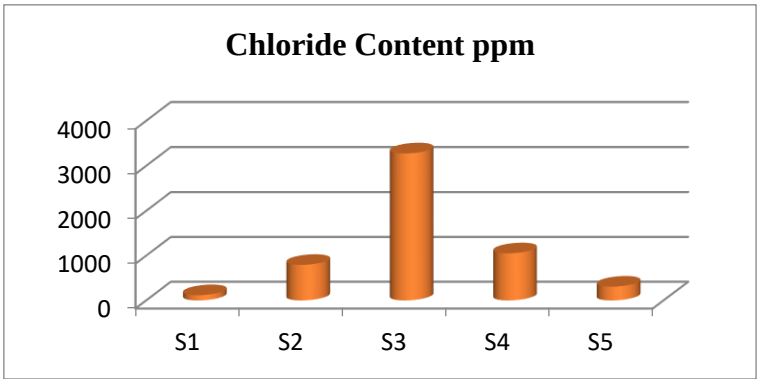

Fig. 4 Chloride content

3.11 Turbidity (NTU)

TSS, TDS can be used to predict the turbidity of water. The turbidity ranges from < 1 to 248 NTU. Higher level of turbidity is associated with disease causing bacteria's. Station 3 showed high value of turbidity due to factory waste water.

3.12 Sulphate

Sulphate is formed due to decomposition of various sulphur containing compounds in the water. In this study sulphate ranges from 3400 to 48000 g/L. Station 1 showed the higher value due to effluents containing gypsum and minerals. The results are shown in the Table 1 and Fig.5

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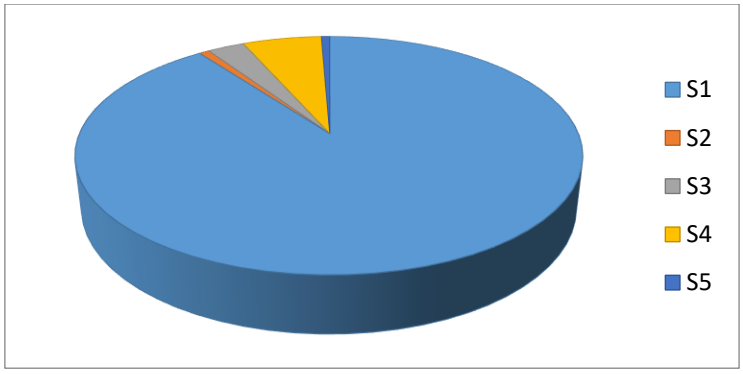

Fig. 5 Sulphate Content

3.13 Phosphate

Water containing phosphate from pesticide, fertilizers, natural phosphate rock and industrial waste water. In this study the phosphate ranges from 33 to 1466 ppm (Fig. 6). Station 3 showed high value of phosphate due to industrial waste. Phosphate leads to eutrophication and resulting into depletion of dissolved oxygen.

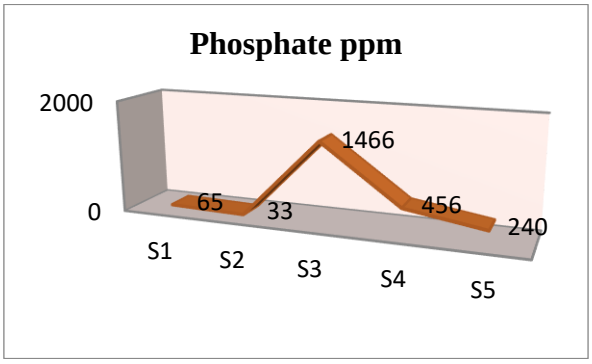

Fig.6 Phosphate Content

3.14 Iron

Iron is one of heavy metal. In this study the iron content ranges from 0 to 2.25 ppm. The sewage water was containing iron due to domestic loads.

3.15 Alkalinity

Carbonate, hydroxide and bicarbonate are responsible for alkalinity. The carbonate and hydroxide alkalinity was not available in the sample. The bicarbonate alkalinity ranges from 68 to 450 ppm as $CaCO_3$ shown in the Table 1. Station 3 showed high value and station 1 showed low value. The factory effluents showed higher value of alkalinity. High alkalinity causes increase of pH value.

3.16 Biological Oxygen Demand (BOD)

BOD is a measure of organic material in water and the dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials. In this study BOD showed maximum of 368 O_2/L. Station 5 showed high BOD due to biodegradation of organic material and it is measure of pollution level in the water.

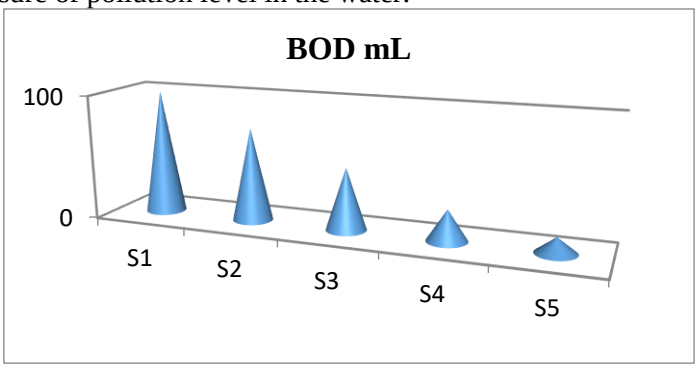

Fig. 7 Biological Oxygen Demand

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3.17 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand or COD is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. Station 3 showed maximum of 440 O_2/L and minimum of 120 O_2/L. Station 4 & 5 was not showing any value.

3.18 Sodium content

In this study station 1 showed maximum of 9990 ppm and station 2 showed minimum of 0.519 ppm. Station 1 received waste water effluents from salt processing unit and showed high content of sodium.

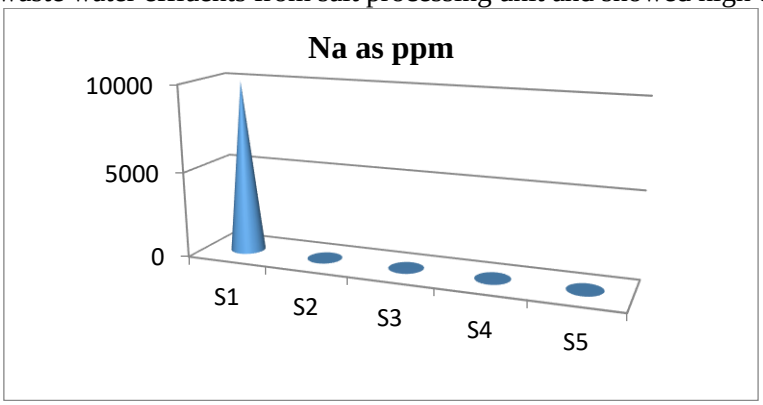

Fig. 8 Sodium Content

4. CONCLUSION

This study was set out to assess the physicochemical parameters of waste water effluents from five different points. The TDS value of ground waste water is also harmful to human beings. High concentration of TDS can result in dehydration of aquatic organisms. The excess amount of chlorine content in water causes the effect of risk to aquatic survival, growth and reproduction. The effluent could be posed a health and environmental risk to the related areas in particular to the flora and fauna, and finally the human beings. So, this study recommended the further development and the necessary steps to take before discharging this wastewater into the receiving lakes, canals, rivers and agricultural fields.

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