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Analysis of Physico-Chemical Parameters of Textile Effluent from Sidco, Vijapuram, Alangadu and Rayapuram Polluted Regions in Noyyal River, Tirupur, Tamil Nadu, India

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Abstract

Globally, textile industries play an important role in the economy of many countries. A huge volume of water is consumed in the various processes of dyeing fabrics and the majority of this is discharged with heavy loads of pollutants into the environment. The present study assessed on quality of textile dyeing effluent by analyze the physicochemical parameters such as pH, color, electrical conductivity, turbidity and total dissolved solids, calcium, total hardness, dissolved oxygen, potassium, phenol, phosphates, nitrates, magnesium, and sulfates of the effluent were analyzed. The results of the analysis were correlated with the water quality standards of Environmental Pollution Agency and Bureau of Indian Standard.

Keywords: Bureau of Indian Standard, Dyes, Environmental pollution agency, Noyyal river, Parameters, Textile effluent, Tirupur

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Introduction

The Noyyal River is a tributary of the River Cauvery and originates from the Vellingiri Hills of the Western Ghats in the Coimbatore district of Tamil Nadu, South India. The Coimbatore district gets maximum rainfall from South-West monsoon followed by the North-East monsoon and is very close to Western Ghats. It is located 410 m above sea level with moderate climate and average annual rainfall of 61.22 cm. The river has moderate to good flow for a short period during the North–East and South–West monsoons and flows over a distance of 180 km in an area of 3510 km^2. It passes through seven taluks (Coimbatore, Tirupur, Avinashi, Palladam, Karur, Erode and Dharapuram) in four districts (Coimbatore, Erode, Karur, and Trichy). The boundary of this river is in north latitude of 10.54′–11.19′ and North Eastern longitude of 76.39′–77.5′.[1] The river supplies water to several Tanks located in and around Coimbatore. The area of land irrigated by the river in Coimbatore district is approximately 1600 acres.[2]

One of the fast growing industries in India is textile industry, consuming large quantities of water and produces large volumes of wastewater during processing unit of textile manufacture. Continuous flow of textile industrial waste into river and cultivated land now is one of the major global problems. Although efforts for reducing water pollution are very limited because the discharge of dye containing effluents, directly released into the water channels is serious problem for human and animal. The dyeing process in textile industries involves more than 8000 chemical products that include sulfides, salts, formaldehydes, metals, and surfactants.[3] During this process, approximately 10–25% of dyes used have been lost and about 2–20% of it is discharged with effluents in different environmental components. Apart from dyes, additives such as solvents, whitening agents, antifoaming chemicals, pH conditioners, and finishing agents are used in the different operations as substrates or as aqueous systems with bulk volumes of water and about the same level are discarded in the environment with variable characteristics and complex nature.[4] The other major pollutants in textile wastewaters include dissolved solids, suspended solids, biological oxygen demand, chemical oxygen demand, heat, color, acidity, chloride, sulfur, metal ions, and many other soluble substances. Hence, it is unfeasible to illustrate a "typical" textile effluent because of its diversity in the process and the constituents used.

Furthermore, untreated industrial effluents flowed into the environment are also hazardous to the flora and fauna life, and are one of the reasons behind food contamination. These effluents are also the carrier of dyes, organic and inorganic materials such as high quantity of Cl, Pb, Fe, Fl, and other heavy metals.[5] Heavy metals present in textile effluents (either in free form or in suspended solids) are also carcinogenic. Due to the increased demand for textile products, the textile industry and its wastewater have been increasing proportionally, making it one of the main sources of severe pollution problems worldwide.

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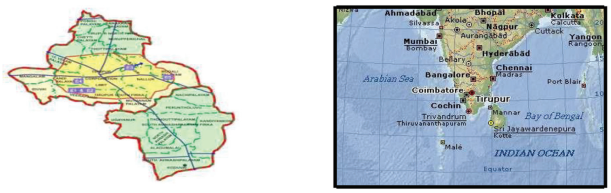
Materials and Methods

Experimental Site



a Tirupur Location map and b Sample collecting location at Tirupur city

The study area selected was Tirupur and it is a textile city in the South Indian state of Tamil Nadu, India Tirupur is the knitwear industry hub of India and the city is now known as the "Dollar City." This knitwear capital of India has 5 lakhs workers from various parts of India, Sri Lanka and Nepal. Tirupur is located on the bank of Noyyal River, a tributary of river Cauvery. It lies between 110100N to 11 0220N latitude and 770210E to 77 0500E longitude. The experimental site was located at SIDCO,VIJAPURAM, Alangadu and Rayapuram polluted regions, Tamil Nadu.

Collection of the Textile Effluent

The effluent was collected from the textile industry situated at SIDCO, Vijapuram, Alangadu and Rayapuram in clean plastic cans and stored at 4°C for physiochemical analysis. The raw effluent was directly collected from the outlet of the industry. The physicochemical parameters of all the samples (textile effluent) were determined using standard procedures (Table 1).

Physicochemical Characterization of Textile Effluent

Physiochemical parameters were determined and compared with water quality standard Bureau of Indian Standard (BIS) limits in Table 2.

pH

The pH of the water sample was measured by an electronic portable pH meter. The pH meter was calibrated with phosphate buffer of known pH. At a constant temperature, a pH change was observed in the electrical property of the solution. This change was read by the electrode and the accuracy was obtained in the middle pH ranges.

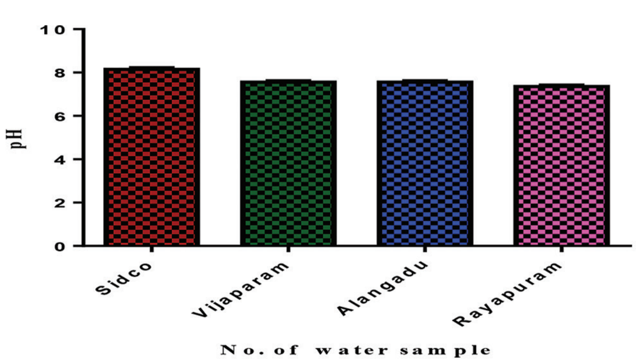


Table 1: Standard Procedures for Physical chemical parameters

Mode	*Parameters*	*Procedures*
Physical	pH	pH meter
	Color	Visual comparison of pond and fresh water
	TDS	TDS meter
	EC	Digital conductivity meter
	Turbitidy	Turbidity meter
Chemical	Calcium hardness	EDTA titrimetric method
	Total hardness	Titration method
	Magnesium	Determined from total and calcium hardness
	Nitrates	Phenolsulfonic method
	Sulfates	Nephelometer
	Chloride	Argento-metric meter
	Dissolved oxygen	Winkler's method
	Potassium	Photo meter
	Phenol	Folin–Ciocalteu method
	Phosphates	Stannous chloride method

TDS: Total dissolved solids, EC: Electrical conductivity, EDTA: Ethylenediamine tetra-acetic acid

Table 2: Values of physicochemical parameters collecting from SIDCO (S1), Vijapuram (S2), Alangadu (S3) and Rayapuram (S4)

Parameters	*S1*	*S2*	*S3*	*S4*	*BIS*
Color	*Pale yellow*	*Colorless*	*Pale yellow*	*Colorless*	*Grey*
pH	8.1	7.6	7.5	7.3	6.5-9
TDS	1090	0931	0934	0618	2,100
EC(ms/cm)	2306	1980	1988	1289	400 (EPA)
Turbitidy	0.02	0.04	0.03	0.02	5
Calcium	168.21	109.33	130.36	142.97	200
Magnesium	6.3423	1.6038	1.5309	1.3851	50
Nitrate	250.00	125.00	125.00	125.00	50
Potassium	10.00	5.00	10.00	5.00	NM
Chloride	0.009926	0.04963	0.029778	0.024815	600
Disolved O_2	1.231	2.95	0.985	1.724	5.2
Sulfate	2.08	1.96	1.12	2.04	2.0
Nitrogen	0.30	0.30	0.30	0.30	10
Phosphorus	0.5	0.15	0.5	0.5	NM
Free Co_2	20.00	20.00	10.00	10.00	NM
Phenol	21.055	8.833	4.944	2.722	1.0
Acidity	4.00	20.00	16.00	20.00	NM
Phosphate	1114.28	1657.14	2142.85	1171.42	NM
Salinity	5.8	18.8	5.4	18.8	NM

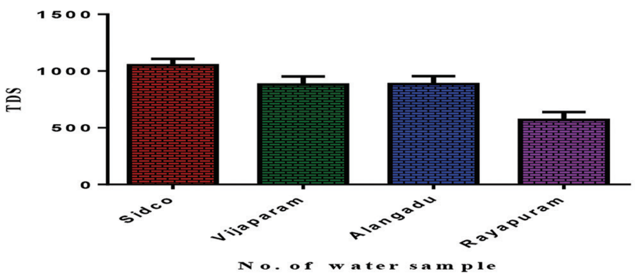
TDS: Total dissolved solids, EPA: Environmental pollution agency, BIS: Bureau of Indian Standard

Color

The term color means true color that is the color of water sample from which turbidity has been removed. True color of the water is due to dissolved material.[6] Color of the sample is determined by visual comparison of pond waters with fresh water.

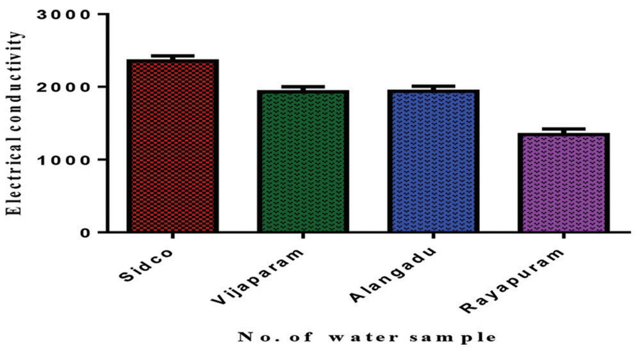
Total dissolved solids (TDS)

Total dissolved solid levels of twenty different pond water samples were analyzed using digital TDS meter. The results were noted in triplicates.



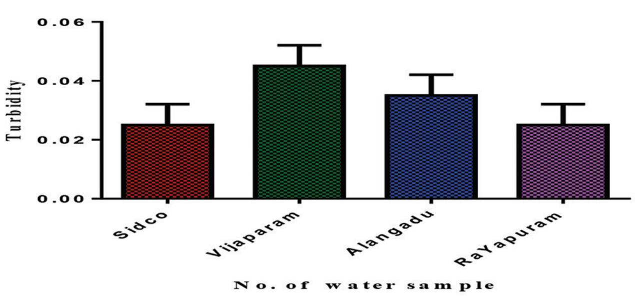
Electrical conductivity (EC)

The electrical conductive ability of four different samples was assessed using a digital conductivity meter. The results were tabulated.



Turbidity

Similarly, the turbidity of four different samples was tested using turbidity meter.



Odor

As soon as possible after collection of sample, fill a bottle (cleaned as in 2.1) half-full a sample, insert the stopper, shake vigorously for 2–3 s and then quickly observe the odol the sample-taken for observation of odor.

Calcium

The presence of calcium (fifth most abundant) in water results from passage through or over deposits of limestone, dolomite, gypsum, and such other calcium bearing rocks. Calcium contributes to the total hardness of water and is an important micro-nutrient in aquatic environment and is especially needed in large quantities by molluscs and vertebrates. It is measured by Ethylenediamine tetra-acetic acid titrimetric method. Small concentration of calcium carbonate prevents corrosion of metal pipes by laying down a protective coating.

Magnesium

Magnesium is a relatively abundant element in the earth's crust, ranking eighth in abundance among the elements. It is found in all natural waters and its source lies in rocks, generally present in the lower concentration than calcium. It is also an important element contributing to hardness and a necessary constituent of chlorophyll.

Nitrate

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The significant sources of nitrates are chemical fertilizers from cultivated lands, drainage from livestock feeds, as well as domestic and industrial sources. Nitrates may find their way into ground water through leaching from soil and at times by contamination.[7] They can be measured by the phenoldisulfonic method.

Sulfates

Sulfates are found appreciably in all natural waters, particularly those with high salt content. Besides industrial pollution and domestic sewage, biological oxidation of reduced sulfur species also add to sulfate content. Soluble in water, it imparts hardness with other cations. Sulfate causes scaling in industrial water supplies, and odor and corrosion problems due to its reduction to hydrogen sulfide. It can be calculated by turbidometric method.

Chloride

The presence of chlorides in natural waters can mainly be attributed to dissolution of salt deposits in the form of ions (Cl^-). It is the major form of inorganic anions in water for aquatic life. High chloride content has a deleterious effect on metallic pipes and structures, as well as agricultural plants. They are calculated by argentometric method.

Dissolved Oxygen

Oxygen dissolved in water is a very important parameter in water analysis as it serves as an indicator of the physical, chemical, and biological activities of the water body. The two main sources of dissolved oxygen are diffusion of oxygen from the air and photosynthetic activity. Diffusion of oxygen from the air into water depends on the solubility of oxygen, and is influenced by many other factors such as water movement, temperature, and salinity. Photosynthesis, a biological phenomenon carried out by the autotrophs, depends on the plankton population, light condition, gases, etc. Oxygen is considered to be the major limiting factor in water bodies with organic materials. Dissolved oxygen is calculated by many methods.[8]

Free Carbon-di-oxide

The important source of free carbon-di-oxide in surface water bodies is mainly from respiration and decomposition by aquatic organisms. It reacts with water partly to form calcium bicarbonate and in the absence of bicarbonates gets converted to carbonates releasing carbon-di-oxide.

Potassium

Potassium ranks seventh among the elements of abundance, behaves similar to sodium and remains low. Although found in small quantities (<20 mg/L), it plays a key role in the metabolism.

Phenol

Total phenolic content was estimated by Folin–Ciocalteu's method. 1 ml of aliquots and standard gallic acid (0.007 mg/mL to 1 mg/mL) was positioned into the test tubes and 5 mL of distilled water and 0.5 mL of Folin–Ciocalteu's reagent was mixed and shaken. After 5 min, 1.5 mL of 20% sodium carbonate was added and volume made up to 10 mL with distilled water. It was allowed to incubate for 2 h at room temperature. Intense blue color was developed. After incubation, absorbance was measured at 750 nm spectrophotometer using ultraviolet visible spectrophotometer instrument. The extracts were performed in triplicates. The blank was performed using reagent blank with solvent. Gallic acid was used as standard. The calibration curve was plotted using standard gallic acid. The data for total phenolic contents of ASE sample were expressed as mg of gallic acid equivalent weight/100 g of dry mass.

Phosphate

Phosphates occur in natural or wastewaters as orthophosphates, condensed phosphates, and naturally found phosphates. Their presence in water is due to detergents, used boiler waters, fertilizers, and biological processes.[5] They occur in solution in particles or as detritus. They are essential for the growth of organisms and a nutrient that limits the primary productivity of the water body. Inorganic phosphorus plays a dynamic role in aquatic ecosystems; when present in low concentration is one of the most important nutrients, but in excess along with nitrates and potassium, causes algal blooms. It is calculated by the stannous chloride method.

Salinity

Put the standard in a 500-mL cylinder. Put the thermometer in the distilled water. Use the Water Temperature Field Guide to measure the water temperature. Record on the Hydrosphere Investigation Quality Control Procedure data Sheet. Gently place the hydrometer into the cylinder. When it stops bobbing, read the specific gravity at the bottom of the meniscus. It should not touch the sides of the cylinder. Read to three places and record on the Hydrosphere Investigation Quality Control Procedure Data Sheet. Look up the specific gravity and water temperature on the conversion table to find the salinity of the water. Record the salinity on the Hydrosphere Investigation Quality Control Procedure Data Sheet. If the salinity standard is off by more than 1 ppt, mix a new standard and repeat the procedure. If it is still off by more than 1 ppt. Discard the 35-ppt standard or pour it into a clean and dry 1-L bottle, cap, and label. Rinse equipment with distilled water, dry, and store.

Results

To assess the changes in the quality of textile effluent of water sample was collected from selected four different area in and around Tirupur (Sidco, Vijapram, Alangadu, and Rayapuram) and analyzed various physicochemical parameters by standard protocol prescribed in Table 1. The pH of the collected samples is found to be lowest in S4 with 7.3 and highest in S1 with 8.1 (BIS limits 6.5–9), 7.6 in S2 and 7.5 in S3, the pH range in S1 shows a slightly alkaline in effluent water. The alkalinity nature due to the presence of different types of dyes in the process. The TDS was measured by digital TDS meter, it represent the organic particles. It increases Osmotic pressure of soil water that leads to increase in respiration rate thus declining the growth and yield of most plants. The effluent showed a nearly above 900 mg/L. As compared with BIS limits values are found to be within the limits so the Values indicates that the discharge of total dissolved solids in effluents is minimal. EC was assessed using digital conductivity meter. It is the capacity of a solution to conduct the electric current. According to BIS limit (400 mg/lit), the maximum acceptable limit of EC is 400 ms/cm^2 and it was found to be higher in SIDCO area (S1) in Noyyal river and the remaining three sample are above the permissible limits only, which indicates that the water is hard. Consequently the effluents should be softened before they are discharged into the receiving bodies. Turbidity ranged from 0.02 to 0.04mg/lit, the values are within the permissible limits (BIS limit 5 mg/lit). Calcium is one of the most abundant micro-nutrient in aquatic environment and is especially needed in large quantities. In the present study, the amount of calcium was analyzed and recorded from 100 mg/L to 160 mg/L which is not exceeds the BIS limits. Magnesium is found to be very little amount as compared with BIS limits (50 mg/L). The discharge of textile waste water containing nitrogen to the environment is undesirable because these nutrients accelerate eutrophication. Further problems occur because certain forms of nitrogen (ammonia, nitrite, and nitrate) are toxic to aquatic life or may lead to diseases. In the present study, the amount of nitrate was recorded from 125 to 150 mg/L which exceeds the BIS tolerance limit of 50 mg/L. It was found to be higher in SIDCO area (250 mg/L). Consequently efficient removal of nitrogen compounds from waste water is of increasing importance. Potassium ranged from 5.0 to 10.0 mg/L in collected textile effluent water. Chloride is the pollutant only at higher concentration levels but in our collected samples the values are not exceeded with BIS limits (600 mg/L) but the presence of chloride due to the use of compounds such as hypochloric acid, hydrochloric acid, and chlorine gas during bleaching, washing, and disinfection processes.[9] The dissolved oxygen, nitrogen, phosphorous, Free CO_2, acidity values all are ranged in minimal values. Phenol values in effluent water exceed with BIS values (1.0 mg/L). In SIDCO area ranges is (S1)21.055, 8.833 in S2, 4.9 in S3, and 2.7 in S4. Phosphate values also ranged from 1000 to 2000 mg/L it was slightly higher in effluent. Phosphate is essential for growth of organisms, if it is present with higher value that leads to algal bloom which will hinder photosynthesis process. Salinity values ranging from 5 to 18 g/L. High salinity may interfere with the growth of aquatic vegetation; salt may decrease the osmotic pressure, causing water to flow out of the plant to achieve equilibrium.

Conclusion

All the parameters are within the BIS and environmental pollution agency limits except EC which is higher in all four samples. And also regarding Nitrate values also are higher than the limited values. From the result of physicochemical analysis of textile effluents has been concluded that pH, EC, TDS, BOD, COD, sodium, chlorides, potassium, calcium, magnesium, sulfates, and trace metals are very high in concentration compared to the standards prescribed by the BIS. The results of the study showed that due to unsafe disposal of textile waste water on the bare land, the organic, and inorganic chemical compounds present in the effluent have leached and found their way into the ground water. Hence, the potable water in the industrial area was significantly contaminated with cadmium, chromium, lead, and copper which were used in the wet finishing process of textile process and released along with the effluent.[10] In the past, several physical and chemical methods have been recommended for the treatment of wastewater but are not widely used because of the high cost and secondary pollution that can be generated by excessive use of chemicals. In further, mycoremediation and phytoremediation are novel technology that uses green plants for cleaning up of contaminated sites, as it seems to be a cost-effective, esthetically pleasant and may contribute to restore soil structure. In Tamil Nadu, particularly in Tirupur the textile industries are growing fast due to its several advantages but on the other hand it is one of the root causes for environmental pollution. In general, the textile industry releases an ample of pollutants from all stages in the processing of fibers and fabrics. By and large the finding of the studies implies that the effluents are toxic in nature and needed imperative treatment before disposal on water bodies to create pollution less and eco-friendly environment in the region of all textile cities.

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