



ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF WASTE WATER EFFLUENTS FROM TEXTILE INDUSTRIAL AREA OF TIRUPUR, TAMIL NADU, INDIA.

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ABSTRACT

The present research work deals with most important physico-chemical parameters of industrial waste water effluents collected from Tirupur, Tamilnadu State, India. The laboratory test of the collected water samples were performed for analysis of various parameters such as pH, Temperature, Salinity, Dissolved Oxygen (DO), Alkalinity, Acidity, Total Hardness (TH), Chloride and Fluoride. The methods employed for the analysis as per standard methods recommended by APHA, WHO, ICMR. The obtained values are compared with the standard limits. The result of this study reveals that the physico-chemical parameters are not maximum permissible limit of WHO with some slight variations in some parameters. Hence, water is not safe which is causing many hazardous to the human life and affected the environment.

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. Earth is the only planet having about 70 % of water than other planets [1]. But ,due to increased human population, industrialization, use of colour dyes in textile industries , fertilizers in the agriculture and man-made activities affected the quality of water with different harmful contaminants especially textile effluents [2]. Textile industry is one of the most important and rapidly developing industrial sectors in worldwide which consumes enormous amount of water as well as producers of wastewaters [3]. Tirupur is an Indian textile town which constitutes many dyeing and bleaching units situated in the upstream. Tirupur serves as one of the major exporters of textiles. The industrial pollution have affected not only the

surface water but also the soils and ground water even though industrial units have either constructed or connected to effluent treatment plants, the level of treatment has not been satisfactory at most of the places. Even today, some of the unit operate illegally and let the untreated effluent in to nearby river. It has caused serious impact on agriculture, livestock and fisheries[4]. The effluents caused various health problems such as skin allergies and lung infections. The Tirupur municipal hospital reports widespread incidence of skin diseases and pulmonological disorders. The diversity in composition of chemical reagents used in textile industries contributes too much of the water pollution. The reagents range from inorganic compounds to polymers and organic products [5]. Waste water generated from textile mill which have high pH, temperature, detergents, oil, suspended and dissolved solids, dispersants, leveling agents, toxic and non-biodegradable matter, colour and alkalinity. [6]. Waste management strategies adopted in India have failed to keep pace with the industrial growth and urbanization. Most of the industries in India are situated along the river

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banks for easy availability of water and also disposal of the wastes. These wastes often contain a wide range of contaminants such as petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals, various acids, alkalis, dyes and other chemicals which greatly change the physico-chemical properties of water. The waste also includes detergents that create a mass of white foam in the river waters. All these chemicals are quite harmful or even fatally toxic to fish[7] and other aquatic populations[8]. It is found that one-third of the total water pollution in India comes in the form of industrial effluent discharge, solid wastes and other hazardous wastes. Similarly, Textile Industrial area of Tirupur, which has been affected by textile effluent and also severely damage the eco friendly environment of Noyyal river. Therefore, the present study focused on the Physico-chemical parameters of industrial waste water effluents from Textile Industrial area of Tirupur, Tamil Nadu, India.

MATERIALS AND METHODS

Study Area

Tirupur town is situated between 11°10'N to 11°22'N latitude and 77°21'E to 77°50'E longitude. It is located on the bank of noyal river, a tributary of river Cauvery. Orathupalayam dam was constructed on the Noyyal River which was irrigate an area of 500 acres in Erode district and 9875 acres in Karur district. The river Noyyal is a seasonal river and it originates from Vellingiri hills in the Western Ghats of Coimbatore district. It flows through Coimbatore, Erode and Karur districts and finally joins into Cauvery River near Noyyal village. It flows over a distance of 175 kilometers. The catchment area of the river is 3.49 lakh hectares.

Fig.1. Map showing the study area



Sample collection

The water samples were collected from the Pitchampalayam puthur textile effluent (0.2 m depth) for the estimation of environmental variables. A precleaned and rinsed polythene water canes of 5 liter capacity and 500 ml BOD bottles (which were used for the dissolved O₂ fixation) were used for collection of water samples for the

analysis of physicochemical characteristics. Samples were protected from direct sun light and immediately transported to the laboratory for further analysis.

Physico-chemical Parameters

Temperature, Light, pH, Alkalinity (Total, Carbonate and Bicarbonate), Nitrite, Nitrate, Total phosphate, Hardness (Total, Calcium and Magnesium) Fluoride, and Dissolved oxygen (DO), Dissolved CO₂, Salinity, was estimated in laboratory by adopting the standard procedures APHA (1989).

RESULTS AND DISCUSSION

The results of physicochemical parameters of the effluents from Tirupur textile industry is shown in Table 1.

Tirupur is an Indian textile town which constitutes many dyeing and bleaching units situated in the upstream[9]. Tirupur serves as one of the major exporters of textiles. The industrial pollution have affected not only the surface water but also the soils and ground water even though industrial units have either constructed or connected to effluent treatment plants, the level of treatment has not been satisfactory at most of the places[10]. Even today, some of the unit operate illegally and let the untreated effluent in to nearby river. It has caused serious impact on agriculture, livestock and fisheries.

The effluents caused various health problems such as skin allergies and lung infections. The Tirupur municipal hospital reports widespread incidence of skin diseases and pulmonological disorders [11].As the textile industries consume large quantities of water and generates waste water in proportionate order. Moreover the dyes used in textile industry are important sources of environmental pollution. It poses serious problems because of its strong color, high COD, BOD and low biodegradability. These effluents usually contain indigo dyes and non-biodegradable dyes, which causes aesthetic problem[12].

Temperature

The Tirupur textile effluent water temperature is 45°C, which is harmful to aquatic life and affected the metabolic activities. According to CPCB, the high temperature above 40°C of the untreated effluent has adversely affected the germination process of aquatic organisms. Temperature also affects the concentration of dissolved oxygen and can influence the activity of bacteria in a water body[13] as well as positively correlated with hardness and phosphate.

Transparency

Transparency measures the clarity of water which is essential for photosynthesis of plants. The Tirupur textile effluent water transparency is 2cm. This value is lower than that of the CPCB standard (5 cm). In many



cases, high value of transparency indicates the purity of wastewater/effluent and it was no correlation with the other parameters[14].

Colour and Odour

The Tirupur textile effluent sample shown dark brownish colour and. It is very important factor for aquatic life for making food from sun rays. The photosynthesis activity is found to be reduced due to dark coloration also affecting other parameters like temperature DO and BOD etc. The odour of the effluent is unpleasant due to the high microbial population[15].

Electrical Conductivity

Electrical Conductivity measures the total ionisable dissolved solids present in water and also measures the electric current of water. The Tirupur textile effluent Electric Conductivity is 2630 μ s and this values is higher than the CPCB standard limit (2500 μ s). Water having high EC values can cause osmotic stress at the root zone of plants which makes it more difficult for a plant to absorb water for growth. Thus increased EC in irrigation water leads to lower crops production[16,17]. EC itself is not a human or aquatic health concern but it can serve as an indicator of other water quality problems[18].

pH

pH is one of the important biotic factor that serves as index for pollution. The Tirupur textile effluent pH value is 8.90 that is higher than the BIS standard limit(6.5-8.5). This higher pH values indicates that the effluents are highly alkaline. High pH reduces fish production[19] and also inhibits the growth of aquatic macrophytes. Low pH can destroy the fish population accompanied by decrease in the variety of species in food chain[20]. In this water used for irrigation for a longer period the soil becomes non fertile resulting in poor crops growth and yield .pH was found positively correlated with alkalinity and negatively correlated with acidity.

Dissolved oxygen

The analysis of Dissolved Oxygen plays a very important role in water pollution control as well as waste water control. Aquatic ecosystem totally depends on DO, various biochemical changes and its effects affected the metabolic activities of microorganism. The Tirupur textile effluent DO is 3.4 mg/lit, that is lower than the BIS standard limit (4-6 mg/lit) The lower DO indicates the use of various organic chemicals in the textile industry. The decay of organic compounds consumes much oxygen and leads to the decrease in DO level[21]. Higher temperature of textile effluent also lowers the DO level[22]. Reduced DO impact adversely on all aquatic life. As DO levels in water drop below 4 mg L-1, aquatic life is put under stress. The lower the concentration, the greater is the stress. Oxygen levels that remain below 1-2 mgL-1 for a few

hours can result in large fish kills. Effluent DO was found to be positively correlated with temperature.

BOD

Biochemical Oxygen Demand (BOD) is important parameters of effluent water. The textile effluent BOD is 472 mg/lit and this value is higher than the BIS standard limit (50 mg/lit)High BOD is harmful to aquatic animals like fish and microorganisms[23]. It also causes bad taste to the drinking water. If the BOD level is too high, the water could be at risk for further contamination interfering with the treatment process and affecting the end product. BOD was found to be positively correlated to COD.

Chemical Oxygen demand (COD)

The COD is a test is used to measure pollution of domestic and industrial waste. The textile effluent COD is 1890 mg/lit. This COD values is higher than the BIS standard limit (250mg/lit).The higher COD concentration can cause a substantial damage to submersed plants. Like BOD, higher COD is also harmful to all aquatic life[24]. COD was found to be positively correlated with BOD, CO₂, acidity, and Mn.

CO₂

Carbon dioxide is an odourless, colourless gas produced during the respiration cycle of animals, plants and bacteria and it is the end product of organic carbon degradation in almost all aquatic environments which makes changes in the net ecosystem metabolism[25].The present report of Tirupur textile effluent water is 13.09 mg/l that is higher than the normal standard limit. The higher CO₂ concentration can cause a substantial damage to submersed plants and kills the sensitive fish immediately.

HARDNESS

The presence of calcium and magnesium contributes to water hardness which states the equilibrium of waters[26]. The Tirupur textile effluent water hardness is 224.44 ppm that is higher than the WHO standard limit (200 ppm).) High Ca content is unfit for human consumption and damage the industrial machineries where it used for cooling purpose[27]. High Magnesium (Mg²⁺) adversely affect the soil quality and decreased the crop yields. High concentration of hardness may cause kidney problems and positively correlated with effluent temperature[28].

Salinity

Salinity is very important factor for water body. Salinity of Tirupur textile effluent is 300.94 and it is higher than the CPCB standard limit (300 ppm). High salinity (the presence of excess salts in water) can be harmful to certain plants, aquatic species, and human[29].High levels of salts in water can lead to high



blood pressure and other health concerns for humans. Salt affects crop germination and density, as also vegetative development, reducing productivity and leads to the generalized plant death, limiting nutrient absorption and reducing the quality of the water[30].

Alkalinity

Alkalinity is Composed of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) that measures the basic property of water. The Tirpur effluent water level of carbonate (CO_3^{2-}) is 4.54mg/lit and bicarbonate (HCO_3^-) is 8.19 mg/lit. Alkalinity acts as a stabilizer for pH. High value of alkalinity causes metabolic alkalosis and severely affects the mucous membrane[31]which is positively correlated with pH, EC, and Chloride.

Nitrate

Nitrate is an essential element in water. The nitrate level of Tirpur textile effluent is 46.40 ppm and it is higher than the WHO standard limit (45 ppm). The large amounts of nitrate will cause Eutrophication, which means an excess of nutrients resulting in oxygen deprivation and fish deaths[32]. When nitrate levels is higher than 30 ppm can inhibit growth, impair the immune system and cause stress in some aquatic species.

Nitrite

Nitrite is an essential element in water. The nitrite level of Tirpur textile effluent is 5.1ppm which is higher than WHO standard limit (3ppm). The large amounts of nitrite will cause excess algae growth in rivers and streams and leads to the death of fish and other important organisms, as well as odour problems[33]. Nitrites causes brown blood disease and produced a serious illness in fish. Nitrites also react directly with haemoglobin in human blood and destroys the ability of blood cells to transport oxygen. This condition is especially serious in babies under three months of age as it causes a condition known as methemoglobinemia or "blue baby" disease[34].

Bromine

The Bromine level of Tirpur textile effluent is 0.3mg/lit. The long-term use of potassium bromide (or any bromide salt) can lead to bromism. This state of central nervous system depression causes the moderate toxicity of bromide in multi-gram doses for humans and other mammals[35]. The very long half-life of bromide ion in the body (~12 days) also contributes to toxicity from bromide buildup in body fluids. Bromide ingestion may also cause a skin eruption resembling acne.

Table 1. Physicochemical Parameters of Textile Industry Effluents from Tirupur

| Physical Parameters | | | | | | |
|----------------------|------------------------------------|-----------------|------------------|--------------------|-------------------|-------------------|
| S.No | Name of the Test | Control | Effluent | CPCB (Permissible) | WHO (Permissible) | BIS (Permissible) |
| 1 | Temperature ($^{\circ}\text{C}$) | 28 | 45 | 40 | - | - |
| 2 | Light (cm) | 5 | 2 | 5 | - | - |
| 3 | Colour | Colourless | Dark brown | - | - | - |
| 4 | Odour | Pleasant | Un pleasant | - | - | - |
| 5 | EC (μs) | 1050 | 2630 | 2500 | - | - |
| Chemical Parameters | | | | | | |
| 6 | pH | 6.40 | 8.90 | 5.5-9.0 | 6.5 – 9.5 | 6.5 -8.5 |
| 7 | DO mg/lit | 6.9 | 3.4 | 4-6 | - | 4-6 |
| 8 | BOD mg/lit | 24 | 472 | 30 | 6 | 50 |
| 9 | COD mg/lit | 4.0 | 1890 | 250 | 10 | 250 |
| 10 | CO_2 mg/lit | 4.4 | 13.09 | - | - | - |
| 11 | Hardness Ppm | 89.33 | 224.44 | 600 | 200 | 600 |
| 12 | Salinity Ppm | 107.94 | 300.94 | - | - | 600 |
| 13 | Carbonate mg/lit | Nil | 4.54 | - | - | - |
| 14 | Bicarbonate mg/lit | Nil | 8.19 | - | - | - |
| 15 | Nitrate Ppm | 17.24 | 46.40 | - | 45 ppm | 100 |
| 16 | Nitrite Ppm | 0.06 | 5.1 | - | 3 ppm | - |
| 17 | Bromine mg/lit | 0.1 | 0.3 | - | - | - |
| 18 | Fluoride mg/lit | 0.10 | 1.47 | - | - | 1.5 |
| 19 | Chlorine mg/lit | 0.1 | 0.5 | - | - | - |
| 20 | Chloride Ppm | 93 | 394 | 500 | 250 ppm | 600mg/lit |
| Biological Parameter | | | | | | |
| 21 | THBP(cfu/ml) | 2×10^1 | 15×10^5 | - | - | - |



CONCLUSION

The increased demand for textile products enhanced the textile industry worldwide which produced large amounts of waste water and released directly to the water bodies near to industries and polluting the environment. In the present study Waste water generated from Tirupur textile mill which have high pH, temperature, detergents, oil, suspended and dissolved solids, dispersants, leveling agents, toxic and non-

biodegradable matter, colour and alkalinity. This study addresses the present status of physicochemical characteristics of the Tirupur textile effluents and the results revealed that the most of the parameters were not within the permissible limit of CPCB, BIS and WHO standard. Most of the Tirupur textile industries discharged the untreated effluents to the nearby rivers that is polluting the ground water and causing various health problems and adversely affect the agriculture and aquatic life.

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