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RESEARCH ARTICLE

Comparative Studies of Some Physicochemical Characteristics of Raw Water and Effluents of Textile Industries of Sitapura, Jaipur.

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Abstract

Textile industries are one of the largest consumers of water as well as the producers of large quantities of wastewater effluents. In this study, the important physicochemical parameters including pH, total dissolved solids (TDS), electrical conductivity (EC), biological oxygen demand (BOD) and chemical oxygen demand (COD) of the raw water used and the effluents generated were analyzed. The physicochemical parameters of the effluent samples were compared with those of the raw water (bore well) samples to analyze the pollution load of the effluents. The values of the studied physicochemical parameters were much higher than the permissible limits as prescribed by CPCB and WHO. Higher values of pH, TDS, BOD and COD have detrimental health effects on both humans and aquatic life. Direct disposal of the untreated industrial effluents into the water bodies is very hazardous for both biotic and abiotic components of the environment. Therefore proper remedial measures are to be taken for the treatment of effluents before their discharge into the water bodies.

INTRODUCTION

Textile industries are one of the most polluting industries in India due to large consumption of water. With the increased demand for textile products, the textile industry and its wastewaters have been increasing proportionally, making it one of the main sources of severe pollution problems worldwide [1,2]. Major operations performed in a typical textile processing industry are desizing, scouring, mercerizing, bleaching, neutralizing, dyeing, printing and finishing. The discharge of polluted effluents and use of various raw materials may cause contamination to soil, surface water and ground water which may have adverse consequences on environment in general and local population in particular.

Major problem in textile industry is the presence of color due to extensive use of dyes. The wastewater containing dyed effluents has been found to be hazardous to aquatic ecosystem because it reduces the rate of photosynthesis due to the reduced penetration of sunlight in colored waters. It not only leads to toxicity of fishes and mammals but also inhibits the activity and growth of microorganisms [3].

The effluents generated from the textile industry are of utmost concern because of high volumes and pollution potential. Quantity and nature of waste generated depends on the fabric being processed, chemicals being used, operating practices & technology being employed. There are more than 8,000 chemical products associated with the dying process and over 100,000 commercially available dyes exist with over 7×10^5 metric tons of dyestuff produced annually [4,5].

Several structural varieties of dyes including acidic dyes, basic dyes, disperse dyes, azo dyes, diazo dyes, anthraquinone-based dyes and metal-complex dyes are being used by textile industries. Interest in the pollution potential of textile dyes has been prompted primarily due to concern over their possible toxicity and carcinogenicity [6]. Wastewater generated by different production steps of a textile mill have high pH, color, temperature, detergents, oils, suspended solids, dissolved solids, dispersants, leveling agents, alkalinity, toxic metals and non-biodegradable matter [7].

Due to increased awareness of worldwide environmental issues, there has been a great interest in the development of eco-friendly wet processing textile techniques in recent years (8). Although the disposal of wastewater has become a significant cost factor, it must be considered in running textile industries. Physicochemical characterization of wastewaters is pre-requisite for the investigation of pollution potential and thus to adopt the necessary treatment options.

Materials & Methods:

Study Area:

The present study area is Sitapura industrial area situated in Bundi, Rajasthan, India and located at 25^{o} 17' 50" North & 75^{o} 41' 55" East. Four textile industries were selected at different places for the sample collection. The designated industries were coded as IND1, IND2, IND3 & IND4.

Sampling:

The representative effluent samples were collected in clean polythene bottles separately with one hour interval in the working period of each industry. Samples collected from each industry were mixed separately to get the composite samples. Composite samples are more important for the study as compared to grab samples because they can give wide information about the effluent characteristics generated. Two types of samples were collected for the physicochemical analysis; a) Raw water (bore well) samples as used by the industries collected from the inlets, &, b) Effluent samples collected from the outlets. This type of sampling was done for the comparative studies of the raw water and effluents generated & thus to assess the pollution load.

After preliminary analysis of color, temperature & pH, the samples were preserved by refrigeration at 4^{o}C without chemical addition for further analysis.

Sample analysis

The physico-chemical analysis of the samples was carried in triplicates in the laboratory as per the Standard Methods of APHA (9). Raw water samples were colorless & odorless. However, the effluent samples were highly colored, pungent smelling & turbid. pH was determined by using pH meter, electrical conductance (EC) by conductometer, total dissolved solid (TDS) by gravimetric method, biochemical oxygen demand (BOD) was determined by dilution method, chemical oxygen demand (COD) was determined by closed reflux method.

Results & Discussions

The average characteristics of triplicates of raw water and effluents from the four different textile industries and the values obtained are correlated with the limits as prescribed by central pollution control board, CPCB (10). The results of the analysis are shown in Table1 & Table2.

Table1: Physicochemical characteristics of Raw Water (Bore Well) used by textile industries.

	pH	EC(µS/cm)	TDS (mg/l)	BOD (mg/l)	COD (mg/l)
IND1	6.91±0.07	587±0.98	296±1.3	1.36±0.01	8.45±0.02
IND2	7.12±0.13	394±0.91	197±1.2	0.93±0.01	7.73±0.02
IND3	7.04±0.06	784±0.52	445±1.7	1.74±0.02	9.01±0.01
IND4	7.03±0.05	475±0.60	235±1.9	1.30±0.01	8.34±0.03

Table2: Physicochemical characteristics of effluents of textile industries.

	pH	EC(µS/cm)	TDS (mg/l)	BOD(mg/l)	COD(mg/l)

IND1	8.91±0.01	4766±0.32	2733±0.32	293.20±0.19	641.43±0.20
IND2	9.21±0.02	7527±0.89	4251±0.95	412.26±0.25	870.90±0.78
IND3	9.52±0.02	6834±0.92	3852±0.91	341.33±0.36	763.23±0.15
IND4	8.95±0.01	5622±0.67	3223±0.64	363.80±0.09	782.56±0.05
CPCB standards	5.5-9.0	--	2000	30	250

From the analysis of samples, it has been observed that the textile wastewaters showed extreme fluctuations from the CPCB standards in terms of pH, TDS, EC, BOD and COD. Also the results show the pollution load in the effluents is much higher than that of the raw water used. Thus, the comparative study of raw water and effluents of textile industries has been taken to assess the impact of industries on the quality of water.

pH is a measure of the acidity or alkalinity of water. Anything either highly acidic or alkaline would kill aquatic life (11) because all metabolic processes are pH dependent. The toxicity of heavy metals also gets enhanced at particular pH. It has been observed that pH also changes soil permeability which results in polluting underground resources of water [12]. Thus, pH is having primary importance in deciding the quality of wastewater released from textile industries.

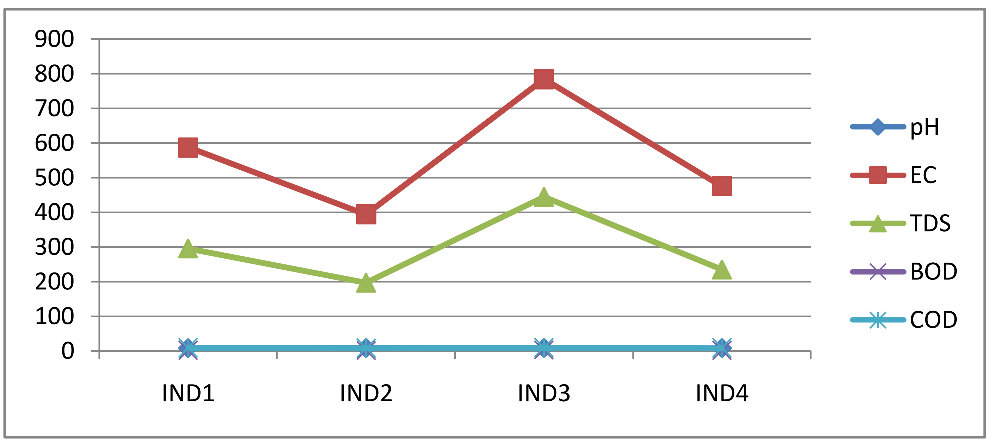


Fig1. Plot showing the variation of pH, EC, TDS, BOD & COD of Raw Water (Bore Well) used by the textile industries. All values are in mg/l except pH & EC. EC is expressed in µS/cm.

In the present study the mean values of pH was in the range of 6.91±0.07 to 7.12±0.13 for the raw water and 8.91±0.01 to 9.52±0.02 for effluents respectively. This shows that the effluents of textile industries under study area are highly alkaline in nature compared to the raw water used. The values are observed to be higher than the standard disposal limit as per CPCB standards of effluent discharge.
The use of bleaching agents and chemicals including NaOH, NaOCl, sodium phosphate and surfactants used in the processes are reasons for high alkaline nature of wastewater (13). Thus due to highly alkaline nature, wastewater needs the treatment to reduce its pH to an appreciable extent as prescribed by CPCB before disposal into the fresh water bodies.

During the present study, the electrical conductivity (EC) for raw water was found in the range of 394±0.91 to 784±0.52 µS/cm while for effluents, the EC ranged between 4766±0.32 to 7527±0.89 µS/cm. The maximum value electrical conductance was 7527±0.89 µS/cm. The high values of electrical conductance can be attributed to the presence of dissolved salts in the untreated wastewater samples of the textile industries as compared to the raw water. Also, the high values of EC are harmful for plant growth (14). Water having high EC and TDS values has been found to cause osmotic stress in the roots of plants, which makes it more difficult for a plant to absorb water for growth. Thus, crop production is highly affected due to high values of EC and TDS in irrigation water [15]. The decreased crop production thus serves as an indicator for water pollution.

A comparative study of Total dissolved solids (TDS) in the raw water used & the effluents generated revealed that the TDS values of effluents were much higher than the CPCB standards. The TDS values for raw water used ranged between 197±1.2 to 445±1.7 mg/l whereas for textile effluents the values ranged between 2733±0.32 to 4251±0.95 mg/l which is higher than CPCB standards for effluent discharge. The cause of high TDS is due to the presence of large number of dissolved salts in natural water as chlorides, carbonates, bicarbonates, sulphates, phosphates, nitrates of sodium, potassium, calcium, magnesium, manganese and iron (16). High content of TDS affects the density of water, reduces solubility of gases (oxygen), influences the osmoregulation of freshwater organisms, utility of water for drinking and irrigation purposes (17).

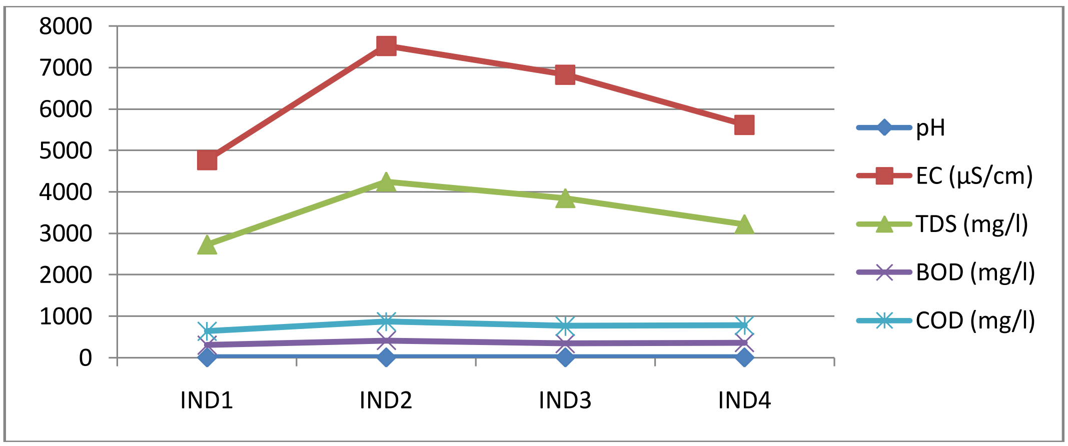
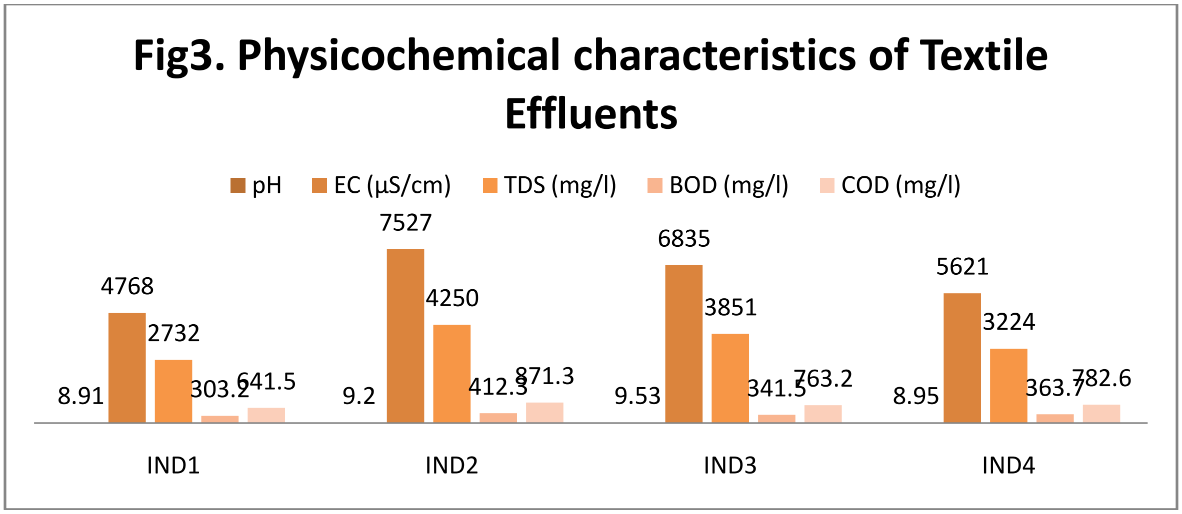


Fig2. Plot showing the variation of Physico-chemical characteristics of Textile Industry effluents. All values are in mg/l except pH & EC. EC is expressed in µS/cm.

BOD is the most important parameter which is used to determine the pollution load of an effluent. BOD is expressed as a measure of quantity of oxygen used by microorganisms in the degradation of organic matter. The BOD of raw water ranged between to 0.93±0.01 to 1.74±0.02 mg/L & that for the effluents, the range was between 293.20±0.19 to 412.26±0.25 mg/l. The values of BOD recorded for textile effluents are higher than the prescribed standards as stipulated by CPCB. Higher value of BOD indicates the extent of biodegradable substances present in the effluents as compared to raw water. Greater the decomposable matter, greater is the oxygen demand, thus greater the BOD values (18). Excessive values of BOD are harmful to the aquatic animals like fish and microorganisms. It also imparts bad taste to the drinking water [19].

The value of COD ranged between 7.73±0.02 to 9.01±0.03 mg/l for raw water and 641.43±0.20 to 870.91±0.15 mg/l for textile effluent which is also higher than CPCB standard. The higher values of COD compared to raw water may be attributed to the use of large quantities of dyes for textile processing (20). This is highly undesirable because continuous discharge of effluents not only affects the receiving water body to some extent but may have negative effects on the quality of freshwater also and subsequently causes harm to aquatic life especially fish (21). A BOD:COD ratio of 0.5 or greater indicates that wastewater is easily treatable by biological means [22]. If the ratio is lower than 0.3 then, the wastewater may either have some toxic components or it may require acclimated microorganisms for its stabilization (23,24). The range of BOD to COD calculated in the present study was 0.447 to 0.473, which indicates that the wastewater may be treated with microorganisms.



Conclusion

From the analysis of raw water and effluent samples of textile industries, it has been observed that the textile wastewaters show extreme fluctuations from the CPCB standards in terms of pH, TDS, EC, BOD and COD. Also the results indicate that pollution load in the effluents is much higher than that of the raw water used. The high pollution load of effluents affects the water quality which in turn leads to significant environmental problems and health risks to the rural communities who rely directly on the receiving water for the domestic purposes without treatment. Therefore, it is recommended that the effluents of textile industries must be treated well before their disposal into the surrounding water bodies. The effluents may be treated by various physico-chemical & biological treatment methods including adsorption by activated carbon, treatment by mixed culture of bacteria & advanced oxidation processes (3). However, efficiency of any physico-chemical or biological treatment process depends largely on the quality, nature and concentration of the organic compounds.

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