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Physicochemical Characterization of Textile Waste Water

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Abstract:
An attempt was made to analyze the water quality of the effluent from the textile industry. The effluent sample was collected from Karur, a textile city in Tamilnadu. In this investigation physicochemical parameters such as colour, odour, electrical conductivity (EC), temperature, total suspended solids (TSS), total dissolved solids (TDS), total solids (TS), pH, total alkalinity, total hardness, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), chlorides, sulphates, phosphates, nitrate nitrogen, lead, nickel, zinc, chromium, copper, oil and grease were determined using standard procedures. The result of this analysis was compared with the water quality standards of BIS (Bureau of Indian Standard). The effluent sample was dark violet in colour with objectionable odour. It showed high electrical conductivity, high TSS, TDS,TS values, alkaline pH, high BOD and COD, low DO, high amounts of chlorides, nitrates, sulphates and also showed the presence of heavy metals, oil and grease. It was observed that all the parameters studied exceeded the BIS limits.

Keywords: *Physicochemical Parameters, Textile Effluent, Water Quality BIS.*

1. Introduction

Water is one of the most valuable resources on planet earth. It is the lifeline of almost all living thing on earth. Although this fact is widely recognized, pollution of water resources is a common occurrence. The world's ever increasing population and progressive adoption of industry based lifestyle have inevitably led to an increased anthropogenic impact on the biosphere. The textile industry is one of the most important and rapidly developing industrial sectors in India (Husain and Husain, 2012) accounting for about 20% of the total industrial production. It provides direct employment to around 20 million people. The textile units are scattered all over India, out of 21076 units, Tamil nadu alone has 5285 units (Bal, 1999).

The textile industry is a high consumer of water mainly as process water (90–94 %), and cooling water (6–10 %), become finally loaded with different pollutants, dyes, surfactants, acids or bases, salts, heavy metals, and suspended solids (Zaharia and Suteu, 2012). Textile fabric manufacturing uses mixtures of dyes with various additives including solvents, antifoaming, whitening agents and pH conditioners.

The waste water thrown out from industries is either used for irrigation purposes or it runs off into natural sources of water (Ahlawat and kumar, 2009). Waste water from textile industries creates a great pollution problem due to the dye content. The inefficiency in dyeing processes has resulted in 10-15% of unused dyestuff entering the waste water directly (Spadarry et al., 1994).

Natural pigments used for coloring textiles have been replaced by "fast colours" which do not fade on exposure to light, heat and water. These features unfortunately go with the perils of harmful effluent quality. About 15% of the dyes used for textile dyeing are released into processing waters (Mishra and Tripathy, 1993).

Dyes used in the textile industries are classified into three classes, (a) anionic (direct, acid, and reactive dyes), (b) cationic (all basic dyes), and (c) non-ionic (dispersed dyes). Basic and reactive dyes are extensively used in the textile industry because of their favorable characteristics of bright color, being easily water soluble, cheaper to produce, and easier to apply to fabric (Karadag et al. 2007). Dye production in India is estimated to be around 60,000 tonnes/year, or about 6.6 % of the world production (Central Pollution Control Board, India). It is estimated that about 40–65 L of textile effluent is generated per kilogram of cloth produced (Manu and Chaudhari 2002). About 15 – 30% of these dyes remain in the effluents for colouring of final products in textile industry. Presence of color or color-causing compounds has always been undesirable in water for any use.

Textile dyeing process demands large amount of water and produces substantial volume of wastewater. Major pollutants in textile waste waters are high suspended solids, chemical oxygen demand, heat, colour, acidity and other soluble substances (Dae-Hee et al., 1999). Colour is imparted to textile effluents because of various dyes and pigments used. In an addition to dyes, various salts and chemicals are the major sources of heavy metals in waste water. Sediments, suspended and dissolved solids are important repositories for toxic heavy metals and dyes causing rapid depletion of dissolved oxygen leading to oxygen sag in the receiving water (Alihameed et al., 2008). The metals and contaminants like dyes tend to persist indefinitely, circulating and eventually accumulating throughout the food chain. The dyes and metals have direct and indirect toxic effects in the form of cancers, allergies besides, inhibiting growth at different trophic levels (Kant, 2012).

Keeping in view the significance of dyes and their environmental problems, the current study was aimed at physicochemical characterization of the textile dyeing effluent and the comparison of the effluent characteristics with BIS (Bureau of Indian standards) limits.

2. Materials and Methods

2.1. Collection of Textile Effluent

The effluent was collected from a small scale dyeing unit at Rayanur of Karur district, Tamilnadu. Karur is famous worldwide for its handloom textile products. Concerning its industrial location, it is one of the developing cities in Tamilnadu and textile industries are its dominating industries. The samples were collected in pre-cleaned 5L polythene bottles from the point of discharge of the effluent from the industry and preserved in a refrigerator at 4°C till the completion of the investigation.

2.2. Physicochemical Characterization of Textile Dyeing Effluent

Physicochemical parameters such as colour, odour, electrical conductivity (EC), temperature, total suspended solids (TSS), total dissolved solids (TDS), total solids (TS), pH, total alkalinity, total hardness, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), chlorides, sulphates, phosphates, nitrate nitrogen, lead, nickel, zinc, chromium, copper, oil and grease were determined using standard procedures (APHA, 1998).

3. Results and Discussion

The textile dyeing effluent sample was found to be dark violet in colour with objectionable odour. The electrical conductivity recorded was 360μmho/cm. The temperature of the sample at the time of collection was 40°C. The values of total suspended solids (TSS), total dissolved solids (TDS) and total solids (TS) were found to be 2000, 8000 and 10000 mg/l respectively.

The effluent showed a pH of 9.5 and a total alkalinity of 430 mg/l. Total hardness recorded was 460 mg/l. Dissolved oxygen content (DO) was 3.5 mg/l. Biological oxygen demand (BOD) and chemical oxygen demand were 90 mg/l and 571 mg/l respectively.

The amount of chlorides, sulphates, phosphates and nitrates were 1298, 948, 2.18 and 80 mg/l respectively. The amount of lead, nickel, zinc, chromium and copper recorded the values of 1.3, 0.9, 5.46, 1.83 and 3.21 mg/l respectively. The amount of oil and grease estimated was 14.7 mg/l.

The results of the physicochemical analysis showed that the textile effluent is characterized by the presence of colour with objectionable odour, high electrical conductivity, high TSS, TDS values, alkaline pH, high BOD and COD, low DO, high amounts of chlorides and sulphates, nitrates and also showed the presence of heavy metals, oil and grease.

Colour of the effluent depends on the dyes used. Different colour marks are used for dyeing different lots of cloth. Both synthetic and natural colours easily disperse in water (Tortman and Tortman, 1964; Cock, 1964). The color value of waste water is extremely pH dependent and it invariably increases as the pH of the effluent is raised or lowered. The textile waste water is highly colored showing the presence of high concentrations of unused dyes. According to Oke et al. (2006), the textile effluents show high colour and this may be the combined results of pH, temperature and acidic conditions that do not allow the chromophore group of dye to degrade making effluent highly colored.

The bad odor could be due to unpleasant odor of volatile compounds. Unpleasant or pungent odour for textile effluent was reported (Arul et al., 2011; Ogunlaja and Aemere, 2009).

The electric conductivity (EC) is usually used for indicating the total concentration of the ionized constituents of water and an indirect measure of ions or charge carrying species in the effluents (Sultana et al., 2009).

High TSS and TDS detected could be attributed to the presence of high colour and they may be the major sources of the heavy metals (Yusuff and Sonibare, 2004).

The high pH of effluent indicates the excessive use of dyes. pH value of waste water has no health implication but many chemical reactions are controlled by pH. Biological activities and some chemical treatment processes are usually restricted by pH. Federal Environmental Protection Agency (FEPA) recommends pH value of range 6 – 9 for effluent to be discharged into stream, as either high or low pH will be harmful to man, aquatic animals and will disturb biological activity of stream if discharged untreated.

Total alkalinity has been reported as a major factor which influences pH (Wetzel, 1972; Verma and Deleta, 1975). Alkalinity is the capacity of water to neutralize acid and is characterized by the presence of hydroxyl ions.

The hardness of water is not a chemical parameter but indicates the water quality mainly in terms of Ca^{2+} and Mg^{2+} and expressed as $CaCO_3$. The hardness has no known adverse effect. Their low concentration in the textile wastewater may be due to the use of soft water in the dyeing and printing process to avoid coagulation of dyes (Hussain and Hussain, 2012).

Dissolved oxygen is essential to all forms of aquatic life including those organisms responsible for the self purification processes in natural waters. Like terrestrial animals, fish and other aquatic organisms need oxygen to live. The presence of oxygen in water is a positive sign of a healthy body of water but the absence of oxygen is a signal of severe pollution (Sultana et al., 2009).
High BOD indicates that there could be low oxygen available for living organisms in the waste water. The high BOD may deplete dissolved oxygen, causing death of aerobic organisms and increase anaerobic properties of water (Jody and Dons, 2003). A high level of COD implies toxic conditions and the presence of biologically resistant organic substances in waste water. It determines the oxygen required for the chemical oxidation of organic matter and assesses the quantity of chemically oxidizing matter in water (Sawyer and McCarty, 1978).
Chloride in the waste water may be due to water softening process or when sodium chloride is used to recharge softeners. The high concentration of sulfate in the untreated waste water is due to use of sulfuric acid in various steps of dyeing and printing process (Hussain and Hussain, 2012).
Presence of heavy metals in the waste water may be due to use of some dyes in which these metals are complexed. It have been reported that the major problem associated with textile processing effluents is presence of heavy metals, which arise from materials used in the dyeing process or in a considerably high amount, from metal containing dye (Correia, 1998).

S. No.	Parameters	Raw Effluent	BIS Permissible Limits
1	Colour	Dark violet	-
2	Odour	Bad odour	-
3	Electrical conductivity (EC)(µmho/cm)	360	600
4	Temperature (°C)	40	>40
5	Total suspended solids (mg/l)	2000	100
6	Total dissolved solids (mg/l)	8000	2100
7	Total solids (mg/l)	10000	

Table 1: Physical Parameters of Textile Effluent and BIS Permissible Limits

S. No.	Parameters	Textile Effluent	BIS Permissible Limits
1	p^H	9.5	5.5 - 9.0
2	Alkalinity	430	200-600
3	Total hardness	460	600
4	Dissolvedoxygen	3.5	-
5	Biological oxygen demand	90	30
6	Chemical oxygen demand	571	250
7	Chloride	1298	1000
8	Sulphate	1118	1000
9	Phosphate	2.18	5
10	Nitrate nitrogen	80	50
11	Lead	1.3	0.1
12	Nickel	2.50	3
13	Zinc	5.46	5
14	Chromium	1.83	2
15	Copper	3.21	3
16	Oil and grease	14.7	10

Table 2: Chemical Parameters of Textile Effluent and BIS Permissible Limits

4. Conclusion

The study addresses the physicochemical characteristics of the textile dyeing effluent and warrants remedial measures to safe guard the environment.
It is recommended that the disposal of industrial waste water without proper treatment should be discouraged and continuous monitoring of water quality is imperative to ensure the protection of water resources from further degradation.

5. References

i. APHA. Standard Methods for the Examination of Water and Wastewater 20th Ed. American Public Health Association Washington, DC, (1998).
ii. Ahlawat, K. and Kumar, A. (2009), Analysis of industrial effluents and its comparison with other effluents from residential and commercial areas in Solan H.P, Journal of Theoretical and Applied Sciences, 1(2), 42-46.
iii. Alihameed, N. and Ahmed, A. (2008), Physicochemical characterization and bioremediation perspective of textile effluent dyes and metals by indigenous bacteria, J. Hazardous Materials, 164, 322-328.
iv. Arul, J.M., Revathi, M.N. and Saravanan, J. (2011), Decolorization and Physicochemical analysis of textileazodye by Bacillus, International Journal of Applied Bioengineering, 5: 35-39.
v. Bal, A.S. (1999), Waste water management for textile industry- an overview, Indian J Environ Health, 41 (4): 264-290.
vi. Cock JG. Handbook of textile fibers, Merrow Publication Co. Ltd., England. 1964.
vii. Correia, V.M. (1998), Sulphanated surfactants and related compounds: Fact of their desulfonation by aerobic and anaerobic bacteria, Tenside surfactants detergents, 35: 52- 56.
viii. Dae- Hee, A., Won-Seok, C. and Tai-Il, Y. (1999), Dyestuff waste water treatment using chemical.
ix. Husain, J. and Husain, I. (2012), Groundwater pollution by discharge of dyeing and printing industrial waste water in Bandi river, Rajasthan, India, International Journal of Environment and Bioenergy, Vol. 2(2), pp:100-119.
x. Jody, T. and Dons, J. (2003), Meeting the challenges of swine manure management, Biocycle, 44(10), 24.
xi. Kant Rita. (2012), Textile dyeing industry and environmental hazard, Natural Science, 4(1), 12-26.
xii. Karadag, D., Akgul, E., Tok, S., Erturk, F., Kaya, M. A., and Turan, M. (2007). Basic and reactive dye removal using natural and modification zeolites. Journal of Chemical and Engineering Data, 52, 2436–2441.
xiii. Manu, B and Chaudhari, S. (2002), Anaerobic decolorisation of simulated textile wastewater containing azo dyes, Bioresour Technol 82:225–231.
xiv. Mishra, G. and Tripathy, m. (1993), A critical review of the treatment for decolourization of textile effluents, Colourage 40: 35- 38.
xv. Ogunlaja, O. and Aemere, O. (2009), Evaluating the efficiency of a textile wastewater treatment plant located in Oshodi, Lagos,African Journal of Pure & Applied Chemistry, 3: 189-196.
xvi. Sawer, C.C. and McCarty, P.L. (1978), Chemistry for Environmental Engineers, McGraw Hill, New Yorh, pp: 331-514.
xvii. Spadarry, J.T., Isabella, L. and Ranganathan, V. (1994), Hydroxyl radical mediated degradation of azo dyes: evidence for benzene generation, Environmental Science and Technology, 28: 1389- 1393.
xviii. Sultana, M., Islam, M., Sahaa, R. and Al-Mansur, M. (2009), Impact of the effluents of textile dyeing industries on the surface water quality inside D.N.D (Dhaka- Narayanganj-Demra) Embankment, Narayanganj. Bangladesh Journal of Scientific and Industrial Research, 44: 65-80.
xix. Tortman SR, Tortman ER. The bleaching, dyeing chemical technology of Textile fibers. Charless Griffen and Comp. Ltd., London 1964.
xx. Verma SR, Dalela RC Studies on the pollution of the Kalinadi by industrial wastes near Mansurpur Part-II: Biological Index of Pollution and Biological Characteristics of the River, Acta Hydrochim Hydrobiol.1975: 3(3): 259-274.
xxi. Wetzel RG, Primary production. In: Mitchel RA. Water pollution microbiology, Wiley Inter science, New York. 230, 1972.
xxii. Yusuff, R.O. and Sonebare, J.A. (2004), Characterization of textile industry
xxiii. Zaharia, C. Suteu, D. (2012), Textile organic dyes characteristics, polluting effects, and separation/elimination procedures from industrial effluents. A critical overview. In: Puzyn T, Mostrag- Szlichtyng A (eds) Organic pollutants—ten years after the Stockholm convention. Environmental and analytical update. Intech Publisher Inc., Rijeka, pp: 55–86.