International Advance Journal of Engineering, Science and Management (IAJESM)
ISSN -2393-8048, July-December 2021, Submitted in November 2021, iajesm2014@gmail.com

A Comparative Study of Physicochemical Properties of Dyed Industry Effluents and Raw Water of Alwar, Rajasthan

Farzana Kausar, Department of Chemistry, Sunrise University Alwar Rajasthan
Dr. Ishtiyak Qadir,Department of Chemistry, Sunrise University Alwar Rajasthan

ABSTRACT

Significant volumes of wastewater effluents are generated and the textile industry is among the biggest consumers of water. The vital physicochemical parameters of the source water utilized and the effluents produced were analyzed in this research. These parameters comprised electrical conductivity, total dissolved solids, chemical oxygen demand and biological oxygen demand. To determine the effluents' contamination burden, a comparison was made between the physical characteristics of the effluent samples and those of the unprocessed water (tap water) samples. Significantly exceeding the CPCB and WHO-mandated permissible limits, the physicochemical parameters under investigation exhibited such values. Humans and aquatic organisms are adversely affected by elevated levels of pH, TDS, BOD, and COD. Both the abiotic and biotic elements of the environment are gravely endangered when untreated industrial effluents are disposed of directly into water bodies. In order to remediate effluents prior to their discharge into bodies of water, it is necessary to implement the appropriate corrective actions.

Key Words: pH, TDS, BOD, COD, Dyes

INTRODUCTION

The intensive textile production contributes significantly to the pollution levels in India's industrial sector. The textile sector and its wastewaters have experienced a commensurate rise in volume with the demand for textile products, positioning it as a significant contributor to global pollution issues [1,2]. Desizing, scouring, mercerizing, bleaching, neutralization, dying, printing, and finishing are significant operations carried out in the textile processing industry. Contamination of soil, surface water, and ground water may result from the discharge of polluted effluents and the utilization of diverse raw materials, which may have detrimental effects on the environment and residents. The textile industry faces a substantial concern regarding color due to the widespread application of dyes.

As a result of the diminished penetration of sunlight in colored waters, wastewater containing dyed effluents has been determined to be detrimental to aquatic ecosystems by reducing the rate of photosynthesis. Furthermore, it impedes the growth and activity of microorganisms and induces toxicity in vertebrates and mammals [3]. As a result of their high volumes and propensity for pollution, textile industry effluents are a major source of concern. Whether fabric is processed, what chemicals are utilized, and what operating procedures and technologies are implemented will determine the quantity and type of waste produced. Dyestuff is produced annually in excess of 7×10^5 metric tons [4,5]. The dying process is associated with over 8,000 chemical products, and there are over 10^5 commercially available dyes.The textile industry utilizes a wide range of structural dyes, including those based on anthraquinones, metal complexes, acidic dyes, basic dyes, disperse dyes and azo dyes. Primary concern for their potential carcinogenicity and toxicity [6] has been the investigation of the environmental impact of textile dyes. As well as detergents, lubricants, suspended solids, dissolved solids, dispersants, leveling agents, alkalinity, toxic metals, and non-biodegradable matter, wastewater produced by various textile mill production steps has elevated pH, color, and temperature [7]. As global consciousness regarding environmental concerns has grown, there has been a significant surge in interest regarding the advancement of environmentally sustainable moist processing textile methods in recent times (8). Despite the increased financial burden associated with effluent disposal, it remains an essential consideration for textile industries. The physicochemical characterization of wastewaters is an essential prerequisite for assessing the potential for pollution and subsequently determining the most suitable treatment alternatives.

Materials & Methods

Sampling: Within each hour of each industry's operating hours, representative effluent samples were taken and placed in clean polythene bottles. To create the composite samples, samples gathered from every industry were combined independently. Comparing grab samples to composite samples, the research finds more value in the latter as the former may provide a greater range of information on the features of the produced wastewater. To conduct the physicochemical analysis, two kinds of samples were obtained: (1) raw water (tap water) samples utilized by the industries, which were taken from the inlets; and (2) wastewater samples, which were collected from the outputs. In order to compare the raw water and effluents produced and therefore determine the pollutant load, this kind of sampling was carried out. The samples were evaluated for color, temperature, and pH first, and then they were refrigerated at 4^{o}C without the addition of chemicals to preserve them for further examination.

Sample analysis: The samples were analyzed physico-chemically in the lab in triplicates using the APHA Standard Procedures (9). Samples of raw water had no colorand smell. The effluent samples, however, were turbid, strongly scented, and brightly colored. A pH meter was used to measure pH, a conductometer was used to measure electrical conductance (EC), a gravimetric technique was used to measure total dissolved solids (TDS), a dilution method was used to measure biochemical oxygen demand (BOD), and a closed reflux method was used to measure chemical oxygen demand (COD).

Results & Discussions

The values derived from the average characteristics of fresh water and effluent triplicates from the four distinct textile industries are compared to the limits specified by the Central Pollution Control Board (CPCB) (10). The findings of the examination are presented in Table 1 and Table 2.

Table 1. Physico-chemical characteristics of Raw Water (Tap Water)

	pH	EC (µS/cm)	TDS (mg/l)	BOD (mg/l)	COD (mg/l)
Sample 1	6.7	598	386	1.39	7.67
Sample 2	7.25	402	199	0.89	7.60
Sample 3	7.12	790	428	1.45	8.89
Sample 4	7.10	469	241	1.26	8.02

Table 1. Physico-chemical characteristics of Raw Water (Tap Water)

	pH	EC (µS/cm)	TDS (mg/l)	BOD (mg/l)	COD (mg/l)
Sample 1	8.09	5890	3302	245	674
Sample 2	9.20	4760	4231	490	790
Sample 3	9.51	6702	4002	340	823
Sample 4	8.92	5673	3768	356	780

Based on the analysis of the samples, it has been determined that the pH, TDS, EC, BOD, and COD of the textile wastewaters deviated significantly from the CPCB standards. Additionally, the findings indicate that the effluents contain a significantly greater pollution burden than the fresh water utilized. Therefore, a comparative analysis of textile industry effluents and untreated water has been conducted in order to determine the extent to which industrial activities affect water quality.

Water's acidity or alkalinity is determined by its pH. Due to the pH dependence of all metabolic activities, aquatic life would be destroyed by anything very acidic or alkaline (11). At a certain pH, heavy metal toxicity increases as well. It has been shown that pH also alters the permeability of soil, contaminating subterranean water supplies [12]. Therefore, pH is the main factor in determining the quality of wastewater discharged by the textile industry.

The pH values of the effluents and untreated water in the current investigation fell within the intervals of 6.70 to 7.25 for the former and 8.09 to 9.51 for the latter. This indicates that the effluents from the textile industries in the area under investigation are significantly more alkaline than the fresh water used. The observed values exceed the standard disposal limit specified by the CPCB for effluent discharge. The production processes incorporate bleaching agents and chemicals, such as sodium hydroxide (NaOH), sodium chloride (NaOCl), sodium phosphate, and surfactants, which contribute to the significantly alkaline characteristics of effluent (13). Therefore, prior to being discharged into freshwater bodies, effluent must undergo treatment to significantly reduce its pH, as mandated by the CPCB, owing to its acidic nature.

The current investigation determined the electrical conductivity (EC) of tap water to be between 469 and 598µS/cm. In contrast, the EC of effluents varied from 4760 to 6702µS/cm. The electrical conductance reached its maximal value of 6702µS/cm. The elevated electrical conductance values observed in untreated effluent samples from the textile industry are attributable to the greater concentrations of dissolved minerals in comparison to the unfiltered water. Additionally, elevated EC levels are detrimental to plant development (14). Water with elevated EC and TDS concentrations has been observed to induce osmotic stress in plant roots, thereby impeding water absorption.

Total dissolved solids (TDS) in the produced effluents and the raw water utilized for comparison showed that the effluents' TDS levels were much greater than the CPCB requirements. While the TDS values for textile effluents varied from 3302 to 4231 mg/l, exceeding CPCB regulations for effluent discharge, the TDS values for raw water utilized ranged from 199 to 241 mg/l. Natural water with a high TDS is caused by an excess of dissolved salts, including chlorides, bicarbonates, sulphates, phosphates, and nitrates of calcium, magnesium, iron, manganese, and carbon (16). A high TDS concentration alters the viscosity of water, decreases the solubility of gases (oxygen), impacts freshwater species' ability to regulate their osmoregulation, and affects the suitability of water for irrigation and drinking (17).

The most crucial parameter utilized to ascertain the pollution burden of an effluent is BOD. Bacterial oxygen demand (BOD) is measured as the amount of oxygen used by microbes during organic matter degradation. The range of BOD values for fresh water and effluents was 0.89 to 1.45to 1.74mg/L and 245 to 490 mg/L, respectively. The biochemical oxygen demand (BOD) measurements obtained for textile effluents exceed the thresholds specified by the CPCB. A greater BOD value signifies a greater concentration of biodegradable substances in the effluents in comparison to the untreated water. As the amount of decomposable matter increases, so does the oxygen demand, resulting in higher BOD values (18). Bacteria, fish, and microorganisms are adversely affected by BOD concentrations that are excessive. Additionally, it damages the flavor of the potable water [19]. The COD concentrations for fresh water and textile effluent varied from 7.6 to 8.89 mg/l and 674to 823mg/l, respectively, both of which exceeded the CPCB standard. The elevated COD levels in comparison to untreated water can be ascribed to the substantial amounts of dyes utilized in the textile manufacturing process (20). This is exceedingly undesirable due to the fact that the continuous discharge of effluents not only has a limited impact on the recipient water body, but may also degrade the purity of freshwater and impair aquatic life, particularly fish (21). If the BOD:COD ratio is equal to or greater than 0.5, then biological treatment of the effluent is feasible [22]. Wastewater that has a ratio below 0.3 may contain toxic substances or necessitate the use of acclimated microorganisms for stabilization (23,24). The range of BOD to COD values computed for the current investigation was 0.458 to 0.475, suggesting that microorganisms might be utilized in the treatment of the effluent.

Conclusion

The examination of raw water and effluent samples from the textile industry has shown that the wastewater from these sources exhibits significant variations in pH, TDS, EC, BOD, and COD when compared to the CPCB requirements. Additionally, the data show that the effluents have a much larger pollutant burden than the raw water utilized. The rural populations who directly depend on the receiving water for household uses without treatment face serious environmental issues and health hazards as a result of the high pollution load of effluents affecting the water quality. Consequently, it is advised that textile industry effluents be thoroughly treated before being dumped into nearby water bodies. Numerous physical-chemical and biological treatment techniques, including as activated carbon adsorption, mixed bacterial treatment, and sophisticated oxidation processes, may be used to treat the effluents . Nonetheless, the quality, makeup, and concentration of the organic components have a major impact on the effectiveness of any physico-chemical or biological treatment method.

BIBILOGRAPHY

1. Andre dos BS., Francisco JC., Jules van BL. (2007). Review paper on current technologies for decolourisation of textile wastewaters: Perspectives for anaerobic biotechnology. Bioresource Technology. 98: 2369- 2385.

2. Asia IO., Oladoja NA., Bamuza-pemu EE. (2006). Treatment of textile sludge using anaerobic technology. African Journal of Biotechnology. 5(18): 1678-1683.

3. Zollinger H. (1987). Colour chemistry-synthesis, properties and application of organic dyes and pigments. VCH Publishers. New York. 92-100.

4. Robinson., Mcmullan G., Marchant R, Ningam P. (2001). Remediation of dyes in textile effluent: A critical review on current treatment technologies with a proposed alternative. Biores. Technol. 77(3): 247-255.

5. CLARKE E. A., ANLIKER R.O. (1980). Organic dyes and pigments. In The Handbook of Environmental Chemistry, Vol. 3, Part A. Anthropogenic Compounds, ed. O. Hutzinger. Springer, Heidlberg. 181-215.

6. Kumar P, Prasad B, Mishra IM, Chand S. (2007). Catalytic thermal treatment of desizing wastewater. J. Hazard. Mater. 149: 26-34.

7. Padma, S.V., Rakhi, S., Mahanta, D., And Tiwari, S.C. (2006): "Ecofriendly Sonicator dyeing of cotton with Rubia Cordifolia Linn using Biomordant". Dyes and Pigments. 11:1-6.

8. APHA. (1998). American public health association. Standard methods for the examination of water and wastewater. 20th edn. DC. New York.

9. CPCB. Environment (Protection) Rules, schedule-VI, Rule 3A. (1986)

10. Lokhande R.S., Singare P.U. and Pimple D.S. (2001). Study of physico-chemical Parameters of waste water Effluents from Taloja Industrial Area of Mumbai, India, International Journal of Ecosystem. 1(1), 1-9

11. Akpoveta O. V., Osakwe S. A., Okoh B. E. and Otuya B. O. (2010). Physiochemical characteristics and levels of some heavy metals in soils around metal scrap dumps in some parts of delta state, Nigeria, J.Appl. Sci. Environ. Mangae. 14(4): 57-60.

12. Paul, S. A., Chavan, S. K. and Khambe, S. D. (2012). Studies on characterization of textile industrial waste water in Solapur city. Int.J. Chem. Sci. 10 (2): 635-642.

13. Morrison G., Fatoki O.S., Persson L. and Ekberg A. (2001) Assessment of the impact of point source pollution from the Keiskammahoek Sewage Treatment Plant on the Keiskamma River-pH, electrical conductivity, Oxygen demanding substance (COD) and nutrients, Water SA. 27(4), 475-480.

14. Tekade P. V., Bawankar S. V. and Mohabansi N. P. (2011). Physico-chemical and microbiological ananlysis of textile industry effluent of wardha region, Water R &D. 1(1), 40-44.

15. AE Ghaly Production. (2014). Characterization and Treatment of Textile Effluents: A Critical Review. J Chem Eng Process Technol. 5:1

16. Ogunfowokan A.O. et al. (2005). Assessment of the impact of point source pollution from a university sewage treatment oxidation pond on the receiving stream-a preliminary study, J. App. Sci. 6(1), 36-43.

17. Igbinosa E.O. and Okoh A.I. (2009). Impact of discharge wastewater effluents on the physico-chemical qualities of a receiving watershed in a typical rural community, Int. J. Environ. Sci. Tech., 6(2), 175-182.

18. Savin I. I. and Butnaru R. (2008). Waste water characteristics in textile finishing mills, J. Environ. Engin. 7(6), 859-864.

19. Ikhu-Omoregbe Daniel., K. Kaipa Pardon., Muzenda Edison and Mohamed Belaid (2009). Characterization of Effluent from Textile Wet Finishing Operations, Proceeding of theWorld Congress on Engineering and Computer Science, Vol. I, 20-22.

20. Nese T., Sivri N., Toroz I. (2007). Pollutants of textile industry wastewater and assessment of its discharge limits by water quality standards. Turkish J Fisheries Aquatic Sciences. 97-103.

21. Krishnaswamy R., Kaliannan S., Kannadasan T., Duraisamy P.K. (2009). Study on Treatment and Re-use of Wash Water Effluent Form Textile Processing by Membrane Techniques. Modern Applied Science. 3: 1-10.

22. Imtiazuddin S.M., Mumtaz M., Mallick A.K. (2012). Pollutants of Wastewater Characteristics in Textile Industries. Journal of Basic & Applied Sciences. 8: 554-556.