# CHARACTERIZATION OF DYE INDUSTRY WASTEWATER: A CASE STUDY IN MYMENSINGH

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## ABSTRACT

This study presents a comprehensive characterization of dye industry wastewater in the Mymensingh region. The dye industry is a significant contributor to industrial activities in Mymensingh but also raises concerns due to the environmental impact of its wastewater discharge. The unmitigated release of untreated wastewater containing a blend of chemical and organic pollutants represents a major challenge associated with these industries. Despite the existence of Effluent Treatment Plants (ETPs), effectively operating and sustaining these treatment facilities remains a challenging endeavor. This study aimed to comprehensively characterize both untreated water and effluent water from a dye industry and Effluent Treatment Plant (ETP) and conduct a comparative analysis with the standards outlined in the Environmental Conservation Rules (ECR, 2023) while also determining the efficiency of the Effluent Treatment Plant (ETP). Various parameters were tested such as pH, color, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), conductivity. These results highlight the need for an improved Effluent Treatment Plant (ETP). While it maintained pH levels within limits, it wasn't very effective at treating other important parameters. This emphasizes the necessity for a more efficient ETP.

***Keywords:*** *wastewater, ETP, untreated water, effluent, efficiency*

## 1. INTRODUCTION

The textile industry has played a major role in boosting Bangladesh's economy. It's been a crucial part of the country's economy for many years. The textile sector brings in nearly 28 billion USD every year from exports, making up around 82% of Bangladesh's total export earnings (Hossain et al., 2018). Bangladesh ranks as the twelfth-largest garment manufacturing nation globally, playing a significant role in employing 50% of its industrial workforce (Hassan et al., 2022). Over 4 million individuals, predominantly women, are employed within these industries, constituting a significant portion of the country's total population (Dey & Islam, 2015). Presently, third-world nations, particularly Bangladesh, find themselves in an uncertain situation. With over 30,000 industrial units in operation, a majority of around 24,000 belong to the category of small and cottage industries (Nuruzzaman et al., 1998). When factories grow too quickly without a plan, they can harm nature a lot. Every day huge amount of water is being used in the dyeing and textile industry and generated wastewater filled with dyes and chemicals. Untreated industrial effluents pose a dual threat. Firstly, they degrade the quality of surface water, contributing to environmental deterioration. Secondly, they are a significant cause of numerous waterborne diseases, posing a severe threat to public health (Sarker et al., 2016). As per the Environmental Act and Rules (1997), textile dyeing factories must install Effluent Treatment Plants (ETPs) to treat wastewater before its discharge from the factory premises (ECR, 1997). Growing international pressure for effluent treatment is prompting heightened concern among international buyers regarding environmentally responsible textile production. This trend suggests that future competitiveness in the global market will likely require the obligatory installation and efficient operation of Effluent Treatment Plants (ETPs). Encouragingly, many industries are proactively advancing by establishing and managing their ETPs to align with both national and international standards, driven by a heightened awareness of the adverse effects of industrial effluents (Islam et al., 2006). As industrialization and urbanization accelerate more rapidly in Bhaluka compared to other areas of the Mymensingh district, water quality becomes increasingly crucial for overall environmental well-being. Lack of proper planning in industrial development, inadequate utilization of Effluent Treatment Plants (ETPs), and the direct disposal of wastewater into nearby water sources have led to a concerning rise in pollution levels in the surface water. This pollution poses significant risks to public health, livestock, fish, wildlife, and overall biodiversity (Hasan & Miah, 2014). For these ETPs to operate effectively and meet national standards, regular and proper monitoring is crucial. Consistent evaluation of untreated and treated wastewater characteristics is necessary to assess the treatment plant's efficiency accurately (Sarker et al., 2016). Hence, this study aimed to evaluate the environmental characteristics of wastewater and effluents from a dye industry located in Bhaluka upazila of Mymensingh district and compare these parameters with ECR(2023) standards.

## 2. METHODOLOGY

### 2.1 Sample Collection

The study area is situated in Bhaluka upazila of Mymensingh district. Samples were systematically collected. Before sample collection, bottles were properly cleaned. Two samples were collected in two different bottles. One sample was collected from the inlet of the Effluent Treatment Plant (ETP), while the other was collected from the outlet of the ETP.

#### 2.1.1 Sample Analysis

The following tests were conducted on the collected water samples: color, temperature, pH level, Electric conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), $Cl^-$, $Na^+$, $Ca^{2+}$, and $Mg^{2+}$. Details relevant to each sample were meticulously recorded in a notebook. Furthermore, each sample, contained in a plastic bottle, was distinctly labeled with a unique identification number. The color was determined using the DR 2700™ Portable Spectrophotometer. pH level was determined using a digital pH meter. EC and DO were measured using the digital meter (model-WA-2015). BOD was measured in two steps: initial BOD ($BOD_1$) was measured immediately after collection, and after a 5-day incubation period at 20°C in dark conditions, the $BOD_5$ was measured. Chloride ion ($Cl^-$)concentration was determined through titration using a standardized solution of silver nitrate ($AgNO_3$) with potassium chromate ($K_2CrO_4$) used as an indicator. These testing methods and procedures were utilized to guarantee a thorough and precise understanding of the water samples, an essential prerequisite for the comprehensive analysis conducted in this study.

## 3. RESULTS

The test results of untreated water and treated effluent are presented in Table 1. The pH values of untreated and treated water were 7.1 and 8.3. The pH value of the treated effluent meets the required standard range of 6 to 9, as specified in the ECR, 2023. The measured dissolved oxygen (DO) level of untreated water was 1.4 ppm. After treatment, a noticeable increase in Dissolved Oxygen (DO) levels was observed in the samples, it was 4.2. Before treatment, the color was measured at 556 Pt-Co, and after treatment, it increased to 598 Pt-Co. According to ECR 2023 standards (150 Pt-Co), both measurements exceeded the acceptable limit. The values for $Cl^-$, $Na^+$, $Ca^{2+}$ and $Mg^{2+}$ in the untreated water were recorded at 27.5 $mgL^{-1}$, 17.61 $mgL^{-1}$, 120 $mgL^{-1}$, and 72 $mgL^{-1}$, respectively. After treatment, these concentrations changed to 150 $mgL^{-1}$, 96.09 $mgL^{-1}$, 80 $mgL^{-1}$, and 48 $mgL^{-1}$, respectively. The concentrations of $Cl^-$ and $Na^+$ in the untreated sample were observed to be higher in comparison to the treated sample, while the concentrations of $Ca^{2+}$ and $Mg^{2+}$ were lower in the treated sample. The Total Suspended Solids (TSS) in the untreated water measured 1740 $mgL^{-1}$. Whereas the TSS concentration in the treated effluent measured 2210 $mgL^{-1}$. The Electrical Conductivity (EC) measured in the untreated water was 167 µS/cm, and the treated effluent was 244 µS/cm. The higher EC value in the treated effluent might be because more ions were added during the treatment process using chemicals.

Table 1: Physiochemical characteristics of untreated water and treated effluent of Dye Industry

| Parameter | Untreated water | Treated effluent | Standard (ECR, 2023) |
|---|---|---|---|
| pH | 7.1 | 8.3 | 6-9 |
| Color (Pt-Co) | 556 | 598 | 150 |
| TDS (ppm) | 1790 | 2190 | 2100 |
| TSS (ppm) | 1740 | 2210 | - |
| BOD (ppm) | 25.2 | 33 | 30 |
| COD (ppm) | 559.27 | 455.12 | 200 |
| DO (ppm) | 1.4 | 4.2 | - |
| EC (µS/cm) | 167 | 244 | - |
| $Cl^{-1}$ (ppm) | 27.5 | 150 | - |
| $Na^+$ (ppm) | 17.61 | 96.09 | - |
| $Ca^{2+}$ (ppm) | 120 | 80 | - |
| $Mg^{2+}$ (ppm) | 72 | 48 | - |

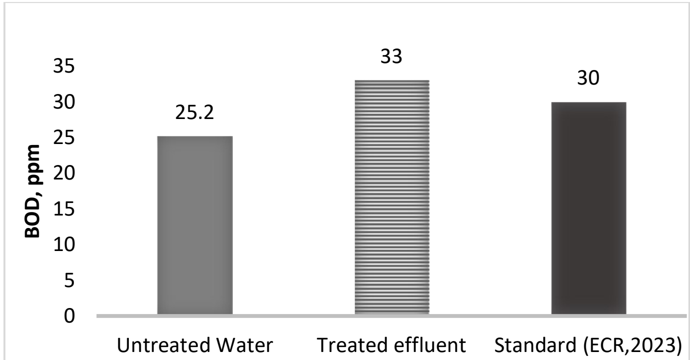


Figure 2: Comparison of BOD values with untreated water, treated effluent, and standard (ECR, 2023)

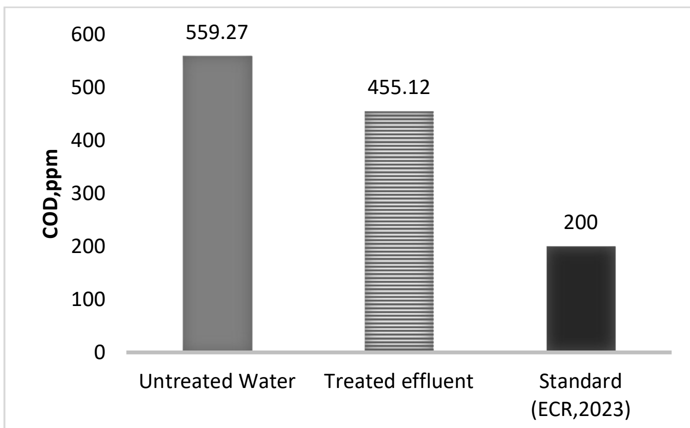


Figure 3: Comparison of COD values with untreated water, treated effluent, and standard (ECR, 2023)

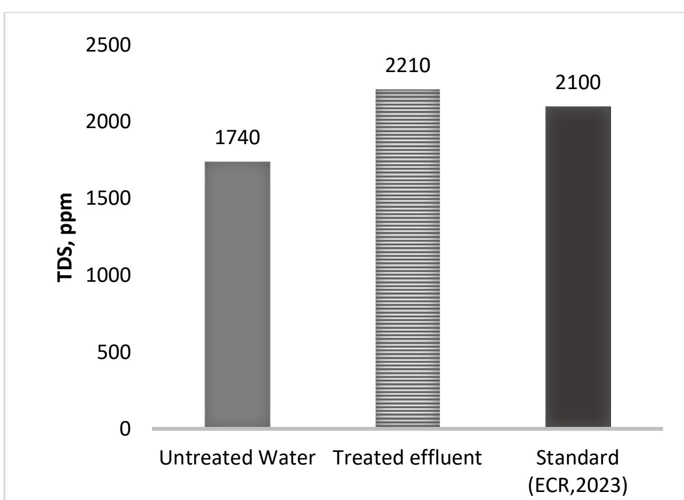


Figure 4: Comparison of TDS values with untreated water, treated effluent, and standard (ECR, 2023)

Figure 2 shows that the BOD value for untreated water was 25.2, slightly lower than the standard of 30. However, the treated effluent recorded a higher BOD value of 33, exceeding the maximum permissible value outlined by ECR 2023.

Figure 3 shows that the COD value for untreated water was 559.27. However, after treatment, the COD level in the effluent decreased to 455.12 ppm, remaining above the maximum permissible value of 200 ppm set by ECR 2023 but indicating a notable decrease compared to the initial untreated water's COD concentration. The untreated samples have high COD values due to the many organic compounds and chemicals used during the dyeing process. The high COD levels observed in the treated water samples may be attributed to the treatment process not being optimized to effectively remove organic compounds, or due to an insufficient dosage of treatment chemicals, resulting in certain pollutants not being adequately treated or removed from the wastewater.

Figure 4 shows that the TDS value for untreated water was 1790 and the treated water was 2190. The treated effluent showed a higher TDS value of 2190, exceeding the maximum permissible value outlined by ECR 2023.

## 4. CONCLUSIONS

Based on the results and discussion, it is evident that the values of TDS, BOD, COD, and EC were identified as higher in the effluent water samples collected from the industry than the maximum permissible limits mentioned in ECR,2023, only the pH level was found to be within the acceptable limits. The current condition of effluents being discharged is unsatisfactory. After treatment by the Effluent Treatment Plant (ETP), parameters have not met the standard limits. Despite exceeding the highest limits set by ECR 2023, the level of some parameters after treatment indicates reduced risks compared to their initial levels. Hence, to ensure a sustainable and environmentally responsible approach, the dye industry must maintain a focus on continuous monitoring and efficient management of ETPs.

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