



# Quality And Management Of Wastewater In An Electroplating Industry

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**Abstract:** The industrial wastewater treatment is a critical aspect of the environmental management, ensuring compliance with the discharge regulations and minimizing the ecological impacts. This study analyzes the wastewater samples collected from an electroplating industry in Bangalore to assess their physico-chemical characteristics. The parameters including pH, temperature, electrical conductivity, total dissolved solids, total suspended solids, turbidity, chemical oxygen demand, biological oxygen demand and heavy metal concentrations like chromium and lead were tested across the ten different samples. The obtained results were compared with the standard permissible limits. The findings indicate the variations in pollutant concentrations across the samples. The research underscores the importance of the regular monitoring and the effective wastewater management to mitigate the industrial pollution and safeguard the aquatic ecosystems.

**Index Terms** - Wastewater, Physico-chemical Analysis, BOD, COD, Heavy metals, Environmental pollution, WQA.

## I. INTRODUCTION

The electroplating industry holds the significant importance in the manufacturing sector, offering solutions for the corrosion prevention, aesthetic enhancement and the improved functionality of various products [1]. Despite its benefits, the processes involved will generate the wastewater containing the hazardous substances such as heavy metals and the toxic pollutants [2]. If untreated, this wastewater poses severe risks to both the environmental and public health [3]. The proper management and treatment of electroplating wastewater are essential to meet the environmental regulations and minimize the ecological harm [4]. The present study mainly focused on analyzing wastewater samples from an electroplating facility located in Bengaluru, a city known for its industrial and technological development [5]. The primary goal of the study is to assess the wastewater by examining the physical and chemical parameters. The results aim to determine the degree to which the effluent deviates from the established regulatory standards [6]. The electroplating industries in Bengaluru significantly contribute to the city's industrial ecosystem but also generate the environmentally hazardous effluents [7]. This study provides an evaluation of the pollution load from such facilities, emphasizing the need for the sustainable practices in the industry. Additionally, the report outlines the methods used for parameter analysis and result the interpretation to ensure a detailed assessment of the wastewater characteristics specific to the electroplating sector [8].

## II. Materials and Methods:

**2.1 Description of the Study Area:** The wastewater samples analyzed in this study were sourced from an electroplating industry in Bengaluru, Karnataka. The electroplating facilities are prevalent in industrial zones such as Peenya, Bommasandra and Jigani, where the metal finishing processes contribute to the effluent generation containing heavy metals acids and other contaminants. As per the confidentiality agreements, the specific industry name and location remain undisclosed. The wastewater samples were delivered to the laboratory by an external representative associated with the industry. Since there was no direct site visit, this study is based entirely on the laboratory analysis of the received samples.

**2.2 Collection of Wastewater Samples:** The wastewater samples examined in this study were obtained from an electroplating industry located in Bengaluru, Karnataka. The samples were collected and transported to the laboratory by an external individual and no direct field sampling was performed. To maintain the sample integrity, the standard collection procedures were followed. The wastewater was stored in clean, pre-rinsed polyethylene containers to prevent the contamination. These containers were sealed immediately after the collection and transported under the controlled conditions to preserve their chemical properties. A total of 10 wastewater samples were received on different dates, allowing for a representative analysis of effluent characteristics over a period of time. Upon the arrival at the laboratory, the samples were stored at 4°C in a refrigerated environment to prevent any changes in their physio-chemical properties before the analysis. The collection, transportation and storage of samples adhered to the Bureau of Indian Standards (BIS) IS 3025 and CPCB effluent monitoring guidelines.

**2.3 Experimental Analysis:** The laboratory analysis of the wastewater samples was conducted using the standardized procedures to determine their physico-chemical properties. Each parameter was analyzed using the standardized methodologies prescribed by the Bureau of Indian Standards (BIS) IS 3025 and CPCB-approved protocols to ensure the precision and reliability. The methods used for each parameter are listed below:

- **pH:** Determined using a calibrated pH meter.
- **Temperature:** Recorded using a digital Thermometer.
- **Turbidity:** Measured using a Nephelometric turbidity meter.
- **Electrical Conductivity:** Assessed using a conductivity meter.
- **Total Dissolved Solids & Total Suspended Solids:** Evaluated through gravimetric analysis after the filtration.
- **Chemical Oxygen Demand:** Determined by the closed reflux method.
- **Biological Oxygen Demand:** Measured using the 5-day incubation method at 20°C.
- **Heavy Metals (Total Chromium & Lead):** Analyzed using UV-Vis Spectrophotometry.

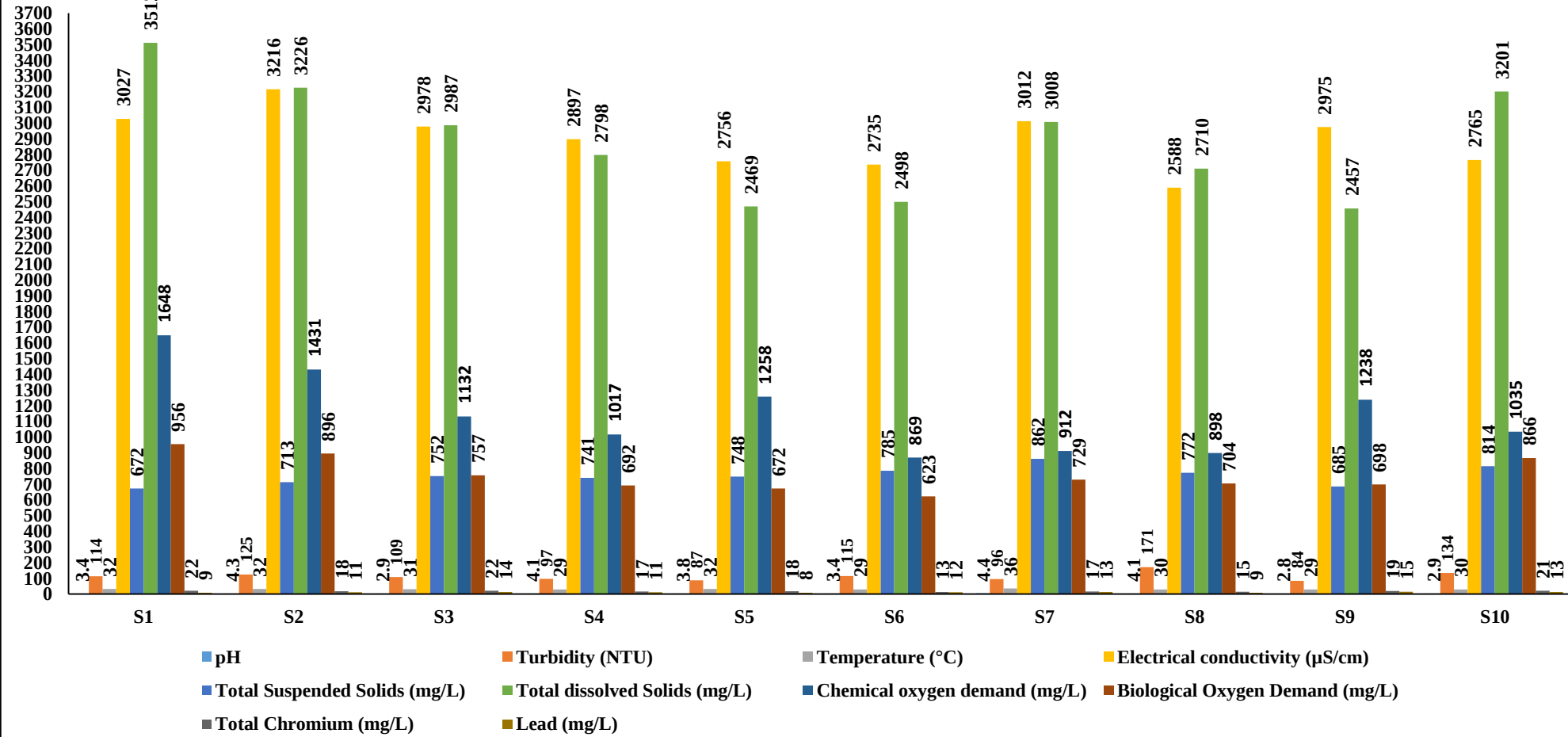
To ensure the data accuracy, all the instruments were calibrated using the standard solutions before analysis. Additionally, the duplicate tests were conducted for the critical parameters to validate the measurement reliability. The obtained values were then compared with the CPCB-prescribed limits to identify the deviations. The results of this experimental analysis offer a detailed insight into the wastewater quality and highlight the need for appropriate treatment measures in the electroplating industries to mitigate the environmental impact.

### III. RESULTS AND DISSCUSSION

**Table 1: Experimental Results of Physico-chemical Parameters of Industrial Wastewater Samples**

| Sl. No. | Parameters               | Water Quality Standards | S1   | S2   | S3   | S4   | S5   | S6   | S7   | S8   | S9   | S10  |
|---------|--------------------------|-------------------------|------|------|------|------|------|------|------|------|------|------|
| 1       | pH                       | 8 to 9                  | 3.4  | 4.3  | 2.9  | 4.1  | 3.8  | 3.4  | 4.4  | 4.1  | 2.8  | 2.9  |
| 2       | Turbidity                | <10 NTU                 | 114  | 125  | 109  | 97   | 87   | 115  | 96   | 171  | 84   | 134  |
| 3       | Temperature              | <40°C                   | 32   | 32   | 31   | 29   | 32   | 29   | 36   | 30   | 29   | 30   |
| 4       | Electrical conductivity  | <2250 $\mu$ S/cm        | 3027 | 3216 | 2978 | 2897 | 2756 | 2735 | 3012 | 2588 | 2975 | 2765 |
| 5       | Total Suspended Solids   | <300 mg/L               | 672  | 713  | 752  | 741  | 748  | 785  | 862  | 772  | 685  | 814  |
| 6       | Total dissolved Solids   | <2000 mg/L              | 3512 | 3226 | 2987 | 2798 | 2469 | 2498 | 3008 | 2710 | 2457 | 3201 |
| 7       | Chemical oxygen demand   | <600 mg/L               | 1648 | 1431 | 1132 | 1017 | 1258 | 869  | 912  | 898  | 1238 | 1035 |
| 8       | Biological Oxygen Demand | <250 mg/L               | 956  | 896  | 757  | 692  | 672  | 623  | 729  | 704  | 698  | 866  |
| 9       | Total Chromium           | <2 mg/L                 | 22   | 18   | 22   | 17   | 18   | 13   | 17   | 15   | 19   | 21   |
| 10      | Lead                     | <0.1 mg/L               | 9    | 11   | 14   | 11   | 8    | 12   | 13   | 9    | 15   | 13   |

Graph 1 : Graphical Representation of Physico-chemical Parameters of Industrial Wastewater Samples



The analysis of wastewater from the electroplating industry reveals the substantial variations in the key parameters, with many exceeding the Central Pollution Control Board (CPCB) standards. The following discussion addresses the significant parameters and their implications for the environment and public health.

1. **pH:** The wastewater samples show highly acidic pH values, ranging from 2.8 to 4.4, which are far below the CPCB acceptable range of 5.5 to 9.0. This acidity is a result of the use of various acids in electroplating processes, such as sulfuric, hydrochloric and chromic acids. Such low pH levels can severely harm the aquatic ecosystems, potentially disturbing the balance of pH-sensitive species in receiving the water bodies.
2. **Temperature:** The temperature of the wastewater samples varies between 29°C and 36°C, which is well below the CPCB limit of 40°C. While this temperature range is not immediately concerning, it can influence the solubility of pollutants and alter the metabolic rates of aquatic organisms in receiving the bodies of water.
3. **Turbidity:** The turbidity of the wastewater samples ranges from 84 NTU to 171 NTU, exceeding the CPCB permissible limit of 10 NTU for the discharge into the surface waters. The high turbidity levels indicate a significant presence of suspended solids, likely from the industrial effluents containing metal oxides, organic matter and fine particulates. The elevated turbidity reduces the light penetration, affecting the aquatic ecosystems and potentially increasing the water treatment costs.
4. **Electrical Conductivity (EC):** From the study, the observed EC levels range from 2588 and 3216  $\mu\text{S}/\text{cm}$ , indicating a high concentration of the dissolved ions, likely from the various metallic and non-metallic components of the electroplating process. This elevated conductivity can affect the ionic balance in the aquatic ecosystems, negatively impacting the aquatic life.
5. **Total Suspended Solids (TSS) and Total Dissolved Solids (TDS):** Both the TSS and TDS are found to be above CPCB standards in all the wastewater samples. The high concentrations of these solids contribute to the increased turbidity, sediment accumulation and reduced the light penetration in the receiving waters, which can affect the photosynthetic processes and disrupt the aquatic life.
6. **Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD):** From the experimental results, it was observed that, the COD values range from 869 to 1648 mg/L and BOD levels range from 623 to 956 mg/L, both exceeding CPCB limits. The elevated COD and BOD levels indicate the high organic contamination, which can deplete the oxygen levels in the water, potentially leading to anaerobic conditions that endanger the aquatic organisms and disturb the ecological equilibrium.
7. **Heavy Metals (Chromium and Lead):** The concentrations of total chromium (Cr) and lead (Pb) in several samples surpass the CPCB standards. These toxic heavy metals present significant environmental and health risks. As non-biodegradable substances, they can accumulate in the food chain, posing long-term ecological and health hazards. Chromium, especially in its hexavalent form, is known to be carcinogenic, while lead is a neurotoxin that can impair the cognitive function and cause other severe health issues.

#### IV. SUMMARY AND CONCLUSION

The combination of the high acidity, excessive dissolved solids, elevated organic load and heavy metal contamination points to a complex pollution scenario that demands the attention and effective treatment solutions. The acidic nature of the effluent, together with the high concentrations of the dissolved solids and heavy metals, could lead to the long-term soil and groundwater contamination if not managed properly. There is also a risk of metal leaching, which can contaminate drinking water and harm the agricultural production. The high organic load, as shown by elevated COD and BOD values, suggests that, the wastewater contains several organic compounds used in the electroplating. These compounds can reduce the oxygen levels in water, creating hypoxic zones that threaten aquatic life. Additionally, some of these chemicals may be toxic or disrupt the endocrine systems, further endangering both the aquatic ecosystems and human health. The presence of hazardous heavy metals like chromium and lead remains a concern. These metals persist in the environment for long periods, accumulating in the living organisms. The Chromium, particularly in its hexavalent form, is known to be carcinogenic, while lead is a neurotoxin that can impair the neurological development and cause a variety of health complications.

This situation underscores the importance for a multi-pronged approach to address the wastewater management in the electroplating industry:

1. **Implementation of Advanced Treatment Systems:** A comprehensive treatment system should be implemented to neutralize pH, remove the heavy metals through chemical precipitation and reduce the organic load with the biological treatment.
2. **Process Optimization:** A review and modification of electroplating processes should be conducted to minimize the use of hazardous chemicals and reduce the wastewater production.
3. **Recycling and Reuse:** The adoption of closed-loop systems can help to recycle and reuse the water within the facility, reducing the volume of effluent released.
4. **Regular Monitoring and Compliance:** A rigorous monitoring system should be established to ensure that the wastewater consistently meets the CPCB standards.
5. **Employee Training:** The staff should be trained on best practices for the chemical handling and wastewater management to prevent the accidental spills and reduce the overall pollution load.
6. **Adoption of Cleaner Technologies:** Investing in advanced, environmentally friendly electroplating technologies can help to minimize the generation of hazardous waste.

The analysis of wastewater parameters from the electroplating industry has identified numerous non-compliances with CPCB standards. The wastewater exhibits the high levels of acidity, dissolved solids, organic matter and heavy metals, posing the serious risks to receiving water bodies and the surrounding environment. To address these issues, the implementation of a comprehensive wastewater treatment system, regular monitoring, water recycling and reuse strategies and the control measures for heavy metal sources are recommended. By adopting these measures, the industry can improve the quality of its wastewater discharge and contribute to the sustainability of its operations. This analysis highlights the importance of the effective wastewater management in the electroplating industry and the need for continuous efforts to minimize the environmental impact of industrial activities.

## V. Acknowledgment

I sincerely express my gratitude to Essen & Co Lab for providing the necessary facilities and support to conduct my research. I would like to thank JSS Academy of Higher Education and Research for giving support to carry out my research.

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