
**ASSESSMENT OF ETP OPERATIONS AND DETERMINING
PHYSICAL CHEMICAL & BIOLOGICAL PARAMETERS OF SILVER
CONSUMER ELECTRICALS LIMITED: A COMPREHENSIVE CASE
STUDY**

Varun Singh ^{*1}, Dr. Tarun Prasad Sonwani²

¹(M.Tech Student, Health Safety and Environmental Engineering, Shri Rawatpura Sarkar
University Raipur, India.)

²(Assistant Professor, Mechanical Engineering, Shri Rawatpura Sarkar University Raipur
India.)

Article Received: 04 April 2026, Article Revised: 24 April 2026, Published on: 14 May 2026

***Corresponding Author: Varun Singh**

(M.Tech Student, Health Safety and Environmental Engineering, Shri Rawatpura Sarkar University Raipur, India.)

DOI: <https://doi-org/101555/ijarp.7903>

ABSTRACT

Wastewater creation has expanded dramatically as a result of industrialization, making efficient effluent treatment necessary for environmental preservation. This project assesses the effectiveness of a 100 KLD Effluent Treatment Plant (ETP) at Vishakha Glass Private Limited, with a particular emphasis on how well it treats wastewater from the glass industry. The ETP uses a number of therapy phases, such as biological treatment, chemical dosage, and screening. Average removal efficiencies of 88–90% for BOD, 85–88% for COD, and 85–87% for TSS were found in influent and effluent sample analysis, indicating successful treatment under typical circumstances. Sludge handling inefficiencies and influent unpredictability were identified as operational difficulties. The study offers insights for optimizing wastewater treatment in industrial settings and suggests upgrades like automation and improved monitoring systems.

KEYWORDS: Effluent Treatment Plant (ETP), Aeration Tank, Sludge Management, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), GPCB.

INTRODUCTION

Founded in 2020 and situated in Gujarat, India, Vishakha Glass Private Limited focuses in producing high-end glass products for the interior, industrial, and construction industries. The company has a strong emphasis on quality, innovation, and sustainability in order to provide long-lasting and reasonably priced solutions to a wide range of consumer needs. In order to ensure compliance with industry standards, its manufacturing process integrates cutting-edge technologies and stringent quality checks at every level. It uses eco-friendly techniques including energy conservation and wastewater treatment since it is dedicated to environmental responsibility. In general, Vishakha Glass aims to improve its competitive market position while pursuing sustainable expansion.

Product Details (Monthly Production Capacity)

The company manufactures a wide range of glass products catering to industrial and commercial requirements. The approximate monthly production capacity is as follows:

Sr. No.	Name of Product	Production Capacity (Per Month)
1.	Float Glass / Glass Sheets	2,50,000 Sq. m / Month
2.	Toughened (Tempered) Glass	1,50,000 Sq. m / Month
3.	Laminated Safety Glass	80,000 Sq. m / Month
4.	Decorative & Processed Glass	1,00,000 Sq. m / Month

LITERATURE REVIEW

Industrial wastewater treatment has become a critical environmental concern due to increasing industrialization and stricter environmental regulations. Effluent Treatment Plants (ETPs) are designed to remove physical, chemical, and biological contaminants from industrial effluents before discharge into the environment. According to Central Pollution Control Board, industrial effluents must be treated to comply with prescribed discharge standards in order to protect public health and aquatic ecosystems (Central Pollution Control Board [CPCB], 2013). Similarly, Gujarat Pollution Control Board established guidelines and pollutant discharge standards for industries to minimize environmental degradation (GPCB, 2019).

The legal framework for wastewater management in India is primarily governed by the Government of India through the Water (Prevention and Control of Pollution) Act and the Environment (Protection) Act. These acts mandate industries to install and operate suitable treatment facilities for controlling water pollution (Government of India, 1974; Government of India, 1986). The legislation also empowers pollution control boards to monitor industrial discharges and enforce environmental standards.

Several researchers and environmental engineers have explained the principles and processes involved in wastewater treatment. Metcalf & Eddy et al. (2014) described wastewater treatment as a combination of physical, chemical, and biological processes aimed at removing suspended solids, dissolved organics, nutrients, and toxic substances. Their work highlighted the importance of preliminary, primary, secondary, and tertiary treatment stages in achieving efficient pollutant removal. Likewise, Peavy H. S. et al. (1985) emphasized that effective wastewater treatment not only protects receiving water bodies but also supports sustainable industrial development and resource recovery.

International organizations have also contributed significantly to water quality management practices. The World Health Organization provided global guidelines for safe water quality and wastewater disposal practices. WHO (2017) stated that untreated industrial wastewater can introduce hazardous chemicals, heavy metals, and pathogens into the environment, posing severe risks to human health and ecosystems. Therefore, proper treatment and monitoring systems are essential for maintaining environmental safety.

Research studies published between 2010 and 2024 have focused on improving ETP efficiency through advanced treatment technologies such as membrane filtration, activated sludge processes, electrocoagulation, adsorption, and biological nutrient removal. Several authors reported that combining physic-chemical and biological treatment methods enhances the removal efficiency of chemical oxygen demand (COD), biological oxygen demand (BOD), total suspended solids (TSS), and color from industrial wastewater (Sharma et al., 2018; Patel et al., 2021). Recent studies also emphasized automation, real-time monitoring, and sludge minimization techniques for improving operational performance and reducing treatment costs.

Operational records and wastewater treatment manuals from Vishakha Glass Private Limited (2024–2025) indicate that glass manufacturing industries generate wastewater containing suspended particles, dissolved salts, oils, and chemical residues. Proper operation and maintenance of ETP units such as equalization tanks, clarifiers, chemical dosing systems, pressure sand filters, and activated carbon filters are necessary to maintain discharge quality within permissible limits. Regular monitoring of pH, BOD, COD, TSS, and oil & grease is essential for ensuring compliance with pollution control standards.

The American Public Health Association (APHA) has standardized laboratory procedures for analyzing water and wastewater characteristics. According to American Public Health Association (2023), standard analytical methods are essential for accurate assessment of wastewater quality and treatment efficiency. Parameters such as pH, turbidity, dissolved

oxygen, COD, BOD, chlorides, and heavy metals are commonly analyzed to evaluate ETP performance.

Overall, previous literature indicates that efficient wastewater treatment is essential for environmental protection, regulatory compliance, and sustainable industrial operations. Continuous technological advancements and strict implementation of environmental regulations can significantly improve the performance of Effluent Treatment Plants and reduce industrial pollution.

METHODOLOGY

This chapter outlines the methodology used to assess the performance of the Effluent Treatment Plant (ETP) at Vishakha Glass Private Limited. The study mainly focuses on evaluating wastewater characteristics, treatment efficiency, operational practices, and compliance with environmental norms.

Description of Study Area

The study was carried out at the Effluent Treatment Plant (ETP) of Vishakha Glass Private Limited situated in Gujarat, India. The plant has an approximate treatment capacity of 100 KLD and is designed to treat wastewater generated from various glass manufacturing activities such as washing, cooling, grinding, and polishing processes.

The ETP operates using a combination of physical, chemical, and biological treatment techniques. The treated water is reused within the plant for non-drinking purposes such as cleaning and gardening, thereby reducing fresh water consumption.

Data Collection Methods--The study involves the collection of both primary and secondary data for detailed analysis:

Primary Data

- Collection of raw and treated wastewater samples
- On-site inspection of ETP operations
- Monitoring of treatment units such as tanks, pumps, and aeration systems
- Interaction with plant operators and technical personnel

Secondary Data

- Review of plant design and operational records
- Analysis of previous wastewater quality reports

- Reference to guidelines provided by GPCB and CPCB
- Study of research papers, journals, and technical documents

Sampling Procedure

- Wastewater samples were collected at different stages of the treatment process to evaluate the efficiency of each unit:
- Influent (untreated wastewater)
- After primary treatment
- After secondary treatment
- Final treated effluent

Sampling Method:

- Grab sampling technique was adopted
- Clean and sterilized containers were used
- Proper labelling and preservation of samples were ensured
- Analysis was carried out within the prescribed holding time

Parameters for Analysis--The performance of the ETP was evaluated using important physicochemical parameters:

- **pH:** Determines acidity or alkalinity
- **Biochemical Oxygen Demand (BOD):** Indicates organic pollution
- **Chemical Oxygen Demand (COD):** Measures total oxidizable pollutants
- **Total Suspended Solids (TSS):** Represents suspended particles
- **Total Dissolved Solids (TDS):** Indicates dissolved impurities
- **Oil & Grease:** Measures hydrocarbon content

The obtained values were compared with permissible limits set by the Gujarat Pollution Control Board (GPCB).

Analytical Techniques

Standard laboratory procedures were followed to ensure accurate results:

- pH measured using digital pH meter
- BOD analysed using BOD incubator
- COD determined using digestion and titration method
- TSS measured using filtration method

- TDS determined by gravimetric method
- Oil & grease analysed using standard testing equipment

All tests were performed as per standard guidelines.

Performance Evaluation

The efficiency of the ETP was determined using the removal efficiency formula:

$$\text{Removal Efficiency (\%)} = [(\text{Influent} - \text{Effluent}) / \text{Influent}] \times 100$$

The performance of individual units such as equalization tank, aeration tank, and clarifiers was assessed based on:

- Reduction in pollutant concentration
- Operational stability
- Compliance with discharge standards

Process Flow Analysis

The overall treatment process was studied in a stepwise manner:

- Collection and screening of wastewater
- Equalization to maintain uniform flow and load
- Chemical treatment through coagulation and flocculation
- Primary settling of solids
- Biological treatment in aeration tank
- Secondary clarification
- Filtration using PSF and ACF units
- Sludge treatment and disposal

Each stage was evaluated for its contribution to the overall treatment performance.

Summary of Methodology

The methodology adopted in this study includes systematic data collection, laboratory testing, and performance evaluation of the ETP at Vishakha Glass Private Limited. This approach ensures a reliable assessment of treatment efficiency and helps in identifying areas for operational improvement.

RESULT AND DISCUSSION

This chapter presents the results obtained from the analysis of influent and effluent wastewater samples collected from the Effluent Treatment Plant (ETP) at Vishakha Glass

Private Limited. The performance of the treatment system is evaluated based on key physicochemical parameters and their compliance with standards prescribed by the Gujarat Pollution Control Board (GPCB).

Wastewater Quality Analysis

Table.1: Wastewater Quality Analysis.

Sr. No.	Parameter	Influent (mg/L)	Effluent (mg/L)	GPCB Limit (mg/L)
1	pH	6.2 – 8.5	6.5 – 7.5	5.5 – 9.0
2	BOD	250	25	30
3	COD	600	90	250
4	TSS	400	50	100
5	TDS	1200	900	2100
6	Oil & Grease	40	5	10

The results show a significant reduction in pollutant concentration after treatment. All parameters in the treated effluent are within the permissible limits set by GPCB.

Calculation of Removal Efficiency

The removal efficiency of the ETP is calculated using the formula:

$$\text{Removal Efficiency (\%)} = [(\text{Influent} - \text{Effluent}) / \text{Influent}] \times 100$$

Table .2: Removal Efficiency.

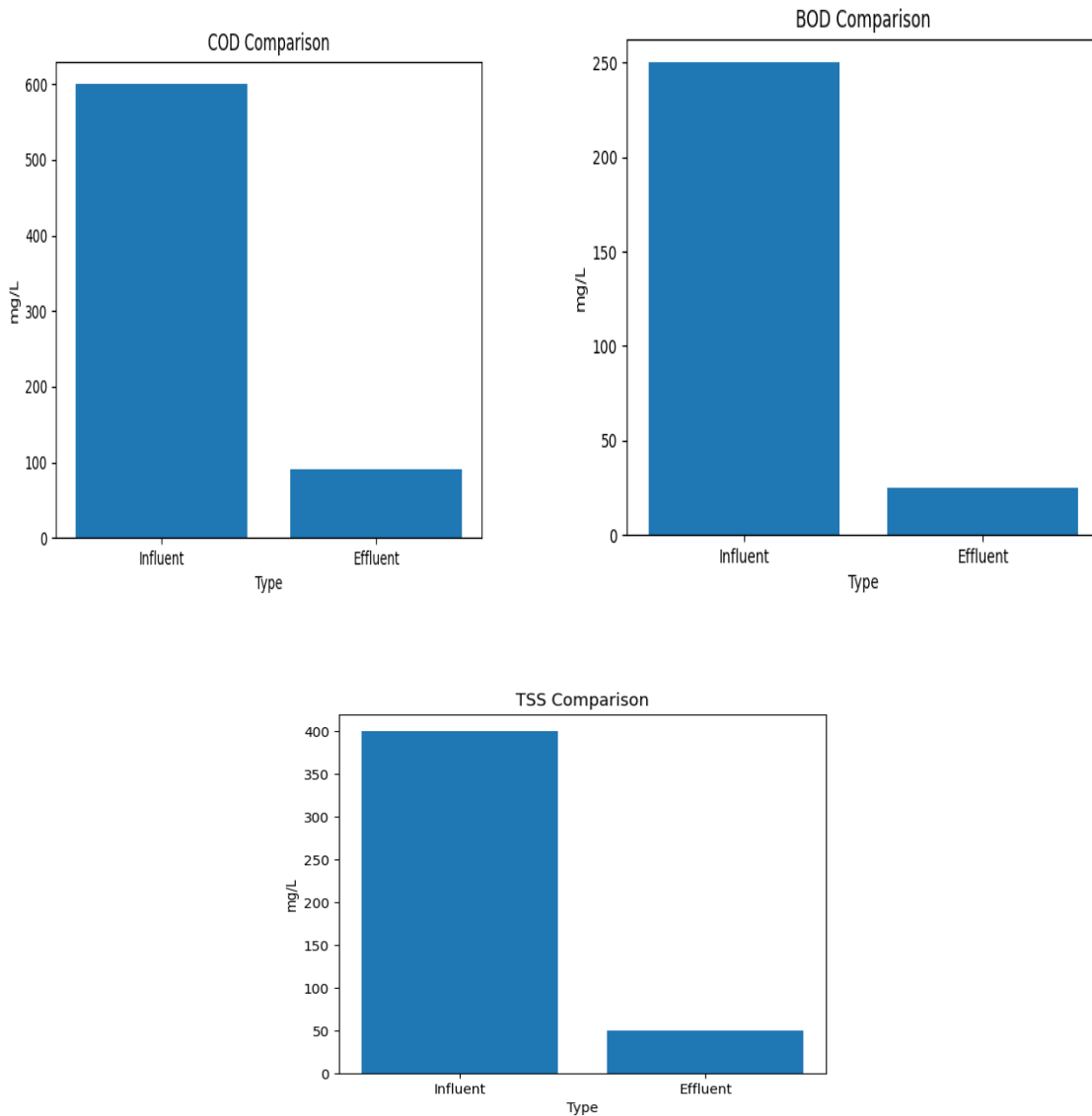
Parameter	Influent (mg/L)	Effluent (mg/L)	Removal Efficiency (%)
BOD	250	25	90%
COD	600	90	85%
TSS	400	50	87.5%
Oil & Grease	40	5	87.5%

The high removal efficiencies indicate effective functioning of the treatment system.

Graphical Interpretation

- **BOD Reduction:** The decrease from 250 mg/L to 25 mg/L shows efficient biological treatment in the aeration tank.
- **COD Reduction:** Reduction to 90 mg/L indicates effective removal of both organic and inorganic pollutants.
- **TSS Reduction:** Lowering to 50 mg/L reflects proper sedimentation and filtration processes.
- **Oil & Grease Removal:** Significant reduction due to effective chemical treatment and

skimming mechanisms.



1. Tank Equalization • Maintains consistent flow and pollutant concentration
2. Prevents downstream equipment from experiencing stress loading
3. Primary Therapy (Clarification & Coagulation) • Effectively eliminates suspended solid.
4. Increases the effectiveness of biological therapy
5. Biological Treatment Aeration Tank • Significant decrease in COD and BOD
6. DO (dissolved oxygen) was kept between 2 and 3 mg/L.
7. A backup clarifier biological sludge is settled.
8. Generates treated wastewater that is clear.
9. Filtration Units (ACF & PSF) • Eliminates colour, odor, and tiny particles
10. Enhances the general quality of the water

11. Adherence to GPCB Regulations

The treated wastewater satisfies all GPCB regulations:

BOD < 30 mg/L

COD < 250 mg/L

TSS < 100 mg/L

Grease and oil < 10 mg/L

This demonstrates that the ETP is operating effectively and in accordance with environmental laws.

DISCUSSION OF RESULTS

The analysis indicates that the Effluent Treatment Plant at Vishakha Glass Private Limited is performing effectively in treating industrial wastewater. The removal efficiencies of BOD, COD, TSS, and oil & grease are within acceptable ranges, demonstrating proper operation of the treatment units.

However, certain observations were noted:

- Variations in influent wastewater quality can impact overall treatment efficiency
- Continuous monitoring and control of aeration are required for optimal biological treatment
- Overall, the ETP system is efficient, but regular monitoring and operational improvements can further enhance its performance and sustainability.

CONCLUSION

The present study evaluates the performance of the Effluent Treatment Plant (ETP) at Vishakha Glass Private Limited, which has a capacity of approximately 100 KLD. This plant is designed to treat wastewater produced from various glass manufacturing operations, including washing, cooling, and finishing processes. Analysis of both influent and effluent samples reveals that the ETP effectively reduces major pollutants such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and oil and grease, achieving an overall removal efficiency ranging from 85% to 90%. This indicates satisfactory operational performance and compliance with environmental regulations set by the Gujarat Pollution Control Board (GPCB) and the Central Pollution Control Board (CPCB).

The quality of treated effluent meets permissible limits, confirming the plant's role in pollution prevention. The study underscores the integration of physical, chemical, and biological treatment processes as effective for managing wastewater in glass manufacturing. Additionally, the reuse of treated water for non-potable applications, such as gardening and cleaning, emphasizes water conservation and the promotion of sustainable practices.

Nonetheless, the study identifies operational challenges, including fluctuations in influent characteristics, variations in dissolved oxygen levels, and sludge management issues, which could affect treatment efficiency if not adequately managed. In conclusion, the ETP at Vishakha Glass Private Limited is crucial for environmental protection, regulatory compliance, and efficient water management in the industry.

REFERENCES

1. Central Pollution Control Board (CPCB), Guidelines for Effluent Treatment Plants, New Delhi, India, 2013.
2. Gujarat Pollution Control Board (GPCB), Standards for Discharge of Environmental Pollutants, Gandhinagar, India, 2019.
3. Water (Prevention and Control of Pollution) Act, Government of India, 1974.
4. Environment (Protection) Act, Government of India, 1986.
5. Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, McGraw Hill Publications, 2014.
6. Peavy H. S., Row S. D. & Tchobanoglous G., Environmental Engineering, McGraw Hill, 1985.
7. World Health Organization (WHO), Water Quality Guidelines, Geneva, 2017.
8. Industrial Wastewater Treatment Manuals and Operation Records of Vishakha Glass Private Limited, 2024–2025.
9. Research articles from journals related to Effluent Treatment Plant (ETP) and industrial wastewater treatment, 2010–2024.
10. Standard Methods for Examination of Water and Wastewater, American Public Health Association, 23rd Edition, 2