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Design of Sewage Treatment Plant

For Samrat Ashok Technological Institute (SATI) Vidisha

[1]Priyank Chaturvedi, [2]Prof. Pramod Sharma
[1]PG Student, [2]Professor of Department of Civil Engineering
[1]Samrat Ashok Technological Institute (SATI), Vidisha, Madhya Pradesh, India

Abstract : This study focuses on the design of a 300 KLD Sewage Treatment Plant (STP) for Samrat Ashok Technological Institute (SATI), Vidisha, to address the increasing wastewater generation from the campus. The influent sewage characteristics considered were BOD: 350 mg/L, COD: 700 mg/L, TSS: 450 mg/L, and pH: 6.2–7.0. The treatment units designed include preliminary, primary, secondary, and tertiary treatment components based on the Moving Bed Biofilm Reactor (MBBR) process. The STP is designed to achieve treated effluent standards prescribed by the Central Pollution Control Board (CPCB), ensuring BOD < 20 mg/L, COD < 100 mg/L, and TSS < 50 mg/L. Detailed hydraulic, process, and structural design of each unit has been carried out following IS codes, and cost estimates have been prepared. The treated water is proposed for reuse in gardening, flushing, and campus landscaping, while the sludge will be dried in sludge drying beds and safely disposed of. The study concludes that the proposed STP will provide sustainable wastewater management for the institute and contribute to environmental protection**.**

***Index Terms* - Sewage Treatment Plant (STP), Wastewater Treatment, MBBR, Effluent Standards, SATI Vidisha.**

I. INTRODUCTION

Water is one of the most critical natural resources essential for life, but its increasing scarcity and pollution have become pressing global concerns. In India, rapid urbanization, industrialization, and population growth have resulted in the discharge of large quantities of untreated or partially treated sewage into rivers, lakes, and groundwater systems. According to the Central Pollution Control Board (CPCB), nearly 70% of the country's sewage remains untreated, contributing significantly to water quality degradation.

Educational institutions, though smaller in scale compared to urban municipalities, are major contributors to localized sewage generation. Hostels, residential quarters, canteens, laboratories, and academic buildings collectively generate large volumes of wastewater. If left untreated, this sewage poses environmental risks such as foul odour, soil contamination, groundwater pollution, and potential health hazards.

Samrat Ashok Technological Institute (SATI), Vidisha, Madhya Pradesh, is a premier engineering institution that caters to thousands of students and staff. The campus currently consumes about 350 KLD of water, leading to nearly the same volume of wastewater generation. At present, sewage from the campus is discharged without adequate treatment, making it imperative to establish a **dedicated sewage treatment plant (STP)**.

The significance of an on-site STP for SATI Vidisha can be summarized as follows:

- **Environmental Protection:** Preventing untreated sewage from contaminating nearby water bodies and land.
- **Resource Recovery:** Recycling treated water for non-potable purposes such as gardening, flushing, and landscaping.
- **Regulatory Compliance:** Meeting effluent standards set by CPCB and the Madhya Pradesh Pollution Control Board (MPPCB).
- **Sustainability:** Demonstrating eco-friendly campus development and setting an example for other academic institutions.

The **objectives** of this study are:

1. To analyze the quantity and characteristics of sewage generated in SATI Vidisha.
2. To select a suitable wastewater treatment technology based on efficiency, space requirement, and sustainability.
3. To design each unit of the 300 KLD STP as per CPHEEO and IS guidelines.
4. To estimate the cost of construction and operation.
5. To evaluate the reuse potential of treated water and disposal method for sludge.

This research focuses on the design of a **300 KLD STP using MBBR technology**, a modern and efficient biological process that combines the advantages of suspended and attached growth systems.

II. LITERATURE REVIEW

Wastewater treatment technologies have been widely studied to address increasing sewage generation. Traditional systems such as the **Activated Sludge Process (ASP)** have been effective but require large areas and high operational costs. In contrast, **Moving Bed Biofilm Reactor (MBBR)** technology has gained popularity due to its compact design, higher biomass concentration, and stable performance under variable loads.

Rusten et al. (2006) demonstrated that MBBR reactors achieve **85–90% BOD removal** even with fluctuating influent quality. Ødegaard (2016) reported that the process reduces sludge production and simplifies operation compared to conventional ASP. Indian studies, including case applications in municipal and institutional STPs, confirm that MBBR units can consistently meet **CPCB effluent standards** with reduced footprint.

The CPHEEO Manual (2013) emphasizes the importance of adopting efficient technologies in space-constrained campuses and urban areas. Standards specified in **IS 1172:1993** and **IS 3025 series** provide guidelines for wastewater characterization and unit design.

Overall, previous research supports the selection of MBBR for medium-scale institutional STPs due to its **efficiency, compactness, and reliability**, making it suitable for the SATI Vidisha campus.

III. RESEARCH METHODOLOGY

The study was carried out in a systematic manner to design a 300 KLD Sewage Treatment Plant (STP) for the SATI Vidisha campus. The methodology included sewage characterization, technology selection, application of standard design guidelines, and unit-wise sizing of treatment facilities.

A. Sewage Characterization

The first step was to analyze the quality and quantity of sewage generated in the campus. As per Indian Standard **IS 3025** series, samples were collected from hostel and residential discharges. The average design flow was taken as **300 KLD**, assuming 80% return of water supplied. The influent wastewater was found to be medium-strength domestic sewage with high organic load. The key parameters are presented in Table 1.

Table 1: Influent Sewage Characteristics

Parameter	Value	Unit
Flow	300	KLD
BOD	350	mg/L
COD	700	mg/L
Total Suspended Solids (TSS)	450	mg/L
pH	8.40	–

The high BOD and COD values indicated the need for a biological treatment process capable of achieving >90% organic load reduction.

B. Selection of Treatment Technology

Various treatment technologies were compared:

- **Activated Sludge Process (ASP):** Efficient but requires high land area and skilled supervision.
- **Sequencing Batch Reactor (SBR):** Compact and effective, but higher operational complexity.
- **Moving Bed Biofilm Reactor (MBBR):** Compact, easy to operate, high shock load resistance, and lower sludge yield.

Considering the campus land availability, simplicity of operation, and required effluent quality, the **MBBR process** was selected. It allows biofilm growth on floating carriers, enhancing BOD/COD removal while reducing space requirements.

C. Standards and Guidelines Adopted

The design followed the **CPHEEO Manual on Sewerage and Sewage Treatment (2013)** and relevant Indian Standards:

- **IS 1172:1993** – Basic requirements for water supply, drainage, and sanitation.
- **IS 3025 series** – Methods for testing water and wastewater.
- **CPCB Norms** – Effluent discharge standards (BOD < 30 mg/L, COD < 250 mg/L, TSS < 100 mg/L).

These codes ensured that the design was both technically accurate and regulatory compliant.

D. Unit Design Approach

The treatment process consisted of the following stages:

1. **Preliminary Treatment** – Inlet chamber with bar screen and grit removal chamber for removal of coarse and inorganic matter.
2. **Equalization Tank** – For balancing flow fluctuations and homogenizing sewage characteristics.
3. **Flocculation Tank** – Provision for chemical addition to enhance solid separation.
4. **Secondary Treatment (MBBR Reactor)** – Biological degradation of organics using attached biofilm on carriers.
5. **Secondary Clarifier** – For separation of biomass and treated water.
6. **Tertiary Treatment** – Sand filter, activated carbon filter, and chlorination unit for polishing.
7. **Sludge Handling** – Sludge drying beds for dewatering and safe disposal.

E. Cost and Feasibility Study

Along with the technical design, a preliminary cost assessment was carried out for civil works, electromechanical equipment, and operation. This ensured that the system is not only technically feasible but also economically viable for an educational institution.

IV. DESIGN OF TREATMENT UNITS

The design capacity of the proposed sewage treatment plant is **300 KLD (300,000 L/day ≈ 3.47 L/s)**. Each unit was sized as per CPHEEO recommendations, ensuring adequate detention time and hydraulic efficiency.

A. Inlet Chamber and Bar Screen

The inlet chamber receives raw sewage and directs it through a bar screen for the removal of floating matter such as plastics, paper, and rags. This prevents clogging of downstream units.

- **Design flow:** 3.47 L/s
- **Bar spacing:** 20 mm
- **Provided dimensions:** 0.3 m × 0.6 m

B. Grit Removal Chamber

The grit chamber allows sand, gravel, and other heavy particles to settle while keeping organic matter in suspension. Maintaining flow velocity at 0.3 m/s prevents organic deposition.

- **Detention time:** 30–45 seconds
- **Flow velocity:** 0.3 m/s
- **Provided dimensions:** 0.3 m × 0.6 m × 5.0 m

C. Equalization Tank

The equalization tank balances fluctuations in sewage flow and quality, ensuring uniform loading on the biological reactor. It also provides partial mixing of sewage.

- **Detention time:** 6–8 hours
- **Volume required:** ≈ 86 m^3
- **Provided dimensions:** 6.0 m × 4.0 m × 4.7 m

D. Flocculation Tank

This unit provides gentle mixing to promote aggregation of fine suspended solids into larger flocs, improving sedimentation efficiency.

- **Detention time:** 30 minutes
- **Volume required:** ≈ 4–5 m^3
- **Provided dimensions:** 1.5 m × 1.5 m × 2.0 m

E. MBBR Reactor

The Moving Bed Biofilm Reactor is the core biological unit, where microorganisms attached to biofilm carriers degrade organic pollutants.

- **Hydraulic Retention Time (HRT):** 6–8 hours
- **Volume required:** ≈ 96 m^3
- **Provided dimensions:** 5.0 m × 4.0 m × 4.0 m
- **Media fill fraction:** 50–55% of reactor volume

F. Secondary Clarifier

The clarifier separates suspended biomass from treated water through sedimentation. Sludge collected at the bottom is recycled or sent to drying beds.

- **Surface overflow rate:** 20–30 m^3/m^2/day
- **Required surface area:** ≈ 12.5 m^2
- **Provided dimensions:** Circular tank, 4.0 m diameter × 3.0 m depth

G. Tertiary Treatment Units

To further polish the effluent, sand and carbon filters followed by chlorination are provided.

1. **Pressure Sand Filter (PSF):** Dia 1.3 m, Height 1.3 m
2. **Activated Carbon Filter (ACF):** Dia 1.3 m, Height 1.6 m
3. **Chlorination Tank:** 2.5 m × 1.5 m × 2.0 m

H. Treated Water Storage Tank

Stores the disinfected water before reuse in flushing and gardening.

- **Capacity:** 70–80 m³
- **Provided dimensions:** 5.0 m × 4.0 m × 3.5 m

I. Sludge Drying Beds

Sludge from the clarifier is conveyed to drying beds where water evaporates and drains, leaving stabilized sludge.

- **No. of beds:** 2
- **Size per bed:** 5.0 m × 5.0 m × 1.0 m

Table 2: Summary of Treatment Units

Treatment Unit	Design Criteria	Provided Dimensions
Inlet Chamber	Flow = 3.47 L/s	0.3 m × 0.6 m
Grit Chamber	Velocity = 0.3 m/s	0.3 m × 0.6 m × 5.0 m
Equalization Tank	6–8 hr HRT	6.0 m × 4.0 m × 4.7 m
Flocculation Tank	30 min detention	1.5 m × 1.5 m × 2.0 m
MBBR Reactor	6–8 hr HRT	5.0 m × 4.0 m × 4.0 m
Secondary Clarifier	SOR = 20–30 m³/m²/day	Dia 4.0 m × Depth 3.0 m
Sand Filter	5–7 m³/m²/hr	Dia 1.3 m × H 1.3 m
Carbon Filter	15–20 min contact	Dia 1.3 m × H 1.6 m
Chlorination Tank	30 min contact	2.5 m × 1.5 m × 2.0 m
Treated Water Tank	Storage ~ 70–80 m³	5.0 m × 4.0 m × 3.5 m
Sludge Drying Beds	2 beds	5.0 m × 5.0 m × 1.0 m each

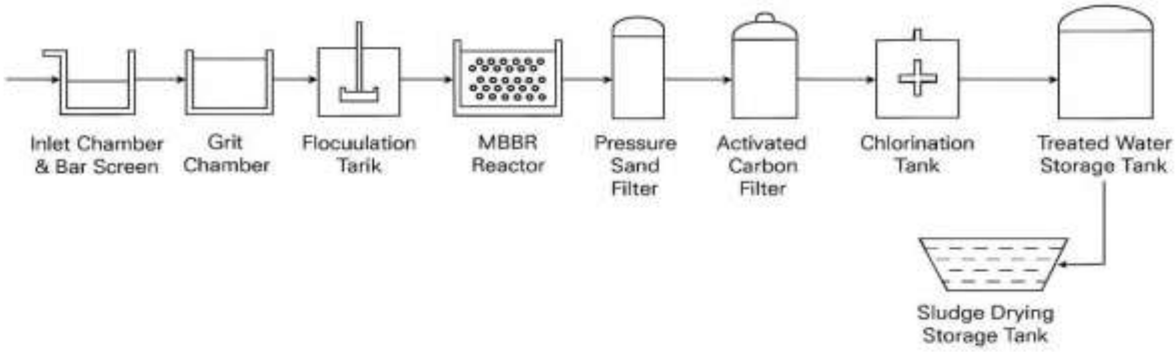

Figure 1 : Process Flow Diagram

V. RESULTS AND DISCUSSION

The designed sewage treatment plant for SATI Vidisha aims to treat **300 KLD of domestic wastewater**. Based on the selected MBBR process and tertiary polishing units, the expected effluent quality meets the **Central Pollution Control Board (CPCB) standards** for discharge and reuse.

Table 3: Expected Effluent Quality vs CPCB Standards

Parameter	Influent (mg/L)	Designed Effluent (mg/L)	CPCB Standard (mg/L)
BOD	350	< 30	30
COD	700	< 250	250
TSS	450	< 100	100
pH	6.2 – 7.0	6.5 – 8.5	5.5 – 9.0

The results indicate that:

- The **MBBR reactor** ensures **>90% BOD and COD reduction**, even under varying influent load.
- The **secondary clarifier** effectively removes suspended solids, reducing TSS to <100 mg/L.
- The **tertiary treatment units** (sand filter, carbon filter, chlorination) provide additional polishing and disinfection, ensuring safe reuse.
- The treated water is suitable for **gardening, landscaping, and flushing**, thus reducing fresh water demand in the campus by nearly 30–40%.
- Sludge produced is stabilized and can be disposed of safely through sludge drying beds, minimizing environmental risk.

Overall, the designed STP not only complies with statutory norms but also contributes to **sustainable wastewater management**. The system ensures resource recovery through reuse of treated water, while demonstrating a model approach for academic institutions in India.

VI. CONCLUSION

The present study focused on the design of a **300 KLD Sewage Treatment Plant (STP)** for Samrat Ashok Technological Institute (SATI), Vidisha. The influent wastewater was characterized as medium-strength domestic sewage with high BOD and COD values. Considering efficiency, space constraints, and ease of operation, the **Moving Bed Biofilm Reactor (MBBR)** technology was selected.

The designed system, consisting of preliminary, primary, secondary, and tertiary treatment units, ensures effluent quality well within **CPCB discharge standards** (BOD < 30 mg/L, COD < 250 mg/L, TSS < 100 mg/L). Treated water is proposed for **reuse in flushing and gardening**, thereby reducing freshwater consumption in the campus. Sludge management through drying beds ensures safe disposal.

Thus, the proposed STP not only addresses environmental concerns but also promotes sustainable wastewater management in academic institutions.

VII. ACKNOWLEDGMENT

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VIII. REFERENCES

1. CPHEEO, *Manual on Sewerage and Sewage Treatment Systems*, Ministry of Urban Development, Government of India, 2013.
2. IS 1172:1993, *Code of Basic Requirements for Water Supply, Drainage and Sanitation*, Bureau of Indian Standards, New Delhi.
3. IS 3025 (Part 1–58), *Methods for Testing of Water and Wastewater*, Bureau of Indian Standards, New Delhi.
4. CPCB, *General Standards for Discharge of Environmental Pollutants Part-A: Effluents*, Central Pollution Control Board, New Delhi.