International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 05 Issue: 03 | March – 2026 DOI:10.55041/ISJEM05933
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Wastewater Treatment for Residential Society: A Sustainable Approach

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ABSTRACT

Wastewater treatment is essential for maintaining environmental sustainability and public health. This paper presents the design and analysis of a wastewater treatment system for a residential society consisting of 80 flats. The study focuses on estimating wastewater generation, selecting an appropriate treatment method, and designing treatment units. The Moving Bed Biofilm Reactor (MBBR) method is chosen due to its efficiency, low maintenance, and compact design. The system is designed to treat approximately 35 KLD (kiloliters per day) of wastewater. The treated water can be reused for gardening and flushing, reducing freshwater demand. This research highlights the importance of proper wastewater management in urban areas and promotes sustainable water reuse practices.

I. INTRODUCTION

Wastewater refers to contaminated water generated from domestic, industrial, and commercial activities. In residential areas, it mainly originates from toilets, kitchens, bathrooms, and washing areas. This wastewater contains organic matter, chemicals, and harmful microorganisms.

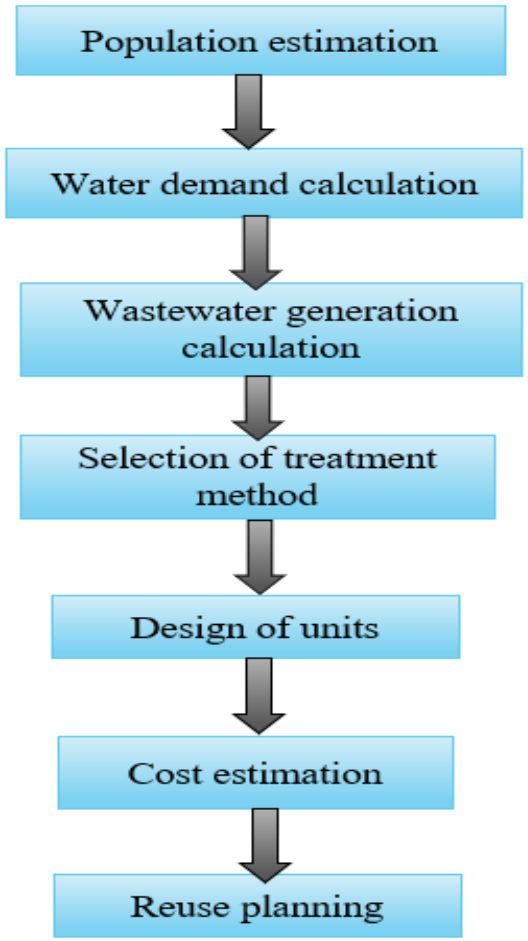
Improper disposal of wastewater leads to serious environmental problems such as water pollution, foul odors, groundwater contamination, and the spread of diseases. With increasing urbanization and water scarcity, wastewater treatment and reuse have become critical. A well-designed treatment system not only reduces pollution but also provides an alternative water source for non-potable uses like gardening and flushing.

II. LITERATURE REVIEW

Wastewater treatment has been widely studied due to its importance in environmental protection and sustainable water management. Traditional treatment methods such as the Activated Sludge Process (ASP) have been extensively used for municipal and domestic wastewater treatment. These systems are effective in removing organic pollutants but often require large land areas, continuous monitoring, and high operational costs. Researchers have highlighted that although ASP provides good Biological Oxygen Demand (BOD) removal efficiency, it is less suitable for small-scale residential applications due to its complexity and maintenance requirements.

In recent years, advanced biological treatment technologies like Sequential Batch Reactors (SBR) and Moving Bed Biofilm Reactors (MBBR) have gained significant attention. Studies show that SBR systems are flexible and efficient, as they combine multiple treatment steps into a single tank, but they require skilled operation and precise timing control. On the other hand, MBBR technology has emerged as a reliable and compact solution, especially for decentralized wastewater treatment. It uses biofilm carriers that provide a large surface area for microbial growth, resulting in higher treatment efficiency and stability even under variable load conditions.

III. METHODOLOGY



IV. BASIC DATA AND ASSUMPTIONS:-

The design of the wastewater treatment plant is based on the following assumptions:

- Total number of flats = 80
- Average persons per flat = 4
- Total population = 320 persons
- Per capita water consumption = 135 liters/day (standard value)

Water Consumption Calculation

Total water demand = 320 × 135 = 43,200 liters/day

Wastewater Generation

Assuming 80% of water becomes wastewater:

Wastewater generated = 43,200 × 0.8 = 34,560 liters/day ≈ 35 KLD

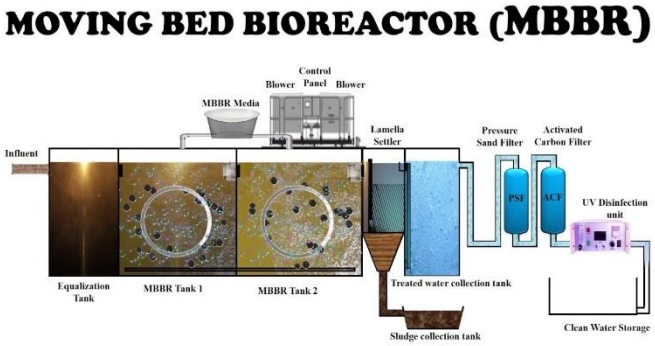
Design Parameters

- Plant capacity = 35 KLD
- Peak flow factor = 2.5
- Suitable for residential wastewater treatment

V. SELETION OF TREATMENT METHOD :-

The MBBR (Moving Bed Biofilm Reactor) method is selected due to:

- High treatment efficiency
- Compact design (requires less space)
- Low maintenance
- Odor-free operation
- Suitable for 20–500 KLD capacity



VI. TREATMENT PROCESS :-

The wastewater treatment process includes the following stages:

1. Screening Tank – Removes large solids
2. Equalization Tank – Maintains uniform flow
3. Aeration Tank (MBBR) – Biological treatment
4. Secondary Clarifier – Settles suspended solids

5. Sand Filter – Removes fine particles
6. Activated Carbon Filter – Removes odor and color
7. Treated Water Tank – Stores treated water
8. Sludge Drying Bed – Handles sludge

VII. BASIC DESIGN CALCULATIONS :-

For 35 KLD:

- Daily flow = 35 m^3/day

Equalization Tank:

Detention time = 8 hours

Volume = (35 × 8) / 24 = 11.6 m^3 ≈ 12 m^3

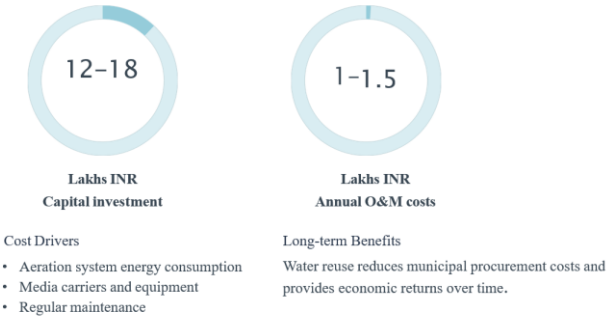
Aeration Tank:

Detention time = 6 hours

Volume = (35 × 6) / 24 = 8.75 m^3 ≈ 9 m^3

(These are simplified academic calculations.)

ECONOMIC ANALYSIS



VIII. RESULT & DISCUSSION :-

The wastewater treatment system designed for 35 KLD using the MBBR method effectively removes pollutants like BOD, COD, and TSS, achieving up to 85–95% treatment efficiency. The process ensures clean and reusable water suitable for gardening and flushing.
The system is compact, low-maintenance, and ideal for residential societies. Although the initial cost is moderate, it provides long-term savings by reducing water bills and tanker dependency. Overall, it is an efficient and sustainable solution for wastewater management.

CONCLUSION:-

1. The designed 35 KLD wastewater treatment plant is efficient and suitable for residential use.
2. MBBR technology provides high treatment efficiency with low maintenance.
3. The system effectively reduces pollutants like BOD, COD, and TSS.
4. Treated water can be safely reused for gardening and flushing.
5. It helps in conserving freshwater and reducing water bills.
6. The plant is compact and ideal for limited space areas.
7. It supports environmental protection and pollution control.
8. Overall, it is a sustainable and cost-effective wastewater management solution.

❖ Future Scope:-

- Integration of smart monitoring systems (IoT) for real-time water quality tracking and automation
- Use of renewable energy (solar power) to reduce operational costs
- Advanced treatment methods for higher quality reuse (e.g., for cooling or washing)
- Expansion of the system for larger residential societies or commercial use
- Implementation of nutrient recovery techniques from wastewater
- Improvement in sludge management and reuse as fertilizer
- Adoption of zero liquid discharge (ZLD) systems for complete water recycling
- Development of more compact and energy-efficient treatment technologies

• Increased awareness and implementation of wastewater reuse in urban areas

REFERENCE:-

[1] S. Madan, R. Madan, and A. Hussain, "Advancement in biological wastewater treatment using hybrid moving bed biofilm reactor (MBBR): A review," *Applied Water Science*, vol. 12, no. 141, 2022.

[2] S. A. Osmani, A. Rajpal, and A. A. Kazmi, "Upgradation of conventional MBBR into Aerobic/Anoxic/Aerobic configuration: A case study of sewage treatment plant," *Journal of Water Process Engineering*, vol. 40, 2021.

[3] G. Parivallal, R. A. Govindaraju, A. Nagalingam, and S. Devarajan, "Performance evaluation of 1 MLD MBBR type sewage treatment plant," *Indian Journal of Microbiology Research*, vol. 9, no. 2, pp. 149–152, 2022.

[4] R. S. Rana, P. Singh, V. Kandari, et al., "Characterization and bioremediation of pharmaceutical wastewater: An Indian perspective," *Applied Water Science*, vol. 7, pp. 1–12, 2017

[5] W. Raja and P. Kumar, "Membrane bioreactors for wastewater treatment: Advances and fouling control strategies," *Indian Chemical Engineer*, 2025

[6] D. Saidulu, A. Majumder, and A. K. Gupta, "A systematic review of MBBR, MBR, and hybrid systems for wastewater treatment," *Journal of Environmental Chemical Engineering*, vol. 9, no. 5, 2021.

[7] M. Biswas Roy, S. Saha, and P. K. Roy, "Constructed wetlands for wastewater treatment: A review of research development," *Ecology, Economy and Society (INSEE Journal)*, vol. 8, no. 1, pp. 13–54, 2025.

[8] "Hybrid treatment system for domestic wastewater using constructed wetlands in India: A review," *Biocatalysis and Agricultural Biotechnology*, vol. 60, 2024.