



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: IV Month of publication: April 2023

DOI: <https://doi.org/10.22214/ijraset.2023.51145>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

Design of 50KLD MBBR based Sewage Treatment for Hostel Building, Nagpur

Unnati Thakare¹, Himani Kimmatkar², Prajakta Shende³, Snehaly Raut⁴, Dr. B. S. Ruprai⁵

^{1, 2, 3, 4}Student, ⁵Assistant Professor, Department of Civil Engineering, K.D.K. College of Engineering, Nagpur

Abstract: Sewage water recovery is the treatment or processing of Sewage water to make it applicable. This paper shows the design of various component of conventional sewage treatment plant using Moving Bed Biofilm Reactor technique at College Hostel, Nagpur. The project consisting of the design of complete Sewage Treatment Plant components consist of Bar Screen Chamber, Equalization Tank, Aeration Tank, Clarifier Tank, Pressure Sand filter, Activated Carbon Filter and Treated Water Tank. Among the available technologies for waste water treatment, MBBR sewage treatment is most suitable. It is a leading technology in waste water treatment as this system can operate at lower vestiges and give advanced efficiency of treatment. It's compact and effective option for domestic waste treatment. In duly designed MBBR, the whole reactor volume is active, with no dead space or short circuiting. This paper demonstrates the detailed procedure for the design of a MBBR grounded sewage treatment plant of 50 KLD capacity for an educational lot.

I. INTRODUCTION

Water plays an imperative part within the development of any action within the world. Due to the development of populace, utilization of water assets is more and accessibility is less. So, the demand for water is expanding. Sewage treatment is the method of evacuating contaminants from squander water, fundamentally from family sewage. Physical, chemical and biological forms are utilized to expel contaminants and deliver treated wastewater that's more secure for the environment. A by-product of sewage treatment is ordinarily semi-solid squander or slurry called sewage slime. The slime needs to experience encourage treatment some time recently being reasonable for transfer or application to arrive. Sewage can be ³ screening to trap strong objects and sedimentation by gravity to expel suspended solids. This level is in some cases alluded to as "Mechanical Treatment" in spite of the fact that chemicals are frequently utilized to quicken the sedimentation prepare. This Treatment can decrease the BOD of the approaching wastewater by 20-30% and the Full suspended solids by a few 50-60%. Essential treatment is the primary arrange of sewage treatment. The auxiliary treatment expels the broken-down natural matter that get away essential treatment. Auxiliary treatment is ordinarily performed by inborn, water-borne micro-organisms in a overseen environment. It requires a division prepare to evacuate the micro-organisms from the treated water earlier to release or tertiary treatment. Tertiary treatment is some of the time is characterized as anything more than essential and auxiliary treatment in arrange to permit discharge into a exceedingly delicate or delicate environment. Tertiary treatment can expel more than 99% of all the debasements from sewage, creating an emanating of nearly drinking water quality. Treated water is now and then sanitized chemically or physically earlier to release into a stream, waterway or wetland.

II. WHAT IS MBBR?

MBBR stands for Moving Bed Biofilm Reactor, which is a biological wastewater treatment process that utilizes microorganisms to remove organic matter and other pollutants from water. The MBBR technology consists of a tank filled with plastic media carriers that provide a surface area for the growth of microorganisms that form a biofilm on the media.

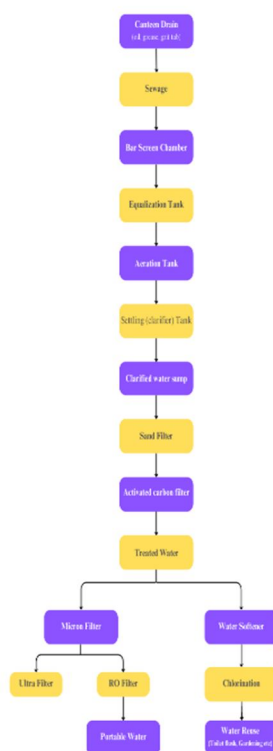


The MBBR technology is highly effective in treating a wide range of wastewater types, including municipal, industrial, and agricultural wastewater. It is also a compact and scalable process, which means it can be used in small or large-scale applications, depending on the specific requirements.

Compared to other biological wastewater treatment processes, the MBBR technology has several advantages, including low energy consumption, easy operation and maintenance, and high treatment efficiency.

These advantages make the MBBR technology a popular choice for wastewater treatment in many parts of the world.

- 1) **Health Risks:** Wastewater can contain harmful microorganisms, pathogens, and chemicals that can pose health risks to humans and animals if not properly treated. Rising levels of wastewater can increase the risk of waterborne diseases and illnesses
- 2) **Environmental Pollution:** Wastewater can pollute surface water and groundwater, leading to the degradation of aquatic ecosystems and harming wildlife. Excess nutrients in wastewater can also cause eutrophication, which can lead to algal blooms and fish kills.



- 3) **Depletion Of Freshwater Resources:** As the demand for water increases, the use of treated wastewater for irrigation and other non-potable purposes is becoming more common. However, if the amount of wastewater generated exceeds the capacity of treatment plants, it can lead to a depletion of freshwater resources.
- 4) **Economic Costs:** Treating wastewater is a costly process, and rising levels of wastewater can put a strain on municipal and industrial wastewater treatment facilities. Inadequate treatment can lead to costly infrastructure repairs, fines for noncompliance with regulations, and lost productivity due to health issues.
- 5) **Climate Change:** Climate change can exacerbate the effects of rising wastewater by altering precipitation patterns, increasing the frequency and intensity of floods and droughts, and affecting water quality. This can further stress water resources and increase the demand for wastewater treatment.

The objectives of the MBBR (Moving Bed Biofilm Reactor) technology are:

- a) **Efficient Removal Of Organic Matter And Other Pollutants From Wastewater:** The MBBR technology uses a biofilm of microorganisms to break down organic matter and other pollutants in wastewater, thereby improving the quality of the effluent.
- b) **High Treatment Efficiency:** The MBBR technology is known for its high treatment efficiency, which is achieved through the use of a large surface area of plastic media carriers, high concentration of microorganisms, and continuous mixing of the wastewater and biofilm.

- c) *Flexibility And Adaptability:* The MBBR technology is adaptable to a wide range of wastewater types and can be easily scaled up or down depending on the specific requirements. The process can also be easily modified to accommodate changes in flow rate and organic load.
- d) *Low Energy Consumption And Operational Costs:* The MBBR technology has lower energy consumption and operational costs compared to other biological treatment processes, due to its low sludge production and low aeration requirements.
- e) *Reduced Environmental Impact:* The MBBR technology can reduce the environmental impact of wastewater treatment by producing a high-quality effluent that can be discharged into water bodies or reused for irrigation or other non-potable purposes. Overall, the objectives of the MBBR technology are to provide an efficient, cost effective, and environmentally friendly method for treating wastewater, thereby helping to protect public health and the environment.

III. DATA

1) General Details

| Description | Values | Values |
|----------------|---|-------------------------------|
| Consumed water | 45 lpcd | 45 |
| Population | 1400 | 1400 |
| Discharge(Q) | $45 * 1400 = 6300 \text{lit/day} = 63 \text{ m}^3/\text{day} = 2.625 \text{ m}^3/\text{hr}$ | 6300 lit/day |
| | | $63 \text{ m}^3/\text{day}$ |
| | | $2.625 \text{ m}^3/\text{hr}$ |

2) Bar Screen Chamber

| Description | Values | Values |
|---|--|------------------------------------|
| Average hourly flow | $2.625 \text{ m}^3/\text{hr}$ | $2.625 \text{ m}^3/\text{hr}$ |
| Peak hourly flow | $3 * 2.625 = 7.875 \text{ m}^3/\text{hr} = 0.0021875 \text{ m}^3/\text{sec}$ | $0.0021875 \text{ m}^3/\text{sec}$ |
| Assume design flow velocity | 0.3 m/sec | 0.3 m/sec |
| Cross sectional area of screen bar | $0.0021875 / 0.3 = 0.00729167 \text{ m}^2$ | 0.00065625 m^2 |
| Cross sectional area is increased by 50 % to compensate | | |
| Flow area blocked by the bars | $0.00729167 * 1.5 = 0.0109375 \text{ m}^2$ | 0.000984375 m^2 |
| Required minimum dimensions | 0.1m * 0.1m | |
| Instead provide as per site condition | | |
| 1*1*2 SWD | | |

3) Equalization Tank

| Description | Values | Values |
|----------------------------|--|---------------------|
| Assume detention time | 6 hr | 6 hr |
| Volume of tank | $Q * DT = 2.625 * 6 = 15.75 \text{ m}^3$ | 15.75 m^3 |
| Assume free board | 0.3 m | 0.3 m^3 |
| Assume water depth of tank | 2 m | 2m |
| Tank area | $15.75 / 2 = 7.875 \text{ m}^2$ | 7.875 m^2 |

4) Aeration Tank

| Description | Values | Values |
|--------------------------|---|--------------------------------|
| Assume BOD | $200 * 10^{-6} \text{ kg/lit}$ | $200 * 10^{-6} \text{ kg/lit}$ |
| Incoming sewage load (Q) | $63 \text{ m}^3/\text{day}$ | $63 \text{ m}^3/\text{day}$ |
| Assume F/M | 0.1 per day | 0.1/day |
| BOD load/day | $63 * 1000 * 200 * (1/1000000) = 12.6$ | 12.6 |
| M (Biomass) | $12.6 \text{ kg/day} = 12.6 / 0.1 = 126 \text{ kg}$ | 126 kg |

| | | |
|--------------------------------|--|-------------------------------|
| Assume MASS = mg/lit | $3500 \text{ mg/lit} = 3.5 \text{ kg/m}^3$ | 3.5 kg/m^3 |
| Aeration tank volume | $126/3.5 = 36 \text{ m}^3$ | 36 m^3 |
| Average retention time | $36 \times 24/63 = 13.71428 \text{ hrs}$ | 13.71428 hrs |
| Assume depth of aeration tank | 2 m | $2 \text{ m}^3/\text{day}$ |
| area of aeration tank | $36/2 = 18 \text{ m}^2$ | 18 m^2 |
| assume width of aeration tank | 2.5 m | 2.5 m |
| length of aeration tank | $18/2.5 = 7.2 \text{ m}$ | 7.2 m |
| assume aeration time | 22 hrs | 22 hrs |
| BOD load/hr | $12.6/22 = 0.57272727 \text{ kg/hr}$ | 0.57272727 kg/hr |
| Assume air per kg BOD | $60 \text{ m}^3/\text{hr}$ | $60 \text{ m}^3/\text{hr}$ |
| air requirement for BOD | $0.57272727 \times 60 = 34.3636362 \text{ kg/hr}$ | 34.3636362 kg/hr |
| assume requirement tank volume | 1.1 m | 1.1 m |
| air required for mixing | $34.3636362 \times 1.1 = 37.80 \text{ kg/hr}$ | 37.80 kg/hr |
| assume requirement floor area | 2 m^2 | 2 m^2 |
| air requirement for mixing | $2 \times 18 = 36 \text{ m}^3/\text{hr}$ | $36 \text{ m}^3/\text{hr}$ |
| air to be supplied | $\max(36, 37.80, 34.36) = 37.80 \text{ m}^3/\text{hr}$ | $37.80 \text{ m}^3/\text{hr}$ |

5) Clarifier Tank

| Description | Values | Values |
|-----------------------------|--|---|
| Q | $63 \text{ m}^3/\text{day}$ | $63 \text{ m}^3/\text{day}$ |
| Assume pumping | 20 hrs | 20 hrs |
| Maximum hourly through put | $63/20 = 3.15 \text{ m}^3/\text{hr}$ | $3.15 \text{ m}^3/\text{hr}$ |
| assume design overflow rate | $16 \text{ m}^3/\text{m}^2/\text{day} = 0.6667 \text{ m}^3/\text{m}^2/\text{hr}$ | $0.6667 \text{ m}^3/\text{m}^2/\text{hr}$ |
| c/s area of tank | $3.15/0.6667 = 4.7247 \text{ m}^2$ | 4.7247 m^2 |
| assume circular tank | $\pi * d^2 = \text{c/s area of tank} = 2.4526 \text{ m} = 2.5 \text{ m}$ | 2.5 m |
| assume depth of tank | 2.5 m | 2.5 m |
| assume MASS | $3500 \text{ mg/lit} = 3.5 \text{ kg/m}^3$ | 3.5 kg/m^3 |
| solid load | $3.15 \times 3.5 = 11.025 \text{ kg/hr}$ | 11.025 kg/hr |
| solid loading rate | $11.025/4.7247 = 2.3334 \text{ kg/m}^2/\text{hr}$ | $2.3334 \text{ kg/m}^2/\text{hr}$ |
| volume of tank | $4.7247 \times 2.5 = 11.8117 \text{ m}^3$ | 11.8117 m^3 |
| hydraulic detention time | $11.8117 \times 24/63 = 4.49 \text{ hrs} = 5 \text{ hrs}$ | 5 hrs |

6) Pressure Sand Filter

| Description | Values | Values |
|-------------------------------|---|--|
| Q | $63 \text{ m}^3/\text{hr}$ | $63 \text{ m}^3/\text{hr}$ |
| assume design filtration | 20 hrs | 20 hrs |
| allow rest | 30 min backwash and 10 min rinse | |
| filtration rate | $63/20 = 3.15 \text{ m}^3/\text{hr}$ | $3.15 \text{ m}^3/\text{hr}$ |
| assume loading rate on filter | $12 \text{ m}^3/\text{m}^2/\text{day}$ | $12 \text{ m}^3/\text{m}^2/\text{day}$ |
| c/s area of filter (min) | $3.15/12 = 0.2625 \text{ m}^2$ | 0.2625 m^2 |
| dia of filter | $\pi/4 * d^2 = \text{c/s area of filter} = 0.57812 \text{ m}$ | 0.57812 m |
| Assume height of filter | 1.5 m | 1.5 m |
| depth of sand filter | 0.6 m | 0.6 m |

7) Activated Carbon Filter

| Description | Values | Values |
|-------------------------------|---|--|
| Q | 63 m ³ /hr | 63 m ³ /hr |
| assume design filtration | 20 hrs | 20 hrs |
| allow rest | 30 min backwash and 10 min rinse | |
| filtration rate | 63/20=3.15 m ³ /hr | 3.15 m ³ /hr |
| assume loading rate on filter | 12 m ³ /m ² /day | 10 m ³ /m ² /day |
| c/s area of filter (min) | 3.15/12 = 0.2625 m ² | 0.315 m ² |
| Diameter of filter | $\pi/4 * d^2 = c/s \text{ area of filter} = 0.57812$ m | 0.633301 m |
| Assume height of filter | 1.5 m | 1.5m |
| depth of sand filter | 0.6 m | 0.6m |

8) Treated Water Tank

| Description | Values | Values |
|-----------------------------|--|-----------------------|
| assume detention time | 6 hrs | 6 hrs |
| detention time vol/Q volume | 6*24/63 = 2.2857 m ³ | 2.2857 m ³ |
| assume circular tank | $\pi/4 * d^2 = \text{volume} = 1.7059$ m | 1.7059 m |
| assume depth of tank | 1.5 m | 1.5 m |

IV. CONCLUSION

Constructing a sewage treatment plant is necessary. According to Indian Codal provision, the plant is properly planned to accommodate for potential future expansion. The plant is precisely constructed to meet the requirement over a very long length of time. Through this paper, the basic strategy for the plan of a MBBR based sewage treatment plant of 50 KLD capacity for a private format is illustrated. The treated water is also utilised for fire protection, toilet flushing and gardening purpose.

REFERENCES

- [1] Noman Sohaila, Sadia Ahmeda, Shinho Chunga, Muhammad Saqib Nawaz, Performance comparison of three different reactors (MBBR, MBR and MBBMR) for municipal wastewater treatment, received 13May 2019; Accepted 4 September2019.
- [2] Sangeeta Madan, Richa Madan, Athar Hussain, Advancement in biological wastewater treatment using hybrid moving bed biofilm reactor (MBBR): a review, received:19 July 2021 / Accepted: 25 March 2022 / Published online:22 April 2022
- [3] Duduku Saidulu, Abhradeep Majumder, and Ashok Kumar Gupta, A systematic review of moving bed biofilm reactor, membrane bioreactor, and moving bed membrane bioreactor for waste water treatment: Comparison of research trends, removal mechanisms, and performance, Volume 9, Issue 5, October 2021.
- [4] Odegaard, Hallvard, "Compact Wastewater Treatment with MBBR," DSD International Conference, Hong Kong, 12, 11-14-2014.
- [5] Odegaard, H., "The Moving Bed Biofilm Reactor," in Igrarashi, Watanabe, Asano, and Tambo N., "Water Environmental Engineering and Reuse of Water," Hokkaido Press 1999, p 250-305.
- [6] Steichen, M. & Phillips, H., Black & Veach, "Process and Practical Considerations for IFAS and MBBR Technologies," Headworks International Presentation, 03/18/2010.
- [7] Rusten, B. and Paulsrud, B, Improved Nutrient Removal with Biofilm Reactors, Aquateam –Norwegian Water Technology Center, Oslo, Norway. McQuarrie, J.P. and Boltz, J.PI, Moving Bed Biofilm Reactor Technology: Process Applications, Design and Performance, Water Environment Research, Vol 83, No.6, June 2011.
- [8] Gzar H A, Jasim N A and Kseer K M 2020 Electrocoagulation and chemical coagulation for treatment of Al-Kut textile wastewater: A comparative study Periodicals of Engineering and Natural Sciences 8 1580-1590.
- [9] Zahraa S H and Gzar H A 2019 Evaluation of the Performance of MBR-RO Technology for Treatment of Textile Wastewater and Reuse IOP Conf. Series: Materials Science and Engineering 584 1-9.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)