Progression of various MBBR media in Wastewater Treatment Process

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Abstract - *Moving Bed Biofilm Reactor (MBBR) is a wastewater treatment technology that utilizes a plastic carrier media with a large surface area to support the growth of microorganisms. The MBBR process has gained popularity due to its flexibility, ease of operation, and efficiency in treating various types of wastewater.*

One such carrier media used in MBBR is Mutag Biochip MBBR, which is a high-performance carrier designed to improve the efficiency of the process. The Mutag Biochip MBBR carrier has a unique design that provides a high surface area for bacterial growth and ensures efficient mass transfer of oxygen and nutrients to the microorganisms.

The use of Mutag Biochip MBBR carrier in MBBR has shown significant improvement in the treatment efficiency of various types of wastewater, including industrial and municipal wastewater. The carrier's high surface area allows for increased microbial activity, which results in better removal of organic matter and nitrogen from the wastewater

***Key Words*: MBBR, Waste water, Mutag Biochip Biofilm, Water treatment, BOD removal.**

INTRODUCTION

Wastewater treatment is essential to protect the environment and human health from the harmful effects of pollutants. Conventional wastewater treatment processes, such as activated sludge and trickling filter, have been widely used for many years. However, these processes have limitations, such as high energy consumption, large land requirements, and poor performance under variable conditions.

The shifting mattress biofilm reactor (MBBR) is a new wastewater remedy era that gives numerous benefits over traditional processes. MBBR is a type of attached growth system that uses small plastic media as a substrate for biofilm formation. The media provide a large surface area for microbial attachment and growth, allowing for efficient biological treatment of organic matter and nutrients. MBBR technology has been successfully applied to various types of wastewater, including municipal, industrial, and agricultural wastewaters.

The Mutag BioChip is a type of plastic carrier media that is designed to provide a large surface area for bacteria to grow on in wastewater treatment applications. The media is designed to be highly efficient at removing organic pollutants from wastewater, and can support a diverse range of bacterial species.

The Mutag BioChip is manufactured by the German company Mutag BioChip Systems GmbH, and is used in wastewater treatment systems around the world. The company claims that the BioChip provides several benefits over traditional carrier materials, including higher efficiency, lower energy consumption, and improved performance in cold temperatures.

It is worth noting that while the Mutag BioChip is a real product that is currently in use, it is not the same thing as the hypothetical Mutag Biochip concept that has been proposed for detecting genetic mutations. The two are unrelated, despite the similarity in name.

OBJECTIVE:

To study and analyse the role and performance of different Moving Bed Biofilm Reactors (MBBR) media in wastewater treatment for the following parameters:

a. Different HRT
b. Different size and shape of MBBR media

I. LITERATURE REVIEW

- **Moving Bed Biofilm Reactor Technology: Process Applications, Design, and Performance**. By Mcquarrie, James & Boltz, Joshua. (2011). stated that,
    - Capacity to achieve nitrogen and carbon oxidation treatment goals similar to activated sludge systems.
    - Biomass retention is independent of clarifiers.
    - The MBBR is a continuous-flow process that doesn't need a special operational cycle to control biofilm thickness.
    - Liquid-solid separation can be accomplished using a variety of processes, including traditional and compact high-rate processes.
- **Performance Evaluation of MBBR (Moving Bed Biofilm Media) for Treatment Of Sewage"** by Vivek Rikame, Ketan Jain, Sahil Arbune, Puja Kadam: Stated that,
    - In comparison to the 78% efficiency of aerated lagoons employed as secondary treatment at

the wastewater treatment facility, an overall efficiency of 83–88% can be reached in the elimination of BOD, TSS, and pH of the sewage sample that is to be treated.
  - The moving bed bio film reactor has shown to be a reliable and portable reactor design for the treatment of waste water.
  - Numerous process combinations have shown the reactor's effectiveness in removing both BOD and COD.
  - It has been applied on both tiny and large plants.
  - Utilizing this technology has decreased the rate of BOD-COD. Since MBBR meets BIS standards for safe disposal, a cost-benefit analysis has not yet been conducted for this method.

- **"Model Studies on the Effectiveness of MBBR Reactors for the Restoration of Small Water Reservoirs"** by Agata Nowak, Robert Mazur, Ewa Panek, Joanna Chmist: Stated that,
  - Based on the completed research, a tentative model of biological treatment efficacy was developed.
  - The operation mode was finally set to reflect the actual circumstances of polluted water reservoirs.
  - The investigated bioreactors were built to a semi-technical standard, allowing for the accurate extrapolation of laboratory findings to real-world scenarios.
  - The MBBR is one-of-a-kind technologies that can be quickly adjusted to treat tiny water reservoirs.

- Journal of Physics: Conference Series **"Application of Moving Bed Biofilm Reactor (MBBR) for Treatment of Industrial Wastewater: A mini-Review**" by Hatem A Gzar, Wisam S. Al-Rekabi and Zahraa K. Shuhaieb: stated that,
  - The continuous flow-through method, which reduces head loss and operational complexity while eliminating the need for backwashing;
  - An extremely compact reactor, due to the biofilm's extensive surface area and the highly active, specialized biomass;
  - Multiple treatment goals, such as bod removal, denitrification, and nitrification in a flow-through series configuration, which offers a fairly adaptable and straightforward system;
  - Because the bulk of the active biomass is kept along with the biofilm carriers, there is no need for sludge separation and no additional space is needed. This provides a benefit over the activated sludge method.
  - Flexibility since MBBR may be retrofitted into the current tanks during a treatment plant upgrade.

II. Types of MBBR Media

I.1. Expanded Clay Media:

Expanded clay media consists of lightweight, porous clay balls. They provide a large surface area for the attachment and growth of microorganisms.

I.2. Polyethylene Media:

Polyethylene media are made of high-density polyethylene (HDPE) and have a complex, multi-sided design. They offer a high surface area and excellent mixing characteristics.

I.3. PVC (Polyvinyl Chloride) Media:

PVC media are typically made of plastic and have a structured design to provide optimal surface area for biofilm growth. They are durable and resistant to clogging.

I.4. Polyester Media:

Polyester media are made of a synthetic material with a high surface area. They are known for their resistance to chemical degradation and fouling.

I.5. Mutag Biochip Media:

The Mutag Biochip MBBR carrier has a unique design that provides a high surface area for bacterial growth and ensures efficient mass transfer of oxygen and nutrients to the microorganisms.

III. Common types of MBBR

II.1. K1 MBBR media:

K1 MBBR media are the most used type of MBBR media. They have a cylindrical shape with small fins that provide a large surface area for biofilm growth. They are typically made from high-density polyethylene (HDPE) and have a specific surface area of around 800 m2/m3.

II.2. K3 MBBR media:

K3 MBBR media are a newer type of media that have a similar shape to K1 media but have a larger diameter and longer fins. They are designed to provide a higher specific surface area than K1 media, with a surface area of around 1200 m2/m3.

II.3. AnoxKaldnes K5 MBBR media:

AnoxKaldnes K5 MBBR media are a specialized type of media that are designed for the removal of nitrogen from wastewater. They have a similar shape to K1 media but are made from a different type of plastic that provides a higher surface area for nitrifying bacteria to attach and grow.

II.4. Biocarrier MBBR media:

Biocarrier MBBR media are a type of media that have a spherical shape and a unique design that provides a high surface area for biofilm growth. They are typically made from polyethylene or polypropylene and have a specific surface area of around 500 m2/m3.

II.5. Fixed Bed Biofilm Reactor (FBBR) media:

FBBR media are a type of media that are like MBBR media but are designed to be stationary within the reactor. They have a larger size than MBBR media and are typically made from PVC or other materials that are resistant to corrosion and fouling.

II.6. Submerged Aerated Fixed Film (SAFF) media:

SAFF media are a type of media that are used in a hybrid wastewater treatment process that combines fixed-film and suspended-growth processes. They have a similar shape to MBBR media but are typically larger and are submerged in the wastewater rather than being in a moving bed.

IV. COMPARISON

Comparison of Mutag Biochip media with conventional MBBR media carriers in terms of characteristics and performance:

Table -1: Comparison

Aspect	Mutag BioChip	Conventional MBBR Media Carriers
Surface Area	High (800-1,200 m^2/m^3)	High (500-1,000 m^2/m^3)
Shape and Design	Patented 3D shape	Spherical or cylindrical
Mixing Requirement	Low	Low
Nutrient Removal	Good performance	Good performance
Process Stability	Stable	Stable
Clogging and Washout	Resistant	Resistant

V. PROPOSED SETUP:

IV.1. Experimental setup:

A constantly running, non-clogging biofilm reactor with a moving bed is the foundation of the moving bed biofilm reactor (MBBR) technology, a biological treatment procedure for attached growth.

There is no need for backwashing, a high specific biofilm surface area, and reduced head loss. MBBR is frequently created as an aerobic system. Prior to treatment, a sample will be taken from the STP plant and its parameters will be assessed. The tank measures 45*25*25 cm. The shifting mattress biofilm reactor (MBBR) set-up recommended for this research might encompass chambers built of plastic. The tank's top inlet configuration is shown. The output is offered at a level below the intake. As indicated in the picture, the suggested experimental setup for moving bed biofilm can be created.

Fig: 1 Experimental Setup

IV.2. MBBR media:

a) AnoxKaldnes K5 MBBR media
b) Mutag Biochip biofilm 25TM media
c) Polyethylene Media
d) BI16 MBBR media

IV.3. Equipment used:

e) Glass tank
f) Aerator
g) Tubes

Fig: 2 Polypropylene MBBR Media

Fig 3: BI16 MBBR Media

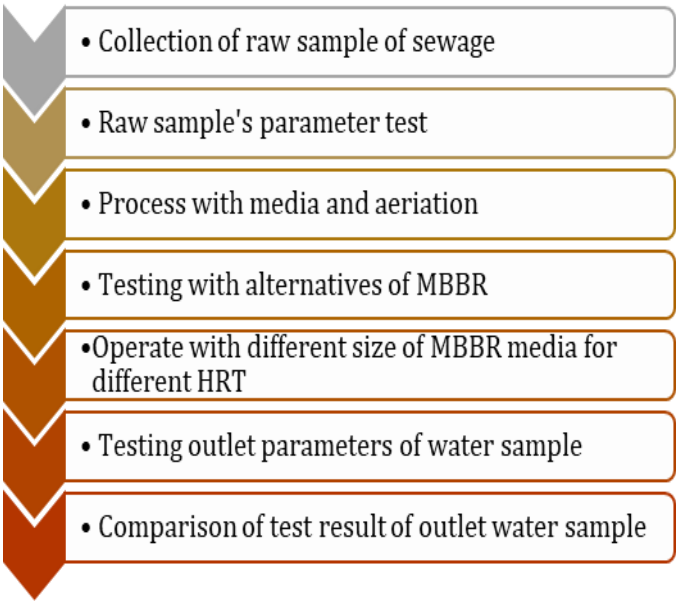
Fig 4: AnoxKaldnes K5 MBBR media

Fig 5: Mutag Biochip Biofilm MBBR media

VI. METHODOLOGY

To maximize the number of microorganisms that can treat the wastewater, the MBBR process uses floating plastic carriers inside the aeration tank. This microbe consumes organic waste, increasing the surface area of the aeration tank where biological bacteria can flourish. The media will be continuously suspended from the oxygen-adding aeration system at the base of the aeration tank. The final treated effluent will be discharged outside after treatment.

We conducted a laboratory scale investigation by running a series of trials with different sizes and shapes of MBBR carriers to treat sewage water from an educational complex. The experimental setup was built, and the MBBR medium (carrier) were suspended in the flow of continuous aeration. To treat the water, HRT of 4 hours, 6 hours, 8 hours, and 12 hours was used.



VII. RESULT

VII.1. Inlet waste water sample parameter

pH	6.7
BOD	286.62 mg/lit
Color	Greyish Black

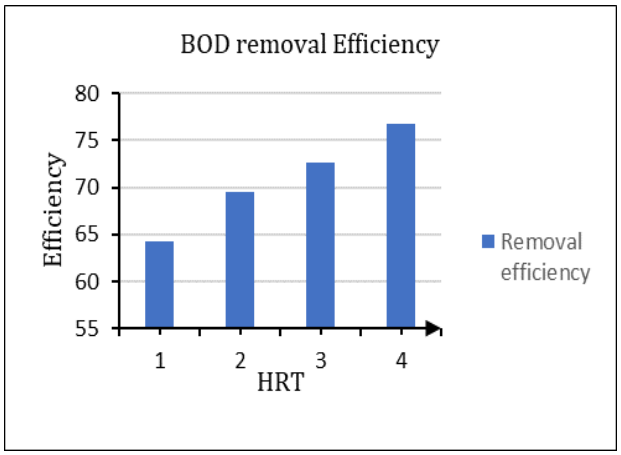
VII.2. Effluent waste water sample parameter

The performance change of MBBR media was analyzed for BOD with different sizes of media carrier for the different HRT i.e., for 4 hours, 6 hours, 8 hours, 10 hours.

Sr. No.	Media carrier	HRT hrs.	BOD	Removal efficiency
1	AnoxKaldnes K5	4	102.4	64.27076
		6	87.5	69.46964
		8	78.4	72.6448
		12	66.8	76.69225
2	Polyethylene	4	148.1	48.32519
		6	137.4	52.05862
		8	126.4	55.89672
		12	119.5	58.30426
3	BI16 MBBR	4	116.6	59.31612
		6	114.4	60.08374
		8	106.9	62.70063
		12	96.1	66.46895
4	Mutag Biochip biofilm 25TM	4	63.2	77.94836
		6	56.4	80.321
		8	49.8	82.62387
		12	33.6	88.27634

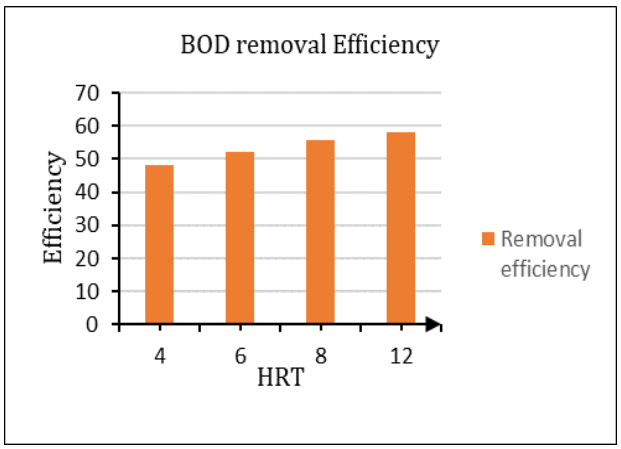
Media 1: AnoxKaldnes K5

The microorganisms in the wastewater depend on the oxygen in the air to survive. The removal efficiency declines as a result of the absence of oxygen. Its BOD removal efficiency for the 4 hrs, 6hrs, 8hrs and 12 hrs retention times under a constant aeration flow rate are 64.27%, 69.46%, 72.64% and 76.69% respectively.



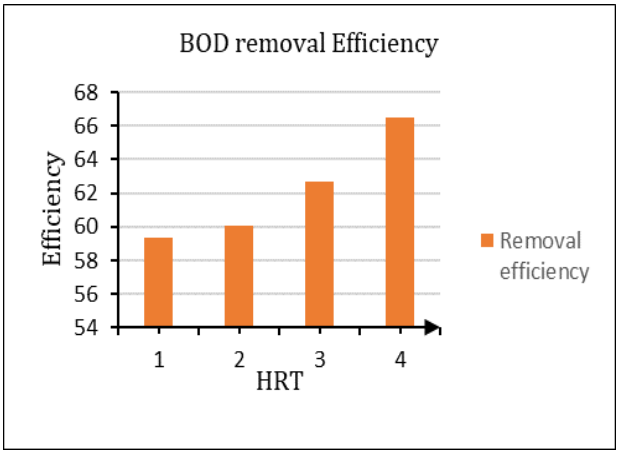
Media 2: Polyethylene MBBR media:

The microorganisms in the wastewater depend on the oxygen in the air to survive. The removal efficiency declines as a result of the absence of oxygen. Its BOD removal efficiency for the 4 hrs, 6hrs, 8hrs and 12 hrs retention times under a constant aeration flow rate are 48.35%, 52.05%, 55.89%, 58.30% respectively.



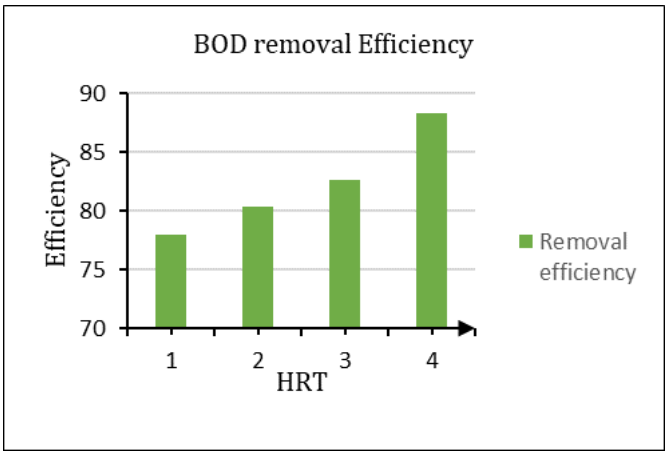
Media 3: BI16 MBBR media:

The microorganisms in the wastewater depend on the oxygen in the air to survive. The removal efficiency declines as a result of the absence of oxygen. Its BOD removal efficiency for the 4 hrs, 6hrs, 8hrs and 12 hrs retention times under a constant aeration flow rate are 59.34%, 60.08%, 62.70%, 66.46% respectively.

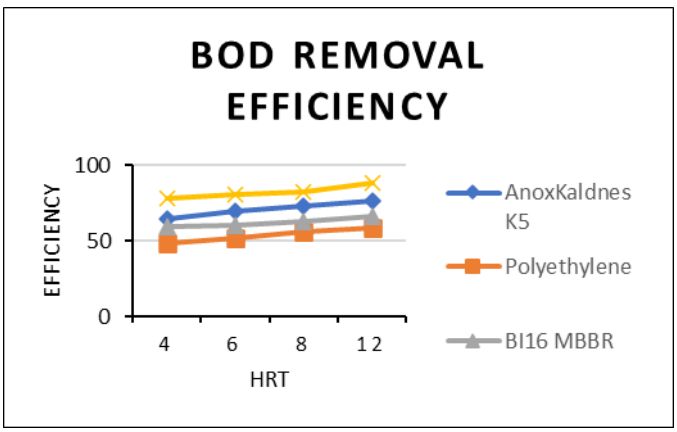


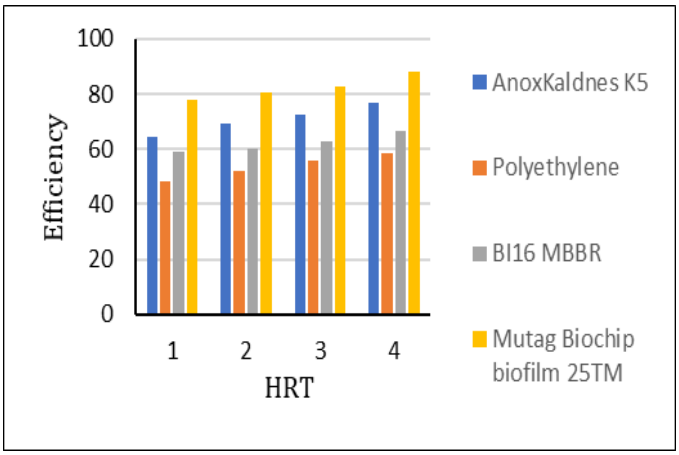
Media 4: Mutag Biochip biofilm 25TM MBBR media:

The microorganisms in the wastewater depend on the oxygen in the air to survive. The removal efficiency declines as a result of the absence of oxygen. Its BOD removal efficiency for the 4 hrs, 6hrs, 8hrs and 12 hrs retention times under a constant aeration flow rate are 77.94%, 80.32$, 82.62%, 88.27% respectively.



VII.3. Comparison of efficiency with different MBBR media





VIII. CONCLUSION

The features of the wastewater were discovered through laboratory testing. The wastewater has the potential to seriously harm the water body if disposal without treatment, as determined by the observed value of several parameters. In order to safely dispose of wastewater into a body of water while staying within BIS-specified permitted limits, the pollutant content of the wastewater must be reduced.

The research study emphasizes the functionality of several MBBR reactor types. To accomplish the intended objectives given by the standards, two criteria are analyzed. It is evident that the HRT has a higher effect on operating and maintenance costs.
The flow rate has an impact on the carrier circulation. As retention time decreases, flow rate rises, causing carriers to circulate quickly.

1. For the removal of BOD, MBBR technique is an effective way to use.
2. Besides of conventional method of removal of BOD from wastewater, MBBR technique is effective.
3. Mutag Biochip Biofilm if more effective than any other MBBR media carriers.
4. As far as economic concern, it has been expensive option with compare to other carriers.

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