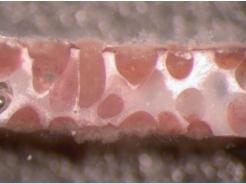
SPECIFICATION DATA SHEET

Mutag EcoChip

TM







Product name: Mutag EcoChip™

Developer, manufacturer, distributor: Multi Umwelttechnologie AG, Zschopauer Strasse 105,

D-09126 Chemnitz (Germany)

Description: High-performance biofilm carrier media for immobilizing

microorganisms in biological water and wastewater treat-

ment plants

Applications: COD/BOD removal, nitrification, denitrification, ANAMMOX

process

Active surface area (protected): Up to 5,500 m²/m³

Bulk weight (net): $165.00 \text{ kg/m}^3 \pm 2\%$

Color: Carbon black

Shape: Round, paraboloid

Pore system: May vary due to raw material

Material: PE post industrial production

Diameter: 30.0 mm

Material thickness: 1.1 mm

Specific gravity: 0.95 kg/l (without biofilm)

Packaging: Standard packaging: BigBags, each 247.5 kg net = 1.5 m³,

optional: Small bags, each 27.5 kg net = 1/6 m³

Container loading: 30 m³ in 1 x 20ft standard sea freight container or 66 m³ in 1 x

40ft HC standard sea freight container

Note: Highly sustainable & high quality alternative to the Mutag

BioChip™.







- for biological water and wastewater treatment

or cuts, which is being granuled in our own production facilities.

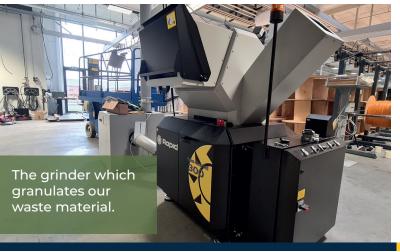
Mutag EcoChip™ has been developed during the past year and is a sustainable and environment-friendly product. It is made from PE post industrial material from our production such as surplus

High quality and performance

Mutag EcoChipTM possesses the exactly same design, quality and performance as our original product Mutag BioChipTM. However the Mutag EcoChipTM is a more eco-friendly product. Both because of the recycled raw material, our focus on zero waste, our use of the newest technology and our production that runs on green energy from wind turbines. All things are part of our strategy to become carbon-neutral.

Mutag EcoChip™ is completely free from phthalates and other plasticizers. It does not contain any questionable compounds which may be harmful to the environment. Furthermore, it does not emit microplastics.

At MUTAG we are very proud to offer the first sustainable product within the biological water treatment market. As for our other products we provide a 10-year product warranty.







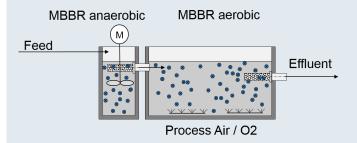




MBBR stands for Moving Bed Biofilm Reactor, and IFAS stands for Integrated Fixed Film Activated Sludge System. Initially, it might seem straightforward: a reaction tank is filled with plastic carriers that are mixed with water or a water/sludge mixture. The key distinction between IFAS and MBBR is that the IFAS system also incorporates achieved sludge from sludge recirculation. This means that a combination of activated sludge and carrier-fixed biofilms is utilized within the same reaction tank volume.

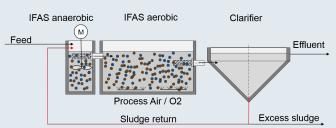
MBBR:

Carrier



IFAS:

- Carrier
- Activated sludge



CONSIDER WATER TEMPERATURE CAREFULLY IN MBBR/IFAS DESIGN

When designing and comparing proposals for MBBR/IFAS systems, the water temperature is a crucial factor. Incorrect temperature assumptions can lead to significant consequences.

1. High Design Temperature:

If you assume a high design temperature the calculations will show a high biological removal rate, resulting in lower requirements for carrier media and smaller reaction tank volumes. This might seem cost-effective initially, however, during normal plant operation at lower temperatures, you will find that the reaction tank volume and amount of carrier media are insufficient to meet discharge requirements. This may necessitate adding more media, but it could be challenging due to media filling rate limitations (typically 50-60%).

2. Low Design Temperature:

Conversely, assuming a low design temperature results in larger tank sizes and more carrier media than necessary. In practice, the water temperature is likely higher than your calculation assumption. While larger tanks and more carrier media do not harm biological processes, they unnecessarily increase investment costs.

Therefore, accurately considering water temperature in your MBBR/IFAS design is essential to avoid costly issues during plant operation. To ensure the right decision for your MBBR/IFAS plants, it is crucial to establish both min. and max. design temperatures and confirm they have been factored in.

CRITICAL REWIEW FOR SUCCESFUL MBBR/IFAS PROJECTS

Careful review and comparison of design proposals are essential to avoid important data is missing.

If oxygen requirements need specification for the aeration system, remember to use the higher of the two design temperature values. This is because oxygen dissolves less readily in warm water compared to lower temperatures. This is opposite to how removal rates are calculated.

Here is a straightforward rule to follow:

- For calculating the necessary tank and carrier media volume, use the lower temperature.
- For determining the oxygen supply, use the higher temperature.

SIGNIFICANCE OF YIELD IN MBBR/IFAS SIZING

Yield is a critical factor in sizing MBBR/IFAS systems, influencing tank size, carrier media volume, and oxygen supply. It is a value obtained from pilot trials and reference plants, specific to the wastewater source. Choosing the wrong yield can lead to inaccurate system sizing.

SIGNIFICANCE OF REMOVAL RATES IN MBBR/IFAS DESIGN

In MBBR/IFAS wastewater treatment, carriers play a vital role in removing pollutants and optimizing plant performance. Removal rates are essential for designing MBBR/IFAS systems as they measure removal efficiency. Carrier media suppliers must know their media removal efficiency to avoid passing on risk to customers.

FACTORS AFFECTING REMOVAL EFFICIENCY

Removal rates are derived from years of operational experience, including data from large-scale plants, pilot trials, and lab studies. Various factors, such as wastewater origin, characteristics, water temperature, nutrient and oxygen supply, impact removal performance. Generalized removal rates are unreliable and copying rates from other carrier type is not responsible.



EVOLUTION OF CARRIER TECHNOLOGY

When certain types of hollow-body carriers have been used in MBBR/IFAS plants for decades, their removal rates are well-documented.

In recent years, research & development efforts have led to innovations like permeable chiptype carriers made from PE-material. Market leaders like MUTAG have invested in product development and practical applications across various wastewater types to provide reliable removal efficiency data for their unique products.

THE IMPORTANCE OF ACTIVE BIOMASS CONCENTRATION

When using hollow-body carriers, microorganisms attach to their surfaces until they detach due to shear-forces. This allows for comparing the theoretically determined surface area, a common practice among different product shapes and manufacturers. However, when it comes to carriers with a pore system, surface area comparisons have limited applicability or may not be meaningful at all.

The reason for this is that the removal efficiency relies on active biomass concentration, making it necessary to conduct long-term tests under the exact process conditions for the specific wastewater.

The optimization of the Mutag BioChip™, with its pore system containing a substantial amount of active biomass, was prompted by the need to enhance performance. This optimization was validated through extensive studies conducted by MUTAG and various institutes/universities.

IN SUMMARY:

When comparing carriers, it is not the surface area of carriers that matters most for removal efficiency, but rather the amount of biomass they can immobilize per unit of volume. Carriers vary significantly in terms of removal capacity, and relying solely on surface area comparisons can lead to problems in plant design.

To ensure accurate plant sizing and minimize risks, it is crucial to validate the removal performance of carriers in the specific wastewater they will treat. Suppliers should possess real performance data for the chosen carrier type.





BIOFILM CARRIERS / MBBR CARRIER MEDIA AND THEIR RESPECTIVE DIFFUSION DEPTH

The diffusion depth as an important aspect to be considered in the evaluation of removal rates and treatment performance of MBBR carriers (biofilm carriers)

In the sector of biological wastewater treatment, it can increasingly be observed that biofilm carriers are applied in so-called Moving Bed Biofilm Reactors (MBBR). In such systems, the carriers are being mixed inside the reactor and kept in permanent suspension. The system does not require any return sludge recirculation and hence, slowly growing microorganisms which have established on the carriers are retained in the system together with the carriers themselves. The availability of high-performance biofilm carriers, which have been developed during the recent years, is certainly one of the reasons for the increase in the application of the MBBR. This development is an outcome of multiple factors such as the research in the sector of biofilm technology, the optimized utilization of polymer technology, the process-technological application up to the evaluation of operating results of long-term-operating large-scale plants.

A significant reason for the optimized product development in this field of application arises from the following question:

"Which biological removal rate can be attained by using the product in operation, and how can it be realized to achieve constant removal rates and process stability?"

Even the decision maker has to ask his- or herself this question and needs to receive reliable design data for being able to come to the correct conclusion:

The surface area which has been indicated in the past by various manufacturers, regardless of whether they referred to the protected or the total calculated surface area, respectively, is not the only characteristic which is crucial for evaluating the desired or required biological removal rate for the respective application. The specific surface area is only a comparative figure used in the competition between the plastics suppliers. This comparative figure is mostly calculated by means of geometrically defined, plain and poreless plastic parts, based on new uncolonized carriers coming directly from the production process. With regard to biological wastewater treatment in practice, the indication of a "theoretical" surface area is helpful only to a certain extent and can become problematic for the decision maker. Hence, the question concerning the biological removal performance in Anammox,

denitrification and nitrification process application or COD-removal, respectively, cannot be answered reliably by indicating the surface area only.

It is in turn crucial how much "active" biomass can establish on the carrier media and hence, which efficiency and removal rate can be attained. It is essential that the biomass is permanently fixed on the carrier media in order to provide an optimal habitat for the required microorganisms. Any biomass that is quickly being sheared off or rinsed off during the movement process (Moving Bed) gives no chance to slowly growing organisms like nitrifying or Anammox-bacteria. It hence is required to establish the biofilm permanently.

A large surface area or a huge quantity of biomass, respectively, is not beneficial as long as the microorganisms are not sufficiently supplied with nutrients. Thereby, an important role is played by the shape or geometry of the numerous carriers which are available on the market. Here as well, not the virgin and unused condition of the carrier media but the biomass that will establish later on during the operation in the sewage treatment plant is crucial. The biomass must stringently be "active" to attain optimal biological removal rates. A biomass which has died off due to the lack of nutrients is not useful and does not contribute to the desired metabolic processes.

The designation "active biomass" shall mean that all microorganisms within the biomass are sufficiently supplied with essential nitrogen (N), phosphorus (P), with the wastewater pollutants to be metabolized, and with oxygen (if required). The so called supply channel of the aforementioned substrates and oxygen is the diffusion depth. For the supply of organisms inside of the biomass (or biofilms), the reaction time-dependent diffusion depth is limited to 0.2 – 0.5 mm (0.00787" to 0.019685").

Subsequently, the organisms which are located in the lower layers of the biomass are not sufficiently supplied with substrates and die off consequently. As a result, the layer below the depth of 0.5 mm (0.019685") does not contribute to the metabolism process (removal rate) and in turn must not be considered for indicating the removal efficiency of the respective carrier. Actually, the died-off biomass can even have a negative impact on the active biomass/biofilms above it, due to fouling processes and H2S-generation.

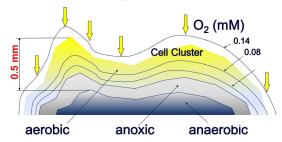
The optimal supply of the biofilms with substrates and oxygen is reached at a layer thickness/depth of up to approx. 0.5 mm.

Hence, the task to be fulfilled by research and development is, among others, to create a surface which allows for the growth of biofilms having a max. thickness of up to 0.5 mm for ensuring an appropriate diffusion.

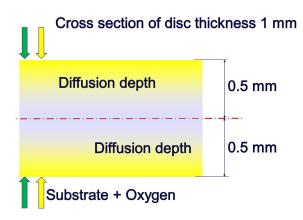
If the biofilm establishes on an even/plain or smooth surface, it tends to be quickly flushed off and in an uncontrolled way or, respectively, grows on to a thick and uncontrolled biofilm containing inactive biomass in the lower layers. Both cases would be of negative benefit.

The task is the protection of the active biomass up to a layer thickness of approx. 0.5 mm (ideal compliance with the optimal diffusion process) on the one hand and the adherence to the aforementioned layer thickness on the other hand; avoiding excessive growth and too thick layers. Hence, by means of the carrier configuration, it must be managed to create the opportunity to shear off/remove the excess sludge and hence, to maintain a biofilm thickness of up to 0.5 mm.

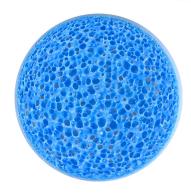
Diffusion of O₂ into a cell cluster



The illustration above shows the O2 removal up to the anoxic zone



Nearly complete diffusion through the entire disc having a thickness of 1 mm thickness, from both sides



Carrier with pore system with rough surface and disc thickness of approx. 1.1 mm (0.043") to fulfill the requirements.

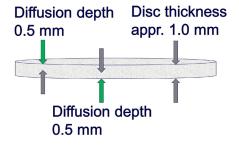
The thickness of the carrier disc is crucial for active biofilms.

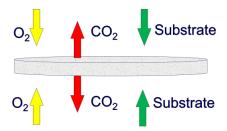
Hence, all carriers which are currently available on the market, regardless of whether hollow body carriers, tube- or helical-shaped or sponge carrier configuration, respectively, are inadequate and not able to fulfill this requirement.

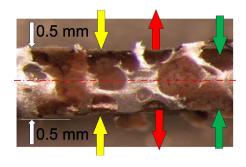
The ideal requirements can be fulfilled by the use of thin, disc-shaped and porous carriers, whereas an optimal and active biofilm establishes inside of the pores and any excess sludge is being removed by shear forces. The shear forces occur when the disc surfaces are contacting each other due to the movement of the carriers in the wastewater (reaction tank).

When using tubular carriers, it is not possible to benefit from the shear forces effect in the inner zones of the carriers, which has been proven to be a significant disadvantage.

When using stable, porous, disc-shaped carriers having a thickness of 1.0 – 1.2 mm (0.039" to 0.047"), the active biofilm can establish inside of the pores and hence, the supply with substrates can be effected from both sides of the carrier.







Another requirement to be fulfilled is the maximum reduction of wear. In most cases, the reason for the occurrence of wear and abrasion of carriers is the kinetic energy, i.e. the energy which is required for slowing-down a body which is moved in the water. Any non-elastic, large and heavy tubular/hollow body carriers which possibly even contain a huge amount of dead biomass, show a disadvantageous kinetic behavior compared to lightweight, flexible disc-shaped carriers. Flexible "buffer zones" in the plastic material maximally reduce the wear. Additionally, the biofilm serves as lubricant layer.

In order to specify the carrier media requirement as well as the removal rates (not the surface area), the determination of the wastewater design temperature is required besides the general design data and hence, is indispensable for a comparison with competitors. Consequently, the water design temperature plays an important role in calculating the carrier media requirement. Anyone who wants to draw a comparison must carry out the latter under similar (equal) preconditions and hence while considering the same design temperature.

Only provided that the essential requirements are fulfilled, the design evidence including removal rates is available and large-scale references can be presented by the carrier media supplier, only then the risk can be assessed and be borne by the decision-maker.

To summarize, it can be stated that the biological removal rate which is calculated by the respective manufacturer – and not solely the surface area – serves to determine the removal target. During the plant operation, an optimal carrier geometry is a stringent requirement for appropriately meeting the biological demands and hence to ensure the optimal development of the biofilm.







Discover how the application of chip-tuning techniques transforms wastewater treatment processes, unlocking new levels of efficiency and effectiveness in managing water quality and process stability.

CHIP-TUNING: ENHANCING EFFICIENCY

Chip-tuning represents the pinnacle of efficiency enhancement. This drive for increased efficiency in both municipal and industrial wastewater treatment plants (WWTPs) arises from challenges related to water quality, process stability, and insufficient performance in COD removal and nitrification processes. The introduction of stricter regulations and the need for higher removal efficiency further emphasize the importance of optimizing existing technologies through "tuning".

ADDRESSING CHALLENGES IN WASTEWATER TREATMENT

In many cases, improving existing WWTPs and processes is challenging because achieving the required increase in removal efficiency is hindered by limited on-site reaction tank capacities. Consequently, expanding the WWTP becomes a necessity, which may not always be straightforward due to site-specific construction challenges. This situation is analogous to cartuning: enhancing an engine's performance by increasing its cubic capacity is often impractical, making chip-tuning a more viable alternative.

INCREASE WWTP EFFICIENCY WITH MUTAG BIOCHIP™

Existing WWTPs often experience shortcomings in their biological stages, which can be effectively addressed through tuning with Mutag BioChip™ high-performance biofilm carriers. This tuning process can also elevate WWTPs to achieve the highest possible treatment performance. By using chip-tuning with Mutag BioChip™ biofilm carriers, WWTP operators gain substantial benefits, including enhanced treatment

efficiency, consistent process reliability, and optimal discharge quality.

For new WWTP construction projects, the Mutag BioChip™ enables implementation on a compact footprint. Consequently, it offers significant advantages that surpass those of conventional biofilm carriers.

In the following sections, we will explore how the Mutag BioChip $^{\text{TM}}$ carriers have consistently delivered these advantages in both municipal and industrial large-scale applications over the years.

ENHANCING BOD/COD REMOVAL AND NITRIFICATION

Biological wastewater treatment plants play a crucial role in removing BOD/COD and, depending on discharge requirements, oxidizing ammonium through the nitrification process. This process involves the bacterial conversion of ammonium nitrogen (NH4-N) into nitrite (NO2) and subsequently nitrate (NO3) in two steps.

To create the ideal habitat for nitrifying microorganisms, the Mutag BioChip™ ensures that they have access to oxygen and essential substrates. This is vital because the size of the bacterial population largely depends on the available surface area for microorganism growth.

With its fine pore structure and protected active surface area, reaching up to 5500 m²/m³ which is roughly equivalent to an area the size of 21.1 tennis courts per m³, it creates highly favorable conditions for bacterial growth.



Mutag BioChip™.



Pore system at magnification.

THE MUTAG BIOCHIP™: A BACTERIAL HAVEN

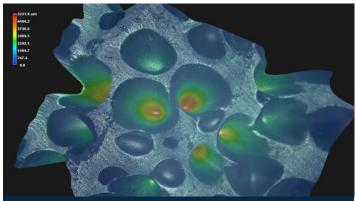
The carrier showcases a diameter of up to 30mm and a thickness of approximately 1.1 mm. Its surface features numerous closely spaced, open pores and channels, offering bacteria an ideal habitat. This habitat provides a significantly larger surface area compared to conventional biofilm carriers. Bacteria can flourish in exceptionally thin biofilms, not just within the pore system but also on the gaps between the pores, effectively covering the entire surface area.

BIOFILM FORMATION IN MBBR SYSTEMS

In a moving bed bioreactor (MBBR), shear forces between chip-shaped carrier media clean their surfaces during contact. Fostering the growth of thin biologically active biofilms. These biofilms remain accessible to oxygen and substrates across all layers.



Cross section through the pore system colonized by biologically active biomass, material thickness approx. 1.1 mm.



Scanning electron microscopic picture of the porous carrier surface, zoom factor 100.

LOW TARE WEIGHT AND OPTIMAL SUSPENSION

The Mutag BioChip™ boasts low tare weight relative to its surface area and require minimal energy for suspension in the MBBR tank. Its paraboloid shape like potato crips, encourages movement driven by process air and tank water turbulence. This low weight, combined with smooth movement and flexibility, minimizes kinetic energy upon impact, ensuring an extended lifetime. In contrast, larger, heavier carrier media experience increased abrasion and wear due to their higher kinetic energy.

OPTIMAL BIOFILM GROWTH AND ENHANCED BIODEGRADATION

The Mutag BioChip™ is ultra-thin. This feature ensures efficient oxygen and substrate diffusion to biofilm layers from both sides, with a shallow diffusion depth of around 0.5 mm. In contrast, carriers with thicker biofilms or dead biomass face challenges in achieving such efficient supply. Additionally, the substantial surface area fosters the growth of pollutant-removing microorganisms, allowing for significant chiptuning and remarkable enhancements in biodegradation efficiency. In retrofitted WWTPs, these advantages contribute to stable and consistent removal rates, thanks to the optimal habitats and generous surface area.

Our aim is to maximize the presence of active bacteria within small reactors. To achieve this, we analyzed the Mutag BioChipTM carriers previously used in a high loaded nitrification stage. We assessed their aerobic ammonium-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) content using advanced VIT ® gene probe technology.



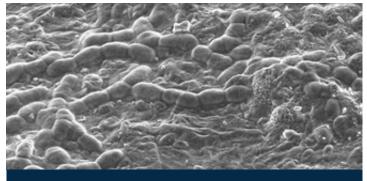
Mutag BioChip $^{\text{TM}}$ nitrification stage in the RAS of a sturgeon farm.



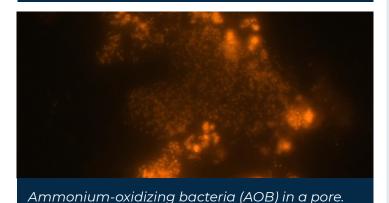
RESULTS

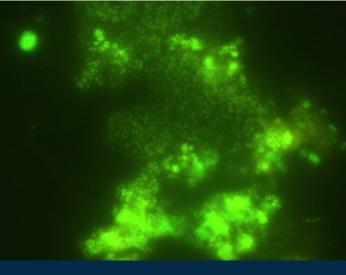
Results showed a stable population of both AOB and NOB on the Mutag BioChip™ carriers, highlighting their effectiveness in supporting these crucial microorganisms.

This demonstrates the success of Mutag BioChipTM carriers in providing an ideal environment for the proliferation of these crucial bacteria, all within a compact reactor space. We can efficiently reduce reactor volumes in the construction of new wastewater treatment plants. Additionally, we have the flexibility to allocate reserve capacities for potential future upgrades.

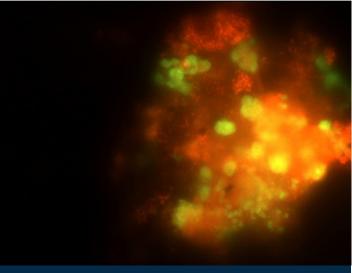


Biofilm in a pore of the Mutag BioChip™.





Nitrite-oxidizing bacteria (NOB) inside of a pore.



Both populations in one photo (AOB: red and NOB: Green).

OPTIMIZING WASTEWATER TREATMENT EFFICIENCY

Mutag BioChip™ has a proven track record of successful operation in various applications, including municipal WWTPs, coke oven plants for treating high-loaded and toxic effluents from gas cleaning processes, and numerous industrial WWTPs spanning industries such as pulp & paper, food & beverage, and chemicals.

Our products draw from decades of experience in applying conventional biofilm carriers in the MBBR. MUTAG serves as both the developer and producer of this exceptional high-performance biofilm carrier, ensuring reliable and efficient wastewater treatment solutions.





EXPLORING THE MAJOR BENEFITS OF THE MUTAG BIOCHIPTM

Multi Umwelttechnologie AG (MUTAG) has more than 20 years of experience working with various types of MBBR carrier media from around the world. Experience used when we developed the Mutag BioChip™. In the following sections, we will highlight the key advantages of the product.

HIGH REMOVAL PERFORMANCE

The Mutag BioChip[™] features an impressive, protected surface area of up to 5,500 m²/m³. In comparison, most competing products, as indicated by their respective suppliers, offer a significantly smaller surface area ranging from 500 to 800 m²/m³. Considering this specific aspect alone, the Mutag BioChip[™] demonstrates a significantly higher removal performance per m³ of carrier media. Furthermore, the Mutag BioChip[™] possesses additional distinctive features that enhance its removal performance.

DISTINCTIVE FEATURES

The biofilms inside the pores remain exceptionally thin, thanks to self-cleaning action caused by shear forces acting on the carrier's outer surface due to its movement in the wastewater. Thin biofilms are essential for optimal substrate and oxygen transfer from the water to the microorganisms in terms of biofilm diffusion depth. When tested alongside conventional media in comparative trials, the Mutag BioChip™ achieved biodegradation rates up to 6-10 times greater, despite having similar bulk volumes to conventional carriers.

THE PORE STRUCTURE

The Mutag BioChip™ features an extensively designed pore system, and it is worth noting that the biofilms develop within these pores. This unique pore structure offers protection to the biofilms, shielding them from potential mechanical disturbances, such as those caused by shear forces.

The motion of the carrier elements within the wastewater generates shear forces on the outer

surfaces of the Mutag BioChipTM carriers. These shear forces consistently wear away the biomass that grows from the pores. As a result, the biofilms remain consistently thin, ensuring optimal transfer of substrate, nutrients, and oxygen from the wastewater to all biofilm layers.

NO CLOGGING

Unlike numerous tube-shaped carriers that frequently encounter the problem of unintended and unregulated microorganism proliferation, referred to as clogging, the Mutag BioChip $^{\text{TM}}$ effectively avoids this issue thanks to its unique shape and motion attributes.

In contrast, clogged carrier elements are characterized by thick biofilms that hinder the supply of substrate, nutrients, and oxygen to the deeper biofilm layers. Consequently, these deeper layers are either minimally or not biologically active at all and furthermore, the thick biofilms reduce the available surface area for the attachment of active microorganisms, leading to a decrease in biodegradation capacity.





Unclogged Mutag BioChip™. Biofilm is only inside pores

WASTEWATER TREATMENT PLANTS

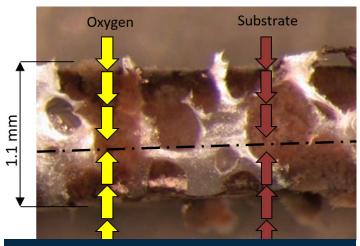
Since 2008, when it was introduced to the market, the Mutag BioChip™ has been operating effectively in numerous wastewater treatment plants across various countries. Since then there have been no reported instances of clogging issues associated with these systems. If desired, arrangements can be made to visit operational large-scale reference WWTPs for firsthand observations.

RELIABLE PERFORMANCE FOR PROCESS STABILITY

The removal performance stays consistently high, all thanks to the naturally regulated thin biofilms on the Mutag BioChipTM, as previously explained, which are maintained at this optimal thickness through the self-cleaning action of shear forces. This means there is no decline in performance due to the formation of thick biofilms, as often seen with conventional tubular carriers. This stability in the biological treatment process is of paramount significance, particularly for end-customers and regulatory authorities, as it guarantees the consistent attainment of the necessary effluent parameters without any exceptions.



Pore system of the Mutag BioChip™, ensuring durably thin biofilms for optimal diffusion of substrate, oxygen and nutrients into all layers. Any biomass expanding out of the pores is permanently removed by shear forces.



Mutag BioChip $^{\text{TM}}$ cross section; substrate and/or oxygen can diffuse into the biofilms down to a depth of approx. 0.5 mm on both sides of the chips. This is possible due to the chip thickness of approx. 1.1 mm.

REDUCED TANK SIZE, LOWER CONSTRUCTION COSTS

The exceptional biodegradation performance of the Mutag BioChip™ carrier enables the use of a smaller carrier volume compared to conventional carriers, as it offers a similar protected active surface area with less volume. This advantage is financially beneficial to customers, resulting in cost savings through reduced tank volumes. Furthermore, it proves to be a vital feature in situations where space for constructing a new WWTP is limited.

SEAMLESS UPGRADES THANKS TO RESERVE CAPACITY

When utilizing tank volumes of similar magnitude as those used with conventional carriers and replacing conventional carriers with Mutag BioChipTM, the media filling level tends to be quite low due to higher surface per m^3 of carriers.

The advantage of this lower media filling is that it allows for the maintenance of a reserve media filling capacity. This reserve can be activated effortlessly by adding more carriers until the same filling ratio is achieved as with other carriers.

RESERVE CAPACITY FOR WASTEWATER PLANT FLEXIBILITY

This feature becomes particularly valuable in situations where a wastewater treatment plant faces increased loads or higher volume flows, possibly resulting from an uptick in production at an associated industrial facility. With conventional carriers, which lack such reserve capacity (as 60% media filling is considered the maximum), achieving a straightforward upgrade of treatment capacity becomes impractical. The only option in such cases would be to construct additional reaction tanks, resulting in significant costs for the costumer.

UNLOCKING ENERGY SAVINGS POTENTIAL

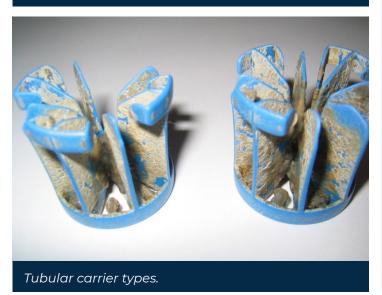
The unique shape and specific density of the Mutag BioChipTM, when colonized, result in distinct motion characteristics that demand less energy for agitation, such as process air supply. To keep the carrier suspended in wastewater. Utilizing the Mutag BioChipTM presents wastewater treatment plant operators with the opportunity to achieve substantial expenditure (OPEX) savings.

UNDERSTANDING ABRASION AND WEAR

Each element of the Mutag BioChip™ media possesses a remarkably low mass relative to its size. Consequently, when these elements interact with one another, the force transferred is so minimal that it effectively reduces the possibility of abrasion and wear to a minimum.



Abrasion of carrier media in operation.





Foam carriers before and after operation - abraded.



Clogged tube-shaped carrier.

MORE THAN JUST PLASTICS: OUR EXPERTISE

The development of the Mutag BioChip™ was based on extensive experience gained from operating various types of conventional biofilm carrier media. Additionally, MUTAG has amassed a substantial database of process data through numerous pilot trials and the operation of numerous large-scale plants that utilize this high-performance carrier.

Leveraging extensive data, MUTAG provides valuable resources to carrier media clients, including design calculations, equipment advice, technical support, and after-sales service for various processes like MBBR, IFAS, or Anammox. Additionally, the company specializes in engineering wastewater treatment plants using Mutag BioChipTM carriers, covering both basic and detailed aspects.





HOW TO AVOID MICROPLASTICS IN WASTEWATER TREATMENT

The term "microplastic" was coined many years ago to describe tiny plastic particles smaller than 5 mm

There are two types: those intentionally made for practical use (e.g. for products like cosmetics) and those formed from larger plastic items breaking down as waste.

Microplastics continue to be a concern in water treatment and wastewater facilities, leading to many discussions about their impact on aquatic environments and aquaculture water systems.

PROTECTING WATER TREATMENT INNOVATIONS

For decades, the moving bed biofilm reactor technology (MBBR) has played a crucial role in water and wastewater treatment, becoming indispensable in many applications. These MBBR reactors use various types of carrier media for the immobilization of microorganisms.

However, a concerning issue has come to light: the plastic elements used as biofilm carriers in MBBR reactors are contributing to microplastic pollution in water bodies. This is problematic because these plants are designed to purify water.

MICROPLASTIC RELEASE FROM PLASTIC CARRIERS

In MBBR systems, plastic carriers have always been used. However, because of their shape or material properties, there is a risk that they release tiny plastic particles through rubbing or degradation.

One type, soft foam cubes made of PU (polyurethane), has shown significant wear,

leading to the need for replacement due to visible signs of deterioration.



Foam-type carrier: virgin material (left) and abraded material (right).



Abrasion of carrier media in operation.

UNDERSTANDING WEAR AND MICROPLASTICS IN MBBR SYSTEMS

Wear in MBBR systems happens due to rubbing, collisions between carriers, and interactions with tank walls and internal structures. Material properties and kinetic energy are key factors.

Lower carrier mass and slower movement in water reduce wear. Ideally, carriers would stay still, but water flow and aeration cause movement.

Carrier geometry, like hollow bodies, can trap inactive biofilms, increasing mass. This biomass does not contribute to substance exchange or metabolism and unnecessarily adds weight, leading to more wear, including microplastic release.



Carrier with signs of abrasion.



For comparison: clogged carrier (left) and unclogged carrier (right).

ECO-FRIENDLY MBBR CARRIERS: A CLEANER FUTURE

Unlike hollow bodies or foam cubes, thin chiptype carriers do not wear down. This has been demonstrated in many plants running for over a decade. The reasons are intricate but make sense. These carriers are lightweight thanks to their solid HDPE foam structure, and their outer protective ring acts like a cushion, preventing abrasion.

A thin chip, about 1.1 mm, allows active biomass to grow on both sides, getting substrate and oxygen for optimal diffusion. This chip stays free of dead biomass, keeping kinetic energy low.

Its shape and slow movement help minimize kinetic energy. The biofilm acts like a protective layer, preventing abrasion. These carriers do not release microplastics and works efficiently.







Biological Water Treatment



The latest generation of MBBR/IFAS media with extremely high removal rates



The Mutag BioChip™ for extremely high removal rates and reliable process stability.

Mutag BioChip™ is used for the immobilization of microorganisms which are in charge of the different biological water treatment processes for challenging industrial and municipal wastewater.

The treatment processes are aerobic and/or anaerobic/ anoxic and can remove even very large pollutant loads in small footprint systems. This means that the treatment tanks can be made much smaller than with traditional plants, and existing plants can be optimized, furthermore reducing energy consumption and thereby total costs significantly.

Large active surface area

Microorganisms need a high and fully available protected surface area for highly efficient biological water and wastewater treatment. It is not the volume of carrier, but the area of the active protected surface which is important.

The large surface area of the Mutag BioChip™ (up to 5,500 m2/m3) provides extremely high removal rates and process stability, especially in nitrification, COD removal and denitrification.





The Mutag BioChip™ is completely free from phthalates and other plasticizers. It does not contain any questionable compounds which may be harmful to the environment. Furthermore, it does not emit microplastics. We work with serious partners and suppliers and demand the highest quality from them. Our production runs on green energy from wind-turbines. We always focus on using the newest technology in our production to reduce our carbon footprint.

We support the Sustainable Development Goals - UN 17 World Goals - especially no. 6, that focuses on water quality, clean water and to use wastewater better.

The high performance and many advantages of the Mutag BioChip™, as well as the high and strong quality of the material, has been proven in more than 800 applications all over the world.

Mutag BioChip™ has a protected surface area of up to

 m^2/m^3



What is so unique and innovative about the solution with Mutag BioChip™



...characteristics
which prove that the
Mutag BioChipTM is
unique on the market:

PRODUCT DATA:

Material:	virgin Polyethylene (PE)
Size:	ø 30.0 mm
Thickness:	1.1 mm
Specific gravity:	0.95 kg/l
Bulk weight (net):	165 kg/m3 (±2.00%)

INCREASED SURFACE AREA:	Larger surface area = potential major bacterial growth in the pores of the carrier media, which results in a higher concentration of biomass that leads to reduced volume requirements
REDUCED ENERGY CONSUMPTION:	Reduced energy consumption for aeration and mixing (compared with conventional carrier media)
SECURITY FOR BIOMASS:	Security for the bacteria colonization due to the special surface with high-quality pore system
OPTIMAL DIFFUSION DEPTH:	Control of the biofilm thickness and therefore an optimal diffusion depth for substrates and oxygen. No limitation to the biological processes
SELF-CLEANING:	Self-cleaning carrier media which ensures a thin and always active biomass
NO DEAD ZONES:	Avoidance of dead zones which means that the entire surface area is used for the biological processes
LONG LIFE MATERIAL:	Paraboloid shape and protection ring ensure no signs of wear and tear. Long lifetime of the material without substitution
EASY RETROFIT & UPGRADE:	Ideal to add when there is no possibility to build new tanks or no space left. All plants are easy to manage and to operate
LOW PRODUCTION OF SLUDGE:	Low sludge production due to thin and controlled biomass
WIDE-RANGE APPLICATION:	Designed to be used in all biological treatment applications



ABOUT MUTAG:

MUTAG is a knowledge-driven company, working with biological, sustainable, and high-technology water treatment processes. Building on more than 20 years of practical experience, we are one of the leading manufacturers of Bio Media for biological water and wastewater purification.

We take the responsibility for the future as well as our planet serious and want to make a real change in the battle of ensuring clean water as an accessible resource on earth for everyone.



KNOWHOW AND SERVICE:

- · MBBR plant design
 - Design of process air supply
 - · Design of carrier retention screens
- · Tank design
- · Process engineering
- \cdot Support during construction
- · Commissioning
- · After Sales Service

WHAT WE ARE:

MUTAG is one of the preferred partners within the field, due to our experience, knowledge sharing as well as product and process optimization. Globally, and not least because of our approach to biological water treatment - contrary to chemical water treatment. Our method & philosophy are green, and our product is many times more efficient than market alternatives

THIS IS WHAT WE DO:

At MUTAC, we know the value of integrated solutions. We have the experience and competence to calculate and design, advise, and qualify, deliver, and implement as well as offer subsequent analysis, service, and optimization. We take water treatment seriously and prefer working as all-round partner to ultimately achieve the most optimal conditions and results together.

THIS IS WHAT YOU GET:

MUTAG provides design and carrier media for biological wastewater treatment plants, an excellent Engineering Service and support for all specific customer needs and requirements.

The outstanding quality of the material as well as the high-tech structure of the surface and the fine pore system, are only a few of the many benefits you can gain from this media.



