CHIP-TUNING FOR BIOLOGICAL WASTEWATER TREATMENT PLANTS

CHIP-tuning is the epitome of increase in efficiency.

The demand for efficiency improvement in municipal and industrial wastewater treatment plants (WWTPs) is increasingly based on problems related to the water quality, process stability and/orVinsufficient performance in the COD removal and/or nitrification process.

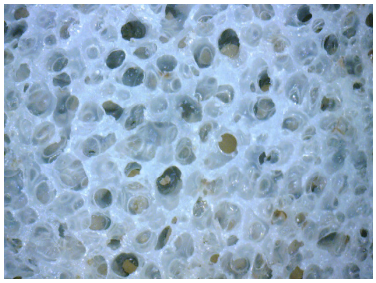
New, stricter requirements or the need for higher removal efficiency intensify the demand for optimizing the existing technology by means of "tuning".

In many cases, an optimization of existing WWTPs and processes is hardly possible to perform since the required increase in the removal efficiency cannot be realized due to too small reaction tank volumes on site. Hence, an expansion of the WWTP would become necessary whereas this is not always easy to implement due to the constructional situation on site. This is similar to car tuning: increasing the performance of the car's engine via increasing its cubic capacity is hardly feasible but performing a CHIP-tuning would be a much better way.

Deficiencies occurring in the biological stages of existing WWTP's can be optimally eliminated by means of tuning with Mutag BioChip 30™ high-performance biofilm carriers. Alternatively, WWTPs can be brought to highest possible treatment performance. By performing a CHIP-tuning with Mutag BioChip 30™ biofilm carriers, the WWTP operator significantly benefits from higher treatment efficiency, constant process reliability and optimal discharge quality. WWTPs which are subject to new construction can be implemented on very small footprint. Hence, the Mutag BioChip 30™ provides crucial advantages which are significantly superior to those of "conventional" biofilm carriers.
In the following, it is explained how the Mutag BioChip 30™ carriers and its previous model are able to provide these advantages which they have been showing with great success in municipal and industrial large-scale applications for years now.

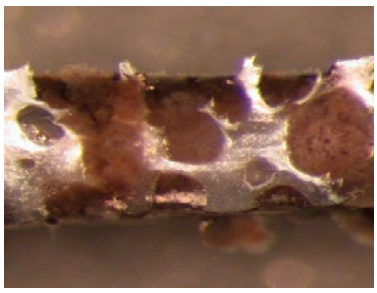
The main tasks of biological WWTPs are BOD/COD removal and, depending on the discharge requirements, also the oxidation of ammonium by means of nitrification process which is to be understood as the bacterial oxidation of ammonium nitrogen (NH4-N) in two steps via the oxidation of the latter first to nitrite (NO2) and subsequently to nitrate (NO3). For this purpose, the nitrifying microorganisms must be sufficiently provided with oxygen and other substrates. The maximum population size of the bacteria depends however on the surface area available for the growth of microorganisms. Due to its fine pore structure and its protected active surface area of up to 5,500 m2/m3 (1,677 ft^2/ft^3) which corresponds to the area of 21.1 tennis courts per m^3, the MUTAG BioChip 30™ provides the optimal habitat conditions to the bacteria.

Mutag BioChip 30™ carrier media (up to 5,000 m^2/m^3 = 1,677 ft^3), virgin PE without any plasticizers.

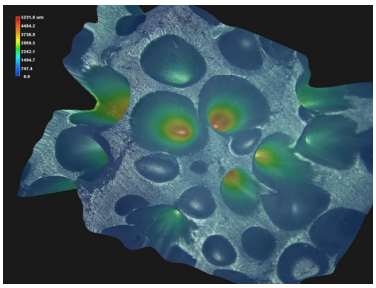


Pore system at magnifacation (zoom factor 40).

The Mutag BioChip 30™ carrier has a diameter of up to 30 mm (1.18'') and a thickness of approx. 1.1 mm (0.043''). Its surface shows a large number of closely spaced, open pores. These open pores and channels provide to the bacteria an optimal habitat at the surface area size mentioned above which accounts for a manifold of the surface area size provided by "conventional" biofilm carriers. On the entire surface area, i.e. not only inside the pore system but also on the spaces between the pores, the bacteria can grow in the form of optimally thin biofilms.
Due to the shear forces occurring on the mutual contact of the chip-shaped carrier media in the moving bed bioreactor (MBBR), the surfaces of the single carrier elements clean each other without any mechanical abrasion effects and allow for the growth of permanently thin and biologically active biofilms whereas all layers of these biofilms are completely accessible to oxygen and substrates.



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.

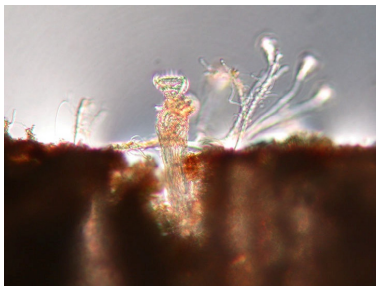
Mutag BioChip 30TH nitrification stage in the ras of a sturgeon farm.

The Mutag BioChip 30™ has a very low tare weight related to the provided surface area, and can optimally be kept in suspension in the MBBR tank by means of low energy to be supplied. The slightly paraboloid shape – comparable to the well-known potato crisps – promotes the carrier movement caused by process air supplied for oxygenation and by the water turbulences in the tank. Due to the low tare weight in conjunction with the optimal and smooth movement in the water, the kinetic energy occurring on the carrier media elements impacting the tank wall and/or other surfaces is remarkably low (negligible) and allows for an absolutely long lifetime. Larger and heavier carrier media types tend to increased abrasion and wear due to their higher kinetic energy.

Due to the low material thickness of approx. 1.1 mm (0.043''), the biofilms on the Mutag BioChip 30™ surface are optimally supplied from both sides with substrate and oxygen. Here, it has to be taken into account that the diffusion depth of substrate and oxygen is approx. 0.5 mm (0.019685'') and both oxygen and substrate can diffuse into all layers of the biofilm from both sides of the chip-shaped carrier media. Compared to this, the optimal supply of oxygen and substrate to the biofilms on other carrier types is not granted due to thicker biofilms and/or due to dead biofilms/ dead biomass (clogging/siltation).

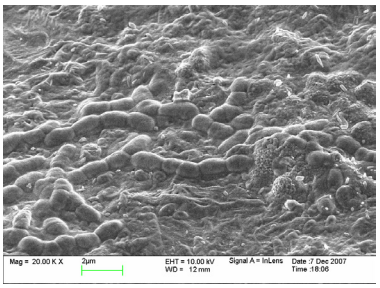
The actual CHIP-tuning for optimizing the biodegradation efficiency by a multiple of it is allowed for by the large surface area (up to 5,500 m^2/m^3 = 1,677 ft^2/ft^3) which is completely available for the growth of pollutant-removing microorganisms. In retrofitted WWTP's, the removal rates were observed to be much more stable and constant, which can be ascribed to the optimal habitats as well as to the large surface area.

The target is to activate a maximum of the population of biologically active bacteria in the smallest possible volume of the reaction tank(s).

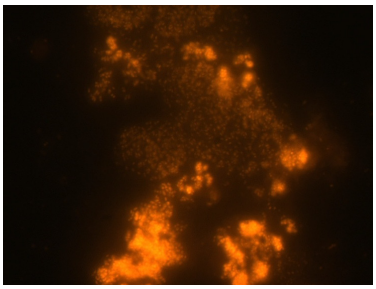


Habitat "pore" of the MUTAG BioChip 30™.

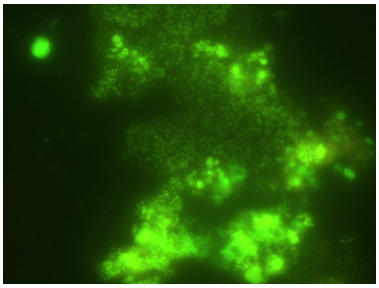
Mutag BioChip 30™ carriers previously operated in a high-loaded nitrification stage were examined in terms of their content of aerobic ammonium-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria
(NOB). For this purpose, the moleculobiological VIT® gene probe technology was applied. As a result, a very stable population of AOB and NOB was identified.



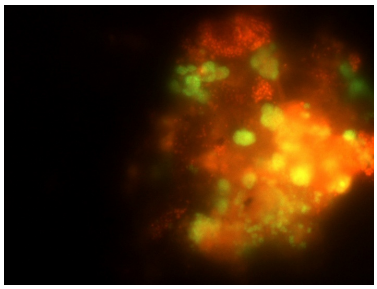
Biofilm in a pore of the Mutag BioChip 30™.



Ammonium-oxidi-zing bacteria AOB) in a pore.



Nitrite-oxidizing bac-teria (NOB) inside of a pore.



Both populations in one picture (AOB in red color and NOB in green color)

Taking into account the very high biodegradation performance of the Mutag BioChip 30™ carrier media and its previous model, the reactor volume can be reduced accordingly within the new construction of WWTPs, or reserve capacities can be considered for potential upgrades which might become necessary in the future.

For years, the Mutag BioChip 30™ and its previous models have been operated with great success in municipal WWTPs; in coking plants for treating high-loaded, toxical effluents coming from the gas cleaning process; as well as in a vast number of industrial WWTPs, for example in the pulp & paper, food & beverage and chemical industry, just to name a few of them. The application range reaches from BOD/COD removal, nitrification, de-nitrification and Anammox process to the treatment of high-loaded, nitrogen-containing and toxical coking plant effluents coming from the gas cleaning process. The Mutag BioChip 30™ and its previous models are products developed by Multi Umwelttechnologie AG based on the company's decades-long experience in the application of "conventional" biofilm carriers in MBBR process, whereas Multi Umwelttechnologie AG is not only developer but also producer and distributor of this unique high-performing biofilm carrier.

With regard to environmental and health-related aspects, it is important to know that the Mutag BioChip 30™ is exclusively made of virgin PE material (no re-granulates from recycled material) and does not contain any plasticizers which are under strong suspicion of being carcinogenic.

The Mutag BioChip 30™ material is very flexible, abrasion-resistant, and it does not break under pressure stress. Any unfoamed biofilm carriers with larger hollow spaces (small tube type, fan washer type, molded media) do not provide any suchlike buffer and, once exposed to pressure, they can get damaged very easily or get fine hairline cracks which may lead to a complete breakage at a later point of time.

Multi Umwelttechnologie AG does not offer the supply of complete WWTPs but is able to provide assistance and constructional support in the design of MBBR tanks as well as of the related aeration and carrier media retention systems based on the decades-long experience gained in the field of MBBR technology. On request, Multi Umwelttechnologie AG can also provide process-related assistance during commissioning and normal operation.

SUMMARY OF MAJOR BENEFITS

- efficiency upgrade in existing systems
- best water quality
- higher, constant process stability in case of fluctuations in the process conditions
- smaller new plants or larger reserve capacities (reduction of reactor volume)
- less transport volumes in shipment at similarly large surface area
- long lifetime due to flexible, abrasion-resistant material
- low mixing energy requirement in the MBBR tank
- virgin PE (no recycled material) without any carcinogenic plasticizers
- optimal supply of substrate and oxygen to the microorganisms due to thin biofilms
- support in the designing or engineering of the aeration and carrier media retention systems
- economical benefits in the price comparison per m^2 of protected active surface area

MUTAG

Multi Umwelttechnologie AG | Zschopauer Straße 105 | D-09126 Chemnitz
Telephone +49 371 / 83 65 20 55 | Telefax +49 371 / 83 65 20 51 | email info@mutag.de

WWW.MUTAG.DE