MBBR process

The Moving Bed Bio Reactor process (MBBR process) which is also known as biological fluidized bed process is a biological wastewater treatment process using purifying microorganisms which are growing within a biofilm that is being immobilized on an artificial carrier media. Hence, the MBBR process belongs to the biological biofilm processes used in the wastewater treatment. Contrary to the Fixed Bed Reactor process, the carrier elements are not fixed but they are moved freely in suspension inside the reaction tank.

Often, tiny and only a few centimeter sized plastic elements, mostly made of polyethylene, are used as carrier material. These carriers usually possess internal bridges, lamellae or bulges in order to increase the potential area for the attachment of biofilms. With regard to the structure and the active surface area, the offered materials are not comparable and/or classifiable. Related to the size of the active surface area available for the immobilization of microorganisms, the so called “Mutag BioChip™“ high-performance carrier media - developed by the German company Multi Umwelttechnologie AG – is significantly outstanding. Thanks to its protected active surface area of more than 3,000 m² per cubic meter of bulk volume, the carrier can be colonized by an astonishingly large amount of biomass which leads to extremely high biodegradation rates.

A crucial factor in the Moving Bed Bio Reactor process is the sufficient and frequent contact between the wastewater components and the microorganisms attached to the carrier (biofilm). The necessary mixing of the carrier elements in the reactor (reaction tank) can be sufficiently attained by means of the process air supply required in aerobic treatment processes. In anaerobic treatment processes, the carriers in the reaction tank can be moved properly by pumping water or by using immersed, slowly-rotating mixers.

The characteristics and quality of the biofilm establishing on the carrier surface is not only influenced by shear forces in the tank but also by the composition and the loads of the pollutants in the wastewater (substrate). The more the wastewater is polluted with biodegradable pollutants, the more intense and the faster the growth of biomass. In waste-paper-processing industries, where the MBBR process is often used for treating the highly polluted wastewater, only a few days may be required for reaching the biofilm growth and the aspired pollutant removal efficiency whereas the thickness of the biofilm can even be multiple millimeters.

Both the transport of the oxygen and the dissolved substrates to the microorganisms embedded in the biofilm as well as the removal of the metabolites from the biofilm happen by diffusion. Depending on the oxygen concentration and the composition of both the biofilm and the substrates, the diffusion depth usually is in the range of approx. 100 and 500 micrometers. Problems caused by a decrease in biodegradation efficiency are largely a consequence of an intense thickness of the biofilms, resulting in a reduction of the active carrier surface area.

With regard to this, the Mutag BioChip™ is completely different: the biofilms, which are colonizing the pores of the Mutag BioChip™ and which try to grow out of the pores due to their mass growth, are being kept constantly thin by shear forces. These shear forces evolve on the outsides of the carrier elements due to their movement in the water, and provide the self-cleaning effect of the Mutag BioChip™. Consequently, the biofilms remain constantly thin whereas they are protected from the shear forces only inside the pores. With regard to the diffusion depth, thin biofilms are crucial for an optimal supply of the microorganisms with substrates (removable pollutants and nutrients) as well as with the oxygen required for the aerobic biodegradation processes. In this way, the Mutag BioChip™ allows for the achievement of constantly high biological removal rates and reliable process stability.

High-performance carrier media Mutag BioChip™

The Mutag BioChip™ is a high-performance biofilm carrier which provides an extremely large specific active surface area of >3,000 m^2 per m^3 of its bulk volume for the immobilization of microorganisms, and which is mainly used in Moving Bed Bio Reactor processes (MBBR process).

The carrier media has been specifically developed for the biodegradation of carbon and the elimination of nitrogen in industrial as well as in municipal wastewater treatment plants and, due its specific characteristics, it can be used equally for aerobic, anaerobic and anoxic processes. The results are extremely high removal rates in denitrification, nitrification and COD eliminination process.

Comparative trials using both the Mutag BioChip™ and “conventional” carriers in parallel, show in a direct comparison that up to 90 % less filling volume of Mutag BioChip™ is required for reaching equally high performance rates. Hence; crucial in the treatment process is not the applied volumetric amount of carrier media but the size of its specific protected active surface area available for the growth of an optimal biofilm. As already mentioned, the Mutag BioChip™ high-performance carrier provides an active surface area of more than 3,000 m^2/m^3 which is proven in numerous large-scale applications and also scientifically certified by means of nanostructure measurements of the carrier surface area.

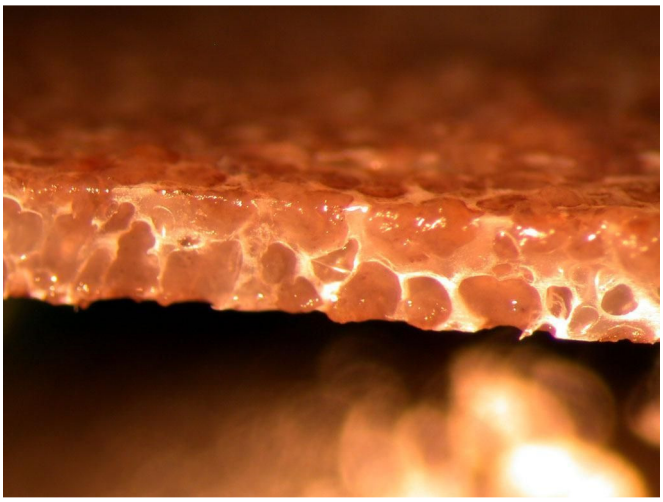
Even with regard to procedural aspects, the Mutag BioChip™ is superior to “conventional” carrier media: its parabolic shape allows for a homogenous mixing of the Chips in the tank as well as for the active biofilm being optimally kept in the water flow. Hence, the supply of the microorganisms with substrate and oxygen is ensured at any time and at any load condition.

Furthermore, the surface of the carrier is self-cleaning by means of shear forces which occur upon the movement of the carrier media in the water. Hence, clogging resulting in a negative impact on the substrate supply is impossible with the Mutag BioChip™. Contrary to that, hollow carriers mostly possess internal areas which tend to clogging by sludge deposits.

The operation and efficiency of the Mutag BioChip™ directly affects the wastewater treatment plant technology in a positive way. For example, treatment plants which are to be newly constructed can be designed considering significantly smaller tank volumes than they would be on applying “conventional” carrier media.

Reflecting on the dimensioning of reaction tanks with regard to future increases of the treatment performance of wastewater treatment plants, reserve capacities in the media filling degree can be realized in advance and do not require any physical alterations. These reserve capacities can be activated by simply adding more carriers.

Similarly, upgradings and performance increases of existing plants can be implemented easily, inexpensively and quickly by replenishing or replacing existing “conventional” carrier media with Mutag BioChip™ carriers.



Environmental pollution caused by plasticizer in carrier media for the biological water and wastewater treatment

The MBBR-Technology is becoming more and more important in the biological water and wastewater treatment sector. The application of plastic carrier media for the attachment of microorganisms allows treatment plant upgrades resulting in highly increased pollutant removal rates. Among others, these biofilm carrier media are also used in the aquaculture sector for the oxidation and elimination of nitrogen. However; abraded material, decomposition products and other substances released by the plastic carrier elements enter into the water cycle; they are directly ingested by fish and enter into rivers, lakes and oceans, and consequently into the human food chain.

Undefined synthetics mostly of unknown origin, such as plastic re-granulate for example, can release **bisphenol A (BPA)** and **phthalates,** which may cause cancer and have hormonal effects.

Biologists already found these substances in human blood and as deposits in human organs. Low-molecular **phthalates** (phthalate acid esters) turned out to be problematic since their toxicity is potentiating in conjunction with other substances, as scientifically proven. Furthermore, **phthalates** are suspected of causing diabetes.

Without plasticizers, hollow bodies for the water treatment (i.e. biofilm carrier media; small plastic wheels) made of brittle plastics would break due to a lack of elasticity. The plasticizer shifts the thermoplastic range to lower temperatures, resulting in the fact that the plastic material shows the desired “more elastic” characteristics within the range of the operation temperature.

Bisphenol A (**BPA**), used as an antioxidant in plasticizers, is a chemical compound of the group of diphenylmethane derivatives and of one bisphenol. The A stands for acetone. Bisphenol A is made from two equivalents of phenol and one equivalent of acetone. Obviously, BPA can influence the hormone balance and can also affect the function of enzymes and carrier proteins. Experiments executed with tissue samples from mice and humans have shown within the scope of a study that BPA irreversibly blocks calcium channels in the cell membrane which are important for the cellular function.

Environmental pollution caused by plasticizers is not necessarily to occur in the biological water treatment, and especially not in the aquaculture.

The company Multi Umwelttechnologie AG has developed a high-performance carrier media for the biological water and wastewater treatment named Mutag BioChip™, which has numerous advantages compared to conventional carrier media (hollow bodies, small plastic wheels, wafer-type chips). Due to its porous structure, this sustainable biofilm carrier is optimized especially in its material quality and does hence not contain suchlike plasticizers causing the mentioned negative side effects.

The Mutag BioChip™ is completely free from phthalates or other plasticizers and does **not** contain Bisphenol A or any other aromatic compounds. It is made of virgin polyethylene (no recycled PE), inorganic fillers, small amounts of monoester of glyceric acid (produced from coconut fat; absolutely harmless), citric acid and soda Na_2CO_3.

Mutag BioChip™ - for the sake of the environment.

Please see www.mutag-biochip.com

Christian Börner, March 2014