

The right choice of biofilm carrier media used in MBBR-Technology

You will proverbially face the agony of choice upon looking for the best suitable biofilm carrier media for the MBBR-Technology in your biological wastewater treatment plant. However; when making up your purchase decision, you should not be misled into buying low-cost products for your individual case of application. The carrier-based biofilm technology for the biological wastewater treatment is known since the 19th century and particularly for this application, a wide range of different types, shapes and materials has been developed during the last decades, contemporaneously to the development of plastics engineering.

The disadvantages of the so called carrier are not often recognized and are rarely made available to third parties by means of publications. Here, the same principle as in every market applies: each vendor or manufacturer claims to provide the “best” product. At a first glance, this topic seems to be familiar and after all, each purchaser of biofilm carrier material does not necessarily have to be an expert in this field. The purchase of a new vehicle is surely more familiar.

In the case that you should face such an important decision, please make sure to pay attention to the points described below.

First of all, it is important to specify and to determine the required biodegradation rates as an objective for the removal rates of the biodegradable substances in order to perform the design calculations, i.e. the calculation of the required amount of carrier material. By doing so, you should consider operation-related fluctuations in the pollutant concentrations of the wastewater – as long as they should not be equalized in the system upstream of the MBBR stage. Hence, every wastewater treatment solution expert should or has to, respectively, ask his customer about the influent and effluent conditions, possible toxic contaminants, application-related basics and the design temperature in order to be in the position to advise and to supply appropriately. Not only the influent and effluent parameters but also the minimum temperature and the biological/biochemical metabolism conditions are a part of the calculations. A slight deviation from the basic parameters gives ample scope to the supplier of which he will mostly take advantage of.

Hence, the first basic rule is to create an appropriate basis for each supplier which the suppliers have to strictly adhere to. This should be explicitly shown and confirmed in their related quotations.

With regard to the basic design, it is crucial to know the biodegradation rates which the supplier calculates with and which he is able to give a proof of in terms of his individual biofilm carrier. The frequently indicated active carrier surface area is indeed an indicator for the potential biodegradation performance of the carrier media, but crucial is the specification of the biodegradation performance in kg [pollutant] per m³ [carrier media] per day. The latter can refer to the COD/BOD or nitrogen load to be removed. As a result, there can be made statements regarding the required quantity of carrier media which is defined in a verifiable indication of the carrier media weight related to the volume as well as in the price related to the biodegradation efficiency per day.

Compared to the familiar purchase of a vehicle, not the engine displacement but the guaranteed speed in km/h or the maximally possible towing capacity in kg is of significance.

After having bindingly specified the aforementioned information, one should give thought to the type of the material of the carrier media and the material density. The plastic carriers offered in the market are usually made of (polyethylene [PE]) virgin material or of more affordable re-granulates (recycled material). In order to simplify the subject, let us confine to the re-granulates. The origin and the composition of the said material cannot always be exactly specified and the re-granulates may hence consist at significant percentage of different plastics which may have a negative impact on the durability (solidity, break resistance). The material density under operating conditions is of major importance. Due to the various types of the recycled plastic materials and their previous applications, re-granulates can show up a significant deviation and fluctuation in the material density. These deviations can only be rarely and consistently adjusted to new density states during the production process. A consequence of this can be a deficiency in the desired carrier movement characteristics.

A repeatedly discussed topic in the specialist press is the usage of plasticizers which can be contained in re-granulates. These plasticizers can also be applied by the manufacturer in order to adjust the material characteristics to the necessary requirements. As a future operator of a MBBR system, one should evaluate – depending on the application e.g. aquaculture, koi farming, etc. – if he would like to use carrier media possessing such negative characteristics. Undefined plastics mostly of unknown origin, such as plastic re-granulate for example, can release **bisphenol A** and **phthalates** which may cause cancer and have hormonal effects. Moreover, low-molecular **phthalates** (phthalate 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.

The Mutag BioChip™ biofilm carrier is completely free from any 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 (made from coconut fat; absolutely harmless), citric acid and soda (Na_2CO_3).

After having made up the decision on whether to use a product made of virgin material or of re-granulates, another important decision has to be made.

What is more of advantage in terms of the application: a dimensionally stable molded (PE or PP) extruded carrier, or a mechanically stressable (i.e. flexible) material? Dimensionally stable carriers often possess the disadvantage of breaking even at small mechanical stress. Furthermore, they get increasingly abraded which is due to their stiffness being stressed by kinetic energy within the MBBR (no crumple zone as available in a vehicle). Fractions at the bridges of the carriers are hence not unusual (please refer to the picture below).



A flexible and simultaneously highly wear-resistant material is more likely to be used. Sponge-type carriers are flexible indeed but they show signs of abrasion already after a short operating period. Contrary to this, highly fine-porous chip-type carriers (Mutag BioChip™) are offering all of the desired characteristics such as a high wear resistance, flexibility, virgin material and many more.



Depending on the sewage quality and the metabolic load, the carrier material may tend to excessive attachment of biomass. Tube-shaped carriers possess the negative characteristic of biomass accumulating within the inner area of the carrier. This biomass cannot be discharged and dies due to a lack of substrate supply and in aerobic applications due to a lack of oxygen supply. The dead biomass is hence blocking the active carrier surface area required for attaching biologically active biomass and reduces the biodegradation efficiency. Thin, fine-porous disk carriers (Chips) with an average thickness of approx. 1.0 mm (coin) have the advantage that the oxygen and the substrate can diffuse from both sides into the carrier to a depth of 0.5 mm. Consequently, the biofilm can be held active and will not die due to clogging.



The pictures above show several carriers which have been applied together with the disk-shaped carrier (Mutag BioChip™) in the same wastewater. Neither a clogging nor an abrasion of the chips can be observed.

Moreover, the transportation costs for the total carrier quantity as well as the filling periods are as important as a proper commissioning instruction and the support in the choice of the carrier media retention system and the aeration system.

After having reflected on the basics regarding the performance, shape, stability, wear resistance, plasticizers and their possible impacts as well as on the clogging aspect, there is one relevant factor remaining to be mentioned.

The provider or supplier of your choice, respectively, should be able to provide procedural support in the design basics as well as own plant-related references, enabling the plant operator to benefit from a wide range of substantive operational data. After the purchase, the buyer of the carrier media should be provided by the supplier with support in operational and biological matters, based on practice-oriented expert experience since in practical wastewater treatment, there are applications again and again in which technical support can be of major assistance. As with the purchase of a vehicle, not the vendor matters but the after-sales service does.

Do not let your choice get unbearable.

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