Energy saving diffuser systems

A specialty of the OTT Group

OTT GROUP

Up to 50% of the electricity consumption of a modern sewage treatment plant is accounted for by the blowers that convey the air into the aeration tanks.

Compared to conventional diffuser systems, the air volume required to achieve the required oxygen transfer can be significantly reduced by a combination of efficient diffusers and an optimized diffuser arrangement in the tank. This increase in efficiency enables energy savings of up to 50 % while maintaining the same oxygen transfer.

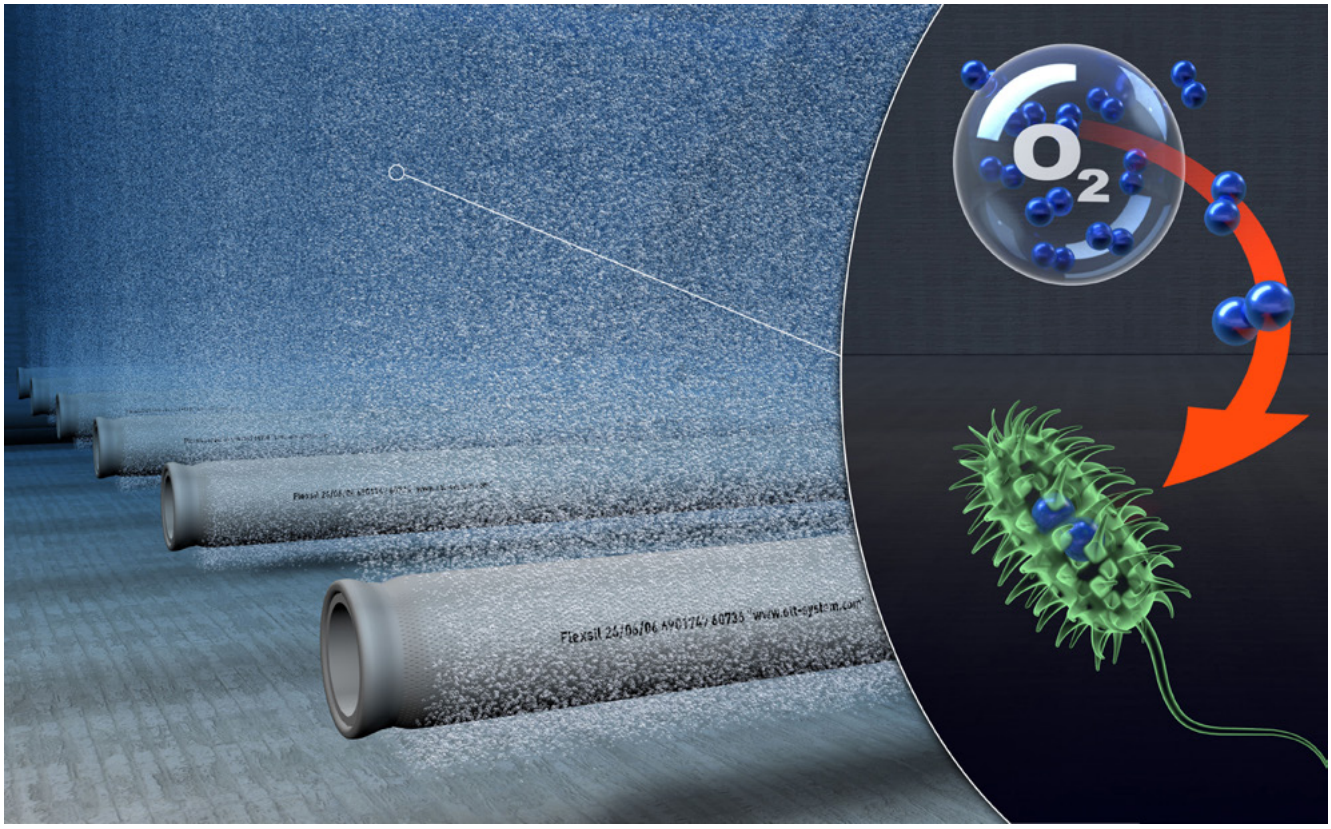
Due to high electricity costs in Germany, we at OTT already started researching diffuser system possibilities for optimizing energy in the mid-90s. As a manufacturer of diffusers and membranes, we have worked extensively on membrane materials, perforation processes and production methods. The influence of these parameters on the performance of the diffusers and the importance of the arrangement of the diffusers in the tank to maximize the energy efficiency of a diffuser system has been developed in close cooperation with universities, conducting measurements, and documenting results.

Today we have more than 20 years of operating experience with energy saving diffuser systems.
Many of the approximately 1000 HE® systems in service have been operated for more than 10 years without requiring maintenance. They continue to sustain reduced energy costs of municipal and industrial sewage treatment plants today.

→ Energy savings through reduction of the air volume

Modern wastewater treatment plant diffuser systems use membrane diffusers to introduce air in the form of air bubbles into the aeration tanks. A part of the oxygen contained in the air bubbles is transferred to the wastewater to support the biological process. This allows the metabolic degradation and purification processes to take place.

The wastewater is supplied with oxygen via the introduced air



The energy consumption of the blowers is mainly determined by the air volume.

The following applies: The more air the blowers deliver, the more energy they consume.

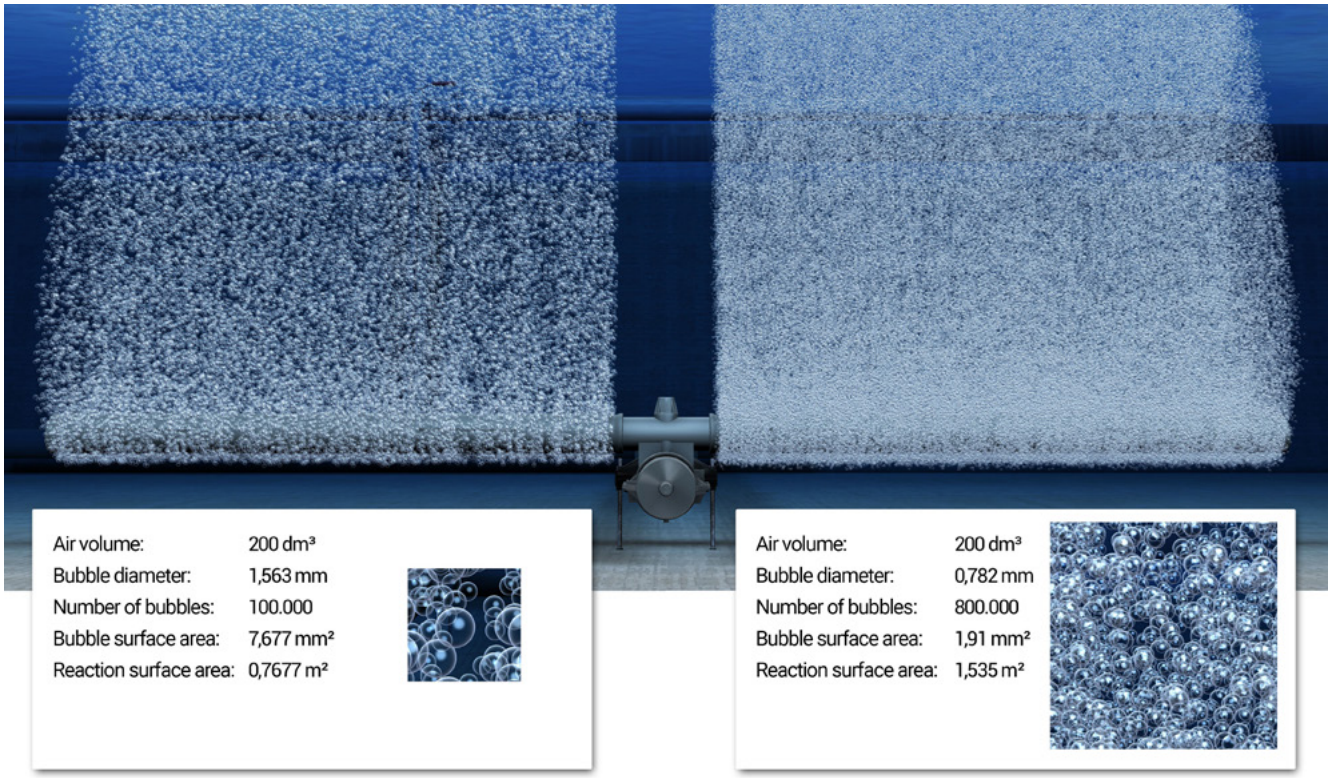
The air volume necessary to deliver the required dissolved oxygen level is determined by how much and how quickly the oxygen is transferred from the air bubbles to the wastewater.

This oxygen transfer is determined by the size of the reaction area of the air, its residence time in the tank and the oxygen concentration gradient between air bubbles and wastewater.

→ Many small air bubbles expand the reaction area

The transfer of oxygen from the air bubble to the wastewater takes place at the surface of the air bubble. The greater the cumulative surface area of all air bubbles in the tank, the higher is the overall surface area between the air and wastewater interface, the most decisive factor influencing the oxygen transfer reaction. It is therefore useful to introduce the air into the wastewater in the form of many small air bubbles to achieve the best oxygen transfer.

Increasing the reaction area by splitting the air volume into small air bubbles



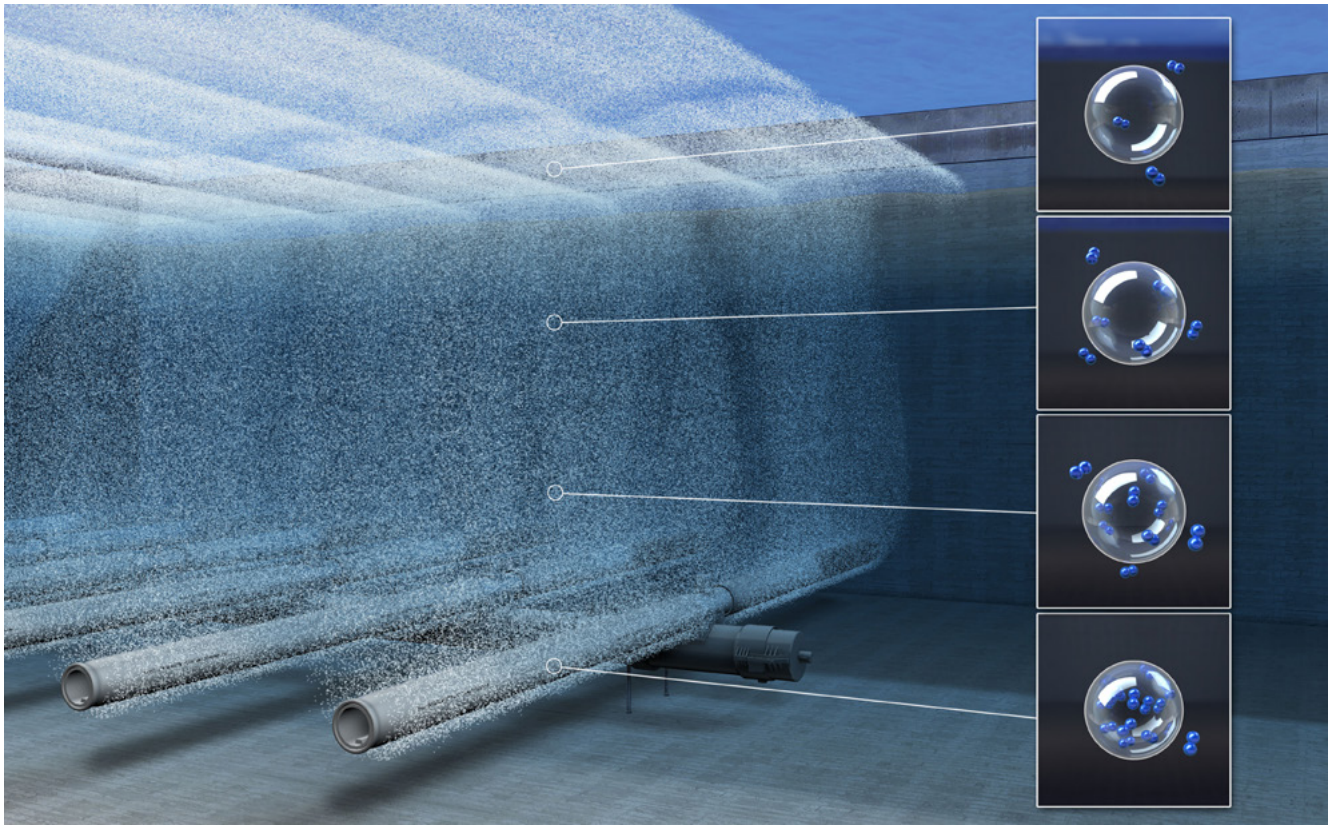
→ Thanks to small perforation slits and a good release behaviour, we guarantee continuous fine bubbles

All OTT membrane diffusers are very finely perforated. Depending on tank depth and oxygen demand, we determine the bubble size for each project and perforate the membrane accordingly.
In order to consistently achieve the intended air bubble size, it is important that the air bubble quickly releases from the membrane as it exits the perforation slit in the membrane. This is because air bubbles that adhere to the membrane for a longer period of time inflate and become larger than intended.
OTT membrane materials and manufacturing techniques enable quick release of the air bubbles uniformly over the entire surface. Thus, OTT diffusers are able to produce particularly fine bubbles.

→ Slowly rising air bubbles increase the oxygen transfer

Slowly rising air bubbles release more oxygen into the wastewater than rapidly rising ones. That's because the slower ascent allows more residence time for the oxygen transfer to occur from the air to the wastewater.

On its way from the bottom of the tank to the water surface, the air bubble continuously releases oxygen to the wastewater



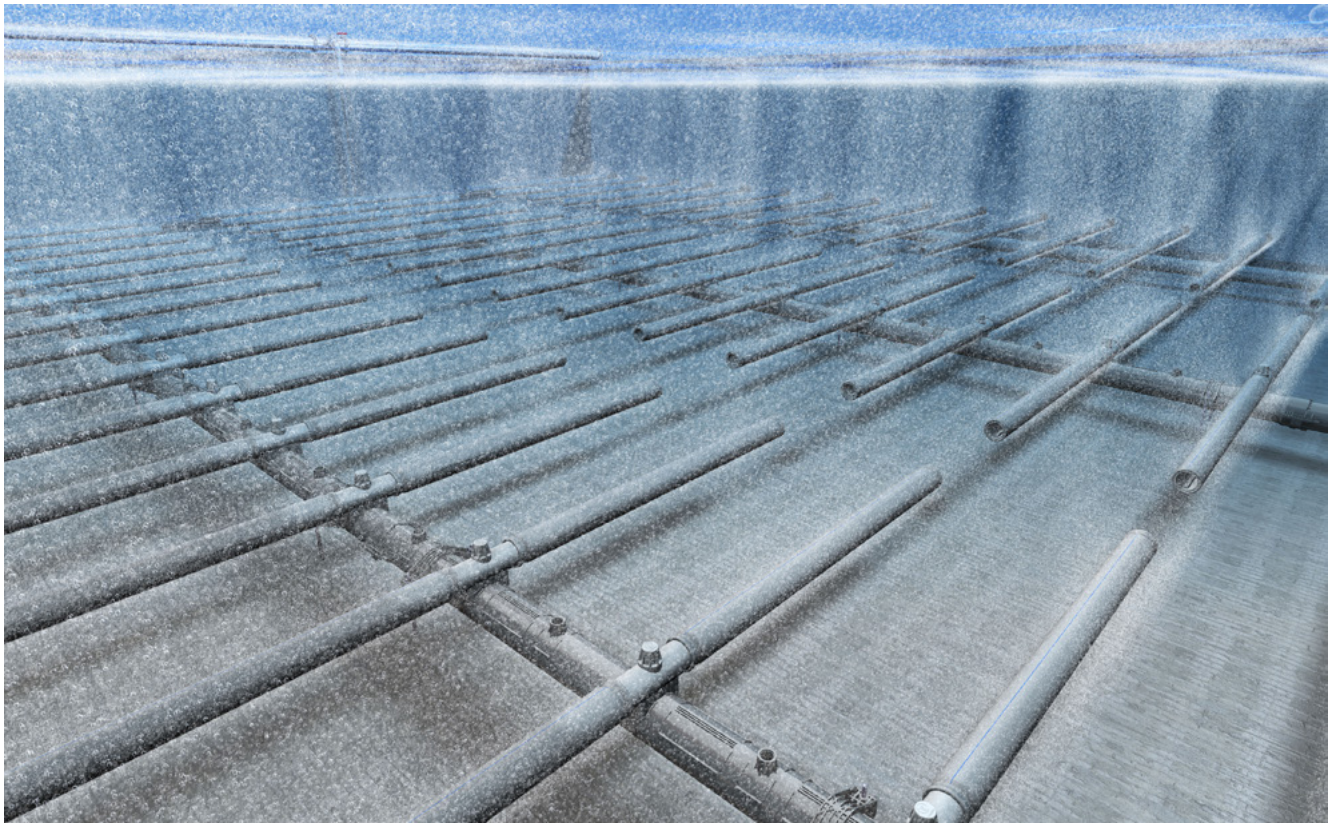
→ The air bubbles rise more slowly due to the low pressure of the diffusers

The increase of the reaction area via the small bubbles increases oxygen transfer. In this way, it is possible to transfer more oxygen from less air. Consequently, a reduction in air volume means that the air is introduced through the membrane into the wastewater with less energy.
Thus, the fine air bubbles rise correspondingly slower and the resulting oxygen transfer occurs at a higher energy efficiency.

→ Complete mixing of the wastewater with air increases the oxygen transfer

As soon as the air bubbles enter the wastewater, diffusive mass transfer begins and oxygen exchange from the air to the wastewater occurs automatically, thereby adjusting the oxygen concentration between the two media. The greater the oxygen concentration gradient between air bubble and wastewater, the faster the oxygen is transferred. For a fast oxygen transfer, it is therefore important that the air bubbles along their ascent path come into contact with as much oxygen-deficient wastewater as possible.

A two-dimensional diffuser layout increases the oxygen transfer



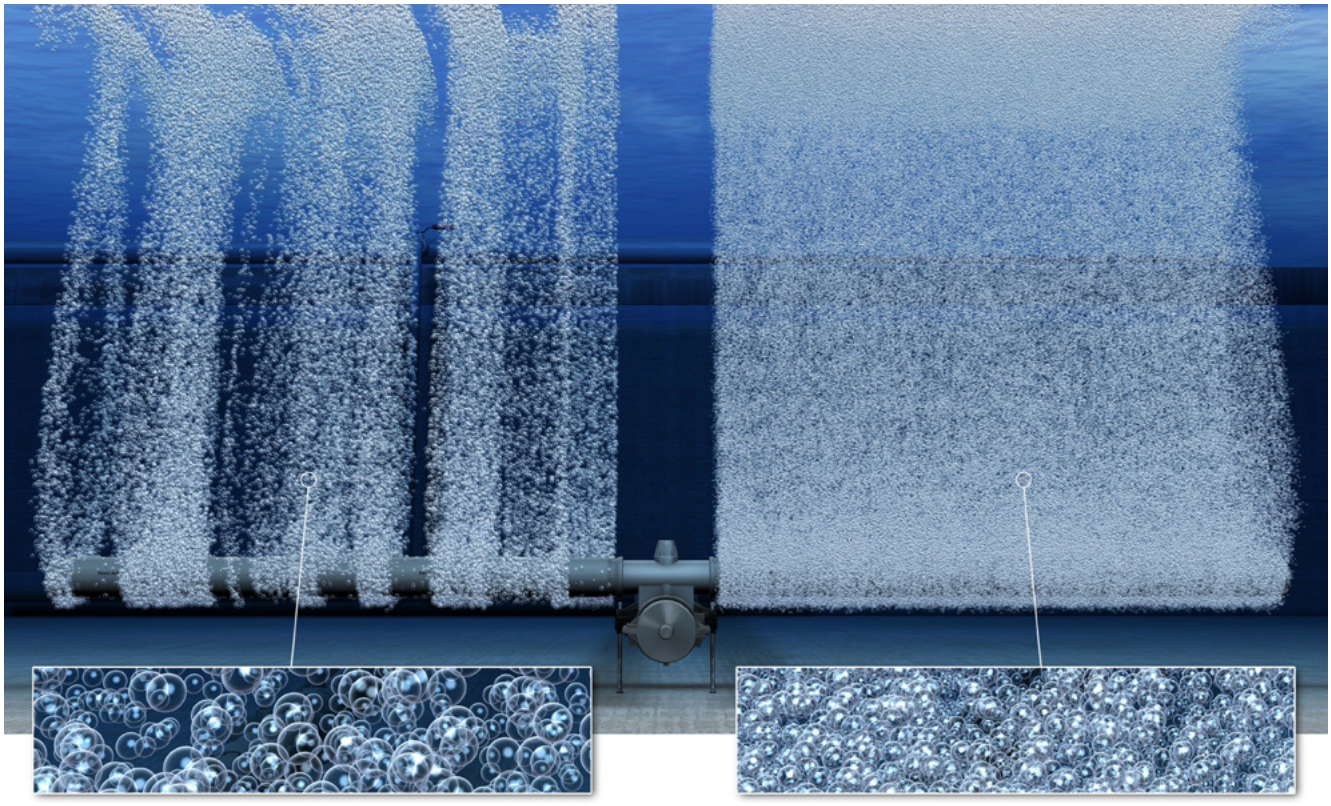
OTT HE® systems are designed in such way that as much tank area as possible is covered by the diffusers. This aerates the entire wastewater volume and increases the oxygen transfer.

→ Uniform aeration: this is why OTT diffusers are more efficient than other brands

To generate the optimum number of air bubbles, it is important that all diffusers in a system diffuse the air uniformly and that the diffusers pass the air over the entire membrane surface.

There is only one way to produce air bubbles in the required number and size > Uniform Diffusion.
If all diffusers did not diffuse uniformly, the system produces fewer air bubbles. A non-uniform diffusion also leads to a different concentration of air bubbles within the cluster of bubbles. This creates turbulences that promote the joining of air bubbles, increasing their size. Both conditions reduce transfer efficiency.

The dense and uniform bubble cluster of OTT diffusers is the basis for the great energy savings

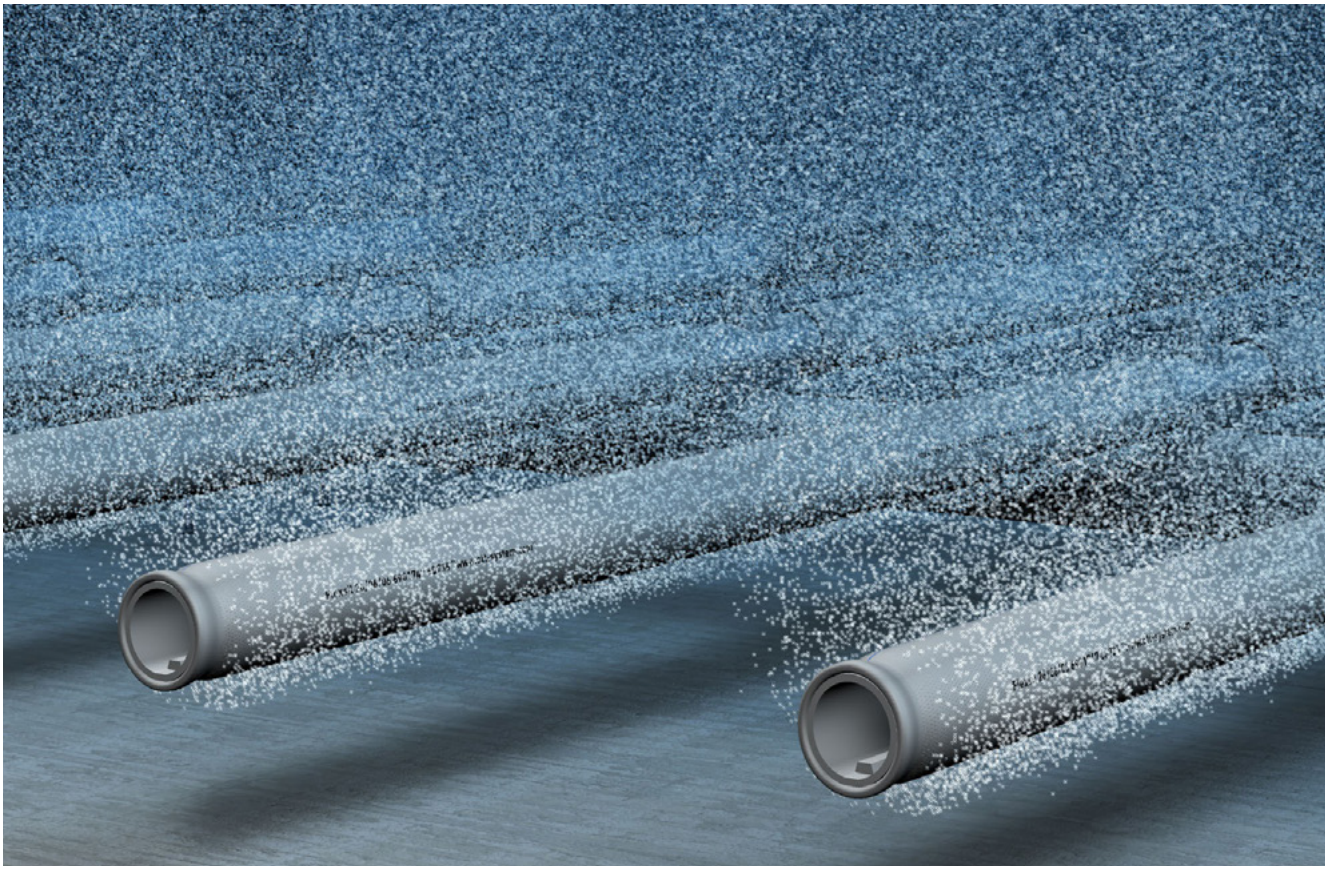


The opening pressure of the perforation in the membrane determines whether all diffusers in a system diffuse uniformly and over their entire surface. When the opening pressure is uniform throughout the system, the air is distributed evenly and the same amount of air passes through each perforation slit. To ensure this, we manufacture our membranes in such way that the opening pressure of all membranes of a system lies within a pressure margin of +/- 4 mbar (0,059psi). The result is an even and dense cluster of bubbles diffused into the wastewater at the desired bubble size.

→ Dimensioning of HE® systems

HE® systems are designed according to the project requirements using the OTT simulation software. Based on the tank geometry and the required oxygen transfer, an algorithm accesses a database having measurement results from various oxygen transfer tests and calculates possible system configurations.

**Many diffusers =
many air bubbles =
high efficiency**



Physical laws prove the following: many diffusers = many air bubbles = high efficiency.
But many diffusers also mean a larger investment. Therefore, the dimensioning of an HE® system is always a balancing act between budget and operating costs. In most cases, the chosen configuration is therefore a compromise between efficiency and investment.

→ Reducing investment costs and lowering operating costs

The high performance of the HE® systems results in energy savings of up to 50 % in the production of compressed air.

As a rule, the additional capital costs of HE® systems compared to a conventional diffuser system are amortized within one to two years and full amortization is achieved within five to eight years.
With new installations or conversions, one can not only expect lower operating costs. The reduction in the air volume also reduces the required blower capacity as well as the required pipe sizes to distribute the air. In this way, the overall capital investment is often lower with this approach.

→ OTT HE® systems – a possibility for rapid capacity expansions

In addition to potential energy savings in the blowers, HE® systems can also extend the capacity of an aeration condition due to their high efficiency.

In this case, the aim is not to reduce the air volume, but to maximize the oxygen transfer. The construction of an additional aeration tank can often be avoided.

Industrial companies or municipal operators with an urgent need to increase treatment capacity within a short time can upgrade their existing wastewater treatment plants through an approach that maximizes oxygen transfer. An HE® system can be quickly and cost-effectively integrated into any aeration tank without interfering with existing control systems and operating methods. And all without the need for work on the concrete or other excavation work.

Make an impression for yourself

Get a first-hand impression of the performance of the HE® systems. We will gladly arrange contact with operators of HE® systems. Have a chat about the operating experience or take a look at measurement reports from various external institutes.

Send us your tank dimensions and the required oxygen transfer rate. We will provide you with an economic efficiency calculation and simulate a diffuser layout free of charge. Share the requirements of your project with us We look forward to working with you!