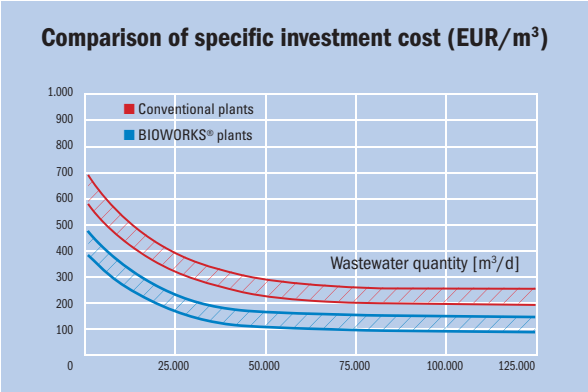
THE CLEAR SOLUTION

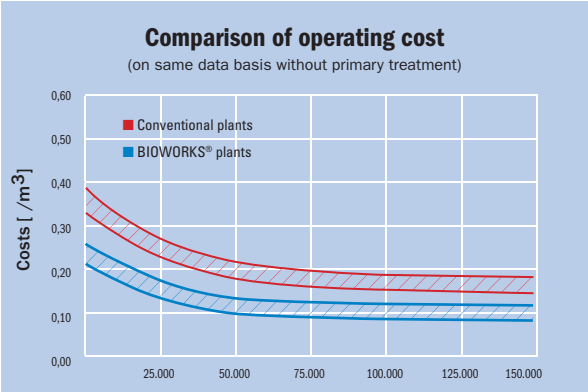
BIOWORKS®
Verfahrenstechnik GmbH

Our company profile

At a time when water is labelled „the oil of the 21st century“, clean water has become our most valuable resource and is under continuous global demand. BIOWORKS® Verfahrenstechnik GmbH is your experienced and reliable partner for wastewater treatment with highly effective technology and efficient process solutions.

Wastewater treatment systems is our special field of expertise. BIOWORKS® is a global player with many years of practical experience in engineering, supply, execution and commissioning of wastewater treatment plants. Our highly experienced team is able to help and assist with almost any wastewater situation.





BIOWORKS® Verfahrenstechnik GmbH can offer design and supply for the following single process steps, which in the end add up to the complete treatment plant concept:

- Mechanical pre-treatment
- Sand and grease removal
- Highly efficient fine bubble aeration systems
- Clarifier and settling equipment with sludge removal
- Filtration (Sandfilter, clothfilter, membranefilter)
- UV-treatment or chlorination
- Sludge treatment and dewatering

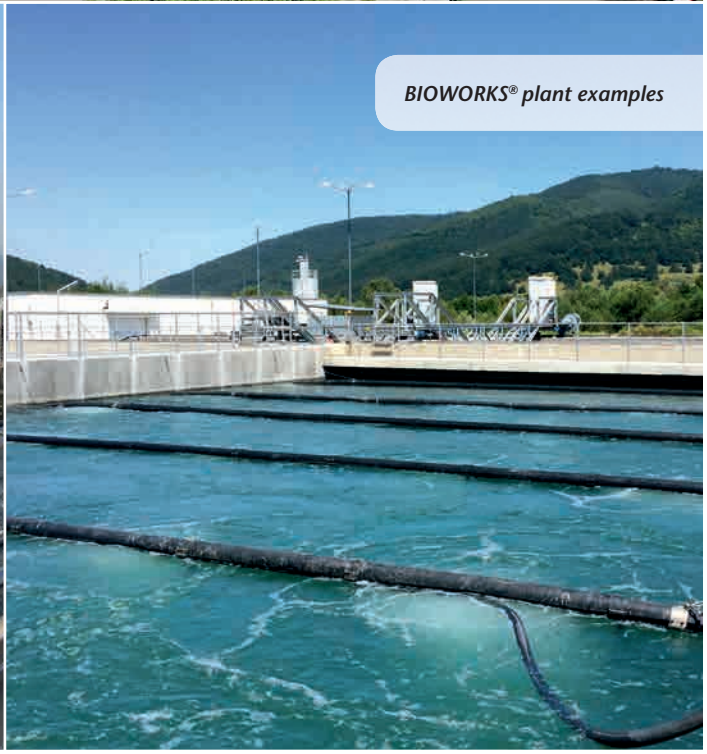
Our project management team will work closely with the client and consulting engineers, from conceptual design phase until commissioning.

Efficiency

Our goal is to make each treatment plant as efficient as possible. For that we have numerous tools at our disposal. For example our special BIOWORKS® design and construction type (p. 5,6,7), the in-house developed aeration system OXIWORKS® (p. 8), structured and successful internal project management (certified according to ISO 9001) and last but not least our competence as system provider, who takes full responsibility from design to commissioning cost effective operation.

Our services don´t stop with commissioning. Trouble-free operation of a treatment plant is an important cost factor. We assist our clients with O&M and provide consulting and training of the O&M personnel. This enables the owner to operate his plant with best possible effluent results, low energy demand and as efficient as possible.

BIOWORKS® headquarter in Putzbrunn, Germany



BIOWORKS® plant examples

Clean water:
The most challenging task
of our time

Safety and reliability

Safety and reliability are key factors in this sensitive area of environmental technology. That's why we, as process designer and equipment provider offer a process guarantee for our design.

BIOWORKS® stands for core values like sustainability and reliability. Almost all of our highly qualified and experienced engineers have been working at BIOWORKS® for many years, thus providing continuity and stability. Our business philosophy is highly focussed on the clients' requirements and always in his best interests.

Dialoge and partnership

Our experience tells us: Our clients need real partnership. A deep understanding on the local requirements and standards is necessary.

BIOWORKS® cooperates with international partners/ representatives and utilizes a global network which can serve the local specific project requirements regarding design and execution. Furthermore personal dialogue and presence are important for success. Our expert staff travels to the project location and is communicating directly with our partners, our clients and local consultants. BIOWORKS® is always prepared to go to any place in the world, in order to analyze the situation and to find working process solutions for even the most serious wastewater problems.

We can proudly say that up to now we were able to cope even with the most challenging requirements.

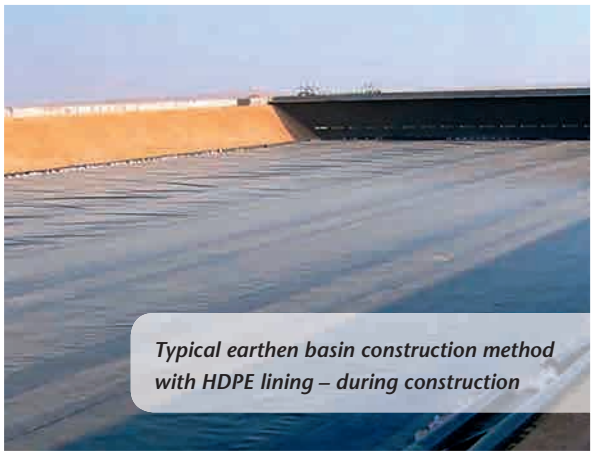
Integrated clarifier with sucking scraper bridge.
Hydraulic capacity 30.000 m³/day

made in Germany

The special basin design: safe, durable and cost effective

Concrete is not always the best building material: BIOWORKS® is utilizing earthen basin type with HDPE lining and compact module construction.

Conventional wastewater treatment plants are mostly using concrete tanks. However concrete is not very cost effective and construction is time consuming. BIOWORKS® offers the possibility to use earth basins with HDPE lining (high density polyethylen), a method which is inherently less costly. The basin is simply excavated and the dug out soil is re-applied on the outside dam. The HDPE liner is rolled out onto the basin surface and welded together to form an impenetrable water sealing. This type of construction is durable and has been approved for many decades. It is providing the client with the safety of latest European quality and security standards and regulations.



Typical earthen basin construction method with HDPE lining – during construction

The advantages:

- Superior lifetime: Concrete basins, in particular when exposed to corrosive sewage, can be seriously damaged within just a few years. Instead HDPE lining has been proven to be very durable and has sustained integrity for more than 30 years (for example in landfills)
- Significantly lower investment costs
- More safety because – contrary to concrete – the flexible earth basin construction with HDPE lining is not sensitive to underground settling or earthquakes.
- Drastically reduced construction time (only a third of concrete tanks)
- Very large process volumes are possible at low cost, this directly benefits the treatment process.

One basin module integrates several treatment steps

Traditional wastewater treatment plants commonly combine several concrete tanks which are interconnected by pipes. The BIOWORKS® process requires only one basin module which is separated into several single treatment steps (p. 6).
Consequently the clarifier is a part of this module. The main advantages are:

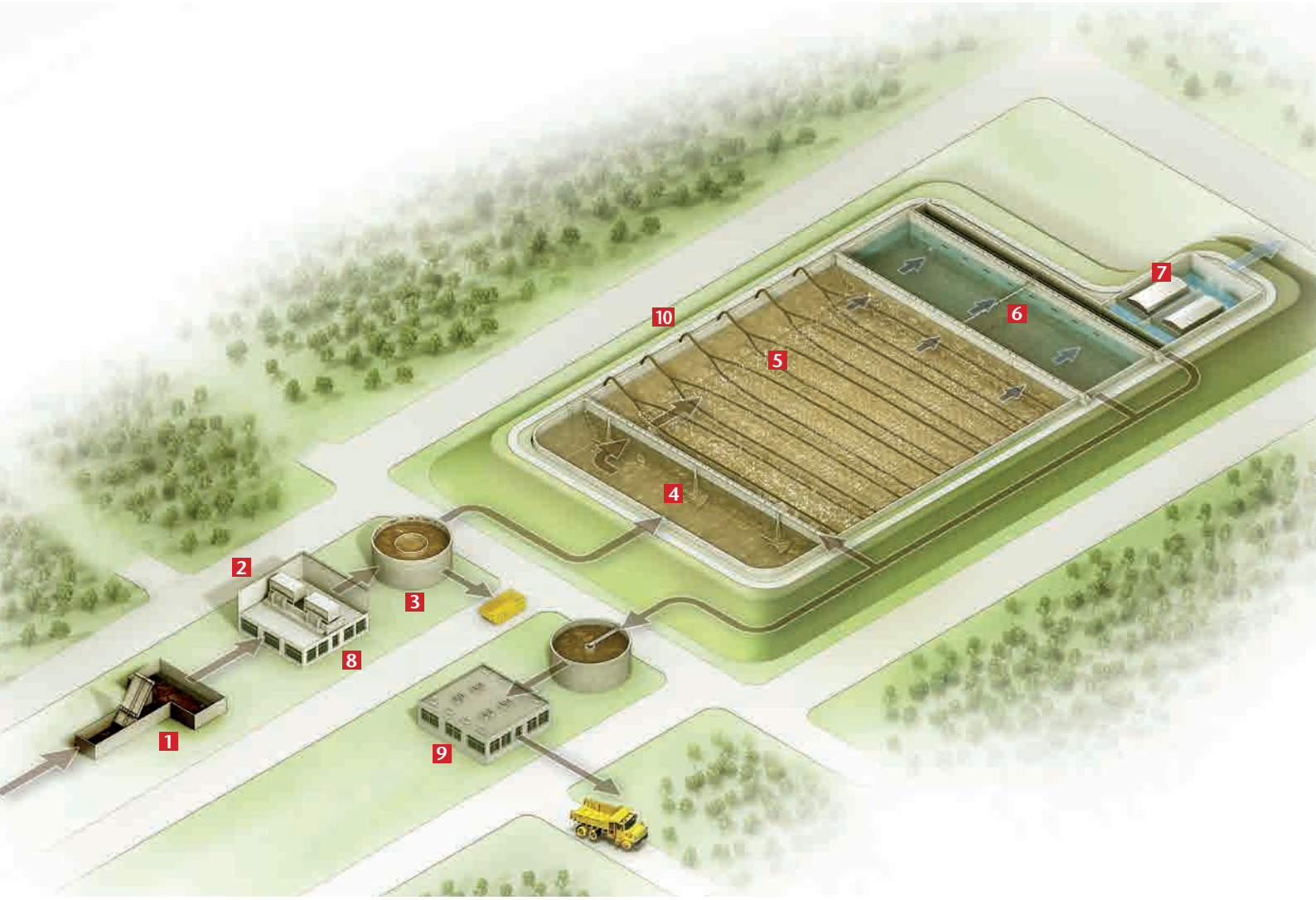
- reduced footprint because of compact construction.
- wastewater is flowing by gravity through the single treatment steps. No interconnecting pipework or external pumping stations are required.

A clarifier does not need to be circular – the geometry

Traditional clarifiers are usually circular. This design may cause hydraulic problem, in particular during high flow, when turbulences at the center inflow and stirrup of settling sludge may occur. Often the inflow must be calmed down by additional measures such as deflecting baffles. BIOWORKS® uses a rectangular clarifier design (p. 7), which avoids such problems and optimizes the settling of the sludge. The advantages of this favorable geometry are significant. The direct common wall connection to the aeration basin results in a wide inflow area , therefore very low inflow velocities are possible and the sludge will settle without disturbance.

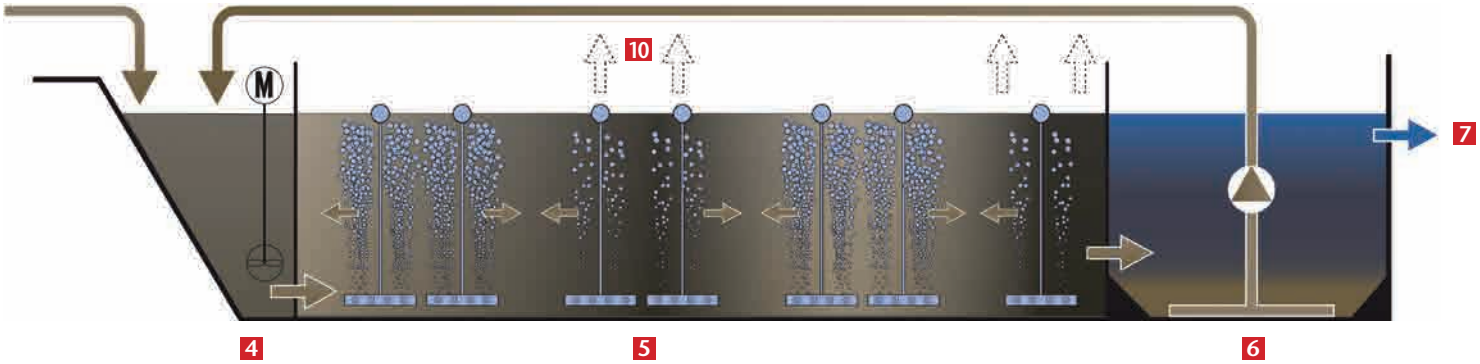
Efficient and economic wastewater treatment

Worldwide rising awareness for the protection of our environment requires increased standards for wastewater treatment, carbon, nitrogen, and phosporous compounds have to be eliminated to the greatest possible degree. The BIOWORKS® process guarantees our clients that this target is achieved, under low investment and O&M costs.



Typical single process steps of a BIOWORKS®-treatment plant:

1 Coarse screen/pumpstation. 2 Fine screening with high level of separation. 3 Sand and grease removal. 4 Anaerobic Bio P-zone for enhanced P-removal. 5 Activated sludge basin with aeration system OXIWORKS® for improved nutrient removal and low O&M costs. 6 Integrated clarifier: Turbulence free geometry and optimal sludge settling. Highly effective sludge removal and recycle system. 7 Effluent and tertiary treatment if required. 8 Central control: simple, reliable and fully automated operation – low personnel demand. 9 Sludge dewatering and further treatment. 10 Automated denitrification.



The biological stage within the BIOWORKS® process

Wastewater contains many nutrients in the form of carbon and nitrogen compounds, phosphates, proteins and other components.

After mechanical pre-treatment 2 + 3 the biological process starts with the Bio-P zone 4. Robust and low maintenance submerged stirrers are mixing the inlet with return sludge. In this selector basin organic acids are created under an anaerobic ambient, this enables the bacteria in a later aerobic stage to absorb more phosphates than usually. Effluent values of total P < 1 mg/l without chemical dosage are possible under the condition of favourable nutrient composition.

The water-sludge mixture flows through the separation wall into the aerobic reactor.

The most important process step is conducted in the activated sludge basin 5. Carbon and nitrogen compounds in the wastewater are aerobically digested by the various kinds of bacteria living in this basin. The aeration system OXIWORKS® enables the bacteria to work as efficient as possible, while the whole basin is mixed properly and efficiently by the fine bubbling suspended aeration system.

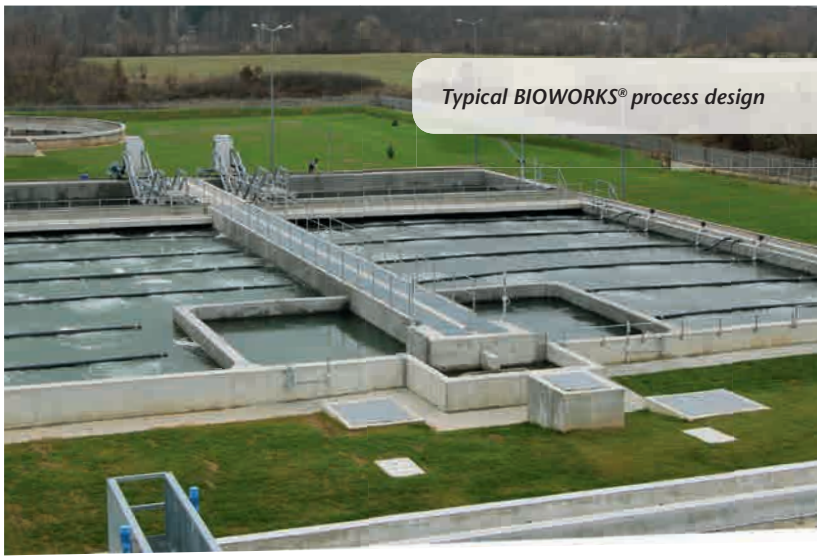
Within the so called denitrification phase lays another important task for the biomass in the activated sludge basin. Smart control of the air flow 10 allows to create anoxic zones within the activated sludge basin. Oxygen which is bound to nitrate is split off and utilized by certain specialized bacteria in order to oxidize carbon compounds, the nitrogen is released to the atmosphere. In the clarifier section the biomass is separated from the clear water by settling. The valuable biomass is withdrawn from the basin bottom of the clarifier and is recycled to the inlet of the basin.

Clear product water is streaming from the effluent of the settling zone 7.

In cases of strict requirements for effluent quality a tertiary filter stage can follow (optional).

Due to its generous design and the high sludge retention time (SRT), the BIOWORKS® process is inherently robust and forgiving. The waste sludge is aerobically digested (extended aeration) and the storage and handling of disposed sludge is eased.

As technological designer for the entire process, we can guarantee that effluent values are fully complying with any requirements – our clients benefit from this high level of safety. Each treatment step is designed as efficient as possible.



Typical BIOWORKS® process design

The key component

... of each wastewater treatment plant is the aeration system. In this area BIOWORKS® sets standards providing its own solution: the aeration system OXIWORKS® with OXIRISE® – field proven, with a track record of highest quality and superior efficiency.

Hard labour in the activated sludge basin

At the core of each wastewater treatment plant lies the biological activated sludge stage. However this underlying principle doesn´t differ all that much from the self-cleaning effects of natural rivers or lakes, which are commonly populated by certain bacteria and higher organisms. These microorganisms, which are also present in the biological stage of a wastewater treatment plant, though in much larger numbers, do most of the cleaning work and digest the pollution in the sewage.

Essential for this hard work is the continuous supply with oxygen, in the correct dosage and at the proper location. Therefore the aeration system is one of the most important factors for the efficiency of the entire wastewater treatment plant.

OXIWORKS® with OXIRISE®: unique quality and innovation.

Aeration systems are the key element when it comes down to performance and efficiency of wastewater treatment – and it is the special expertise of the BIOWORKS® team. Our highly qualified experts have met challenges like extreme climatic conditions (cold areas with permafrost, desertlike temperatures etc.) or even toughest wastewater from industrial applications. This experience evolved with each single process solution that had been installed and the expertise found its reflection in the development of the OXIWORKS®-diffuser with the maintenance and cleaning system OXIRISE®.

Latest state of technology

The OXIWORKS® diffuser with the maintenance and cleaning system OXIRISE® is based on one of the most successful types of aeration technology in existence: the floating and moving fine bubble membrane aeration. This technology has significant advantages:

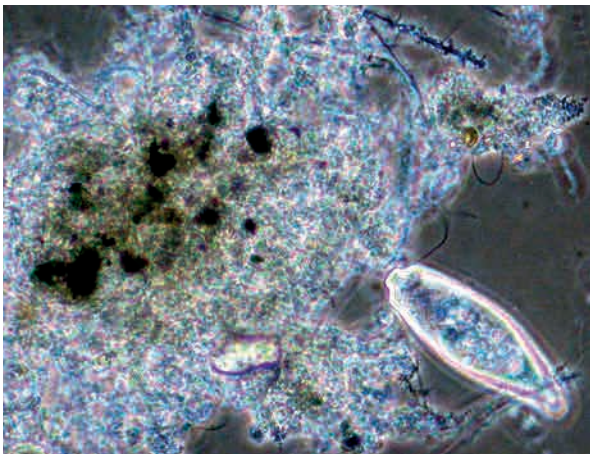
- oxygen transfer rates are verifiable, higher than those of comparable fixed installed aeration systems
- low energy consumption.
- no need for fixation of the diffuser on the basin floor. Anchor bolts or other fixations are not required, a concrete floor is not necessary. Instead the basin can be built with the much more cost effective BIOWORKS® earth-basin design with HDPE lining (see p. 5) – having dramatic effect on the reduction of civil construction costs!

OXIWORKS® with OXIRISE®: Quality guaranteed ...

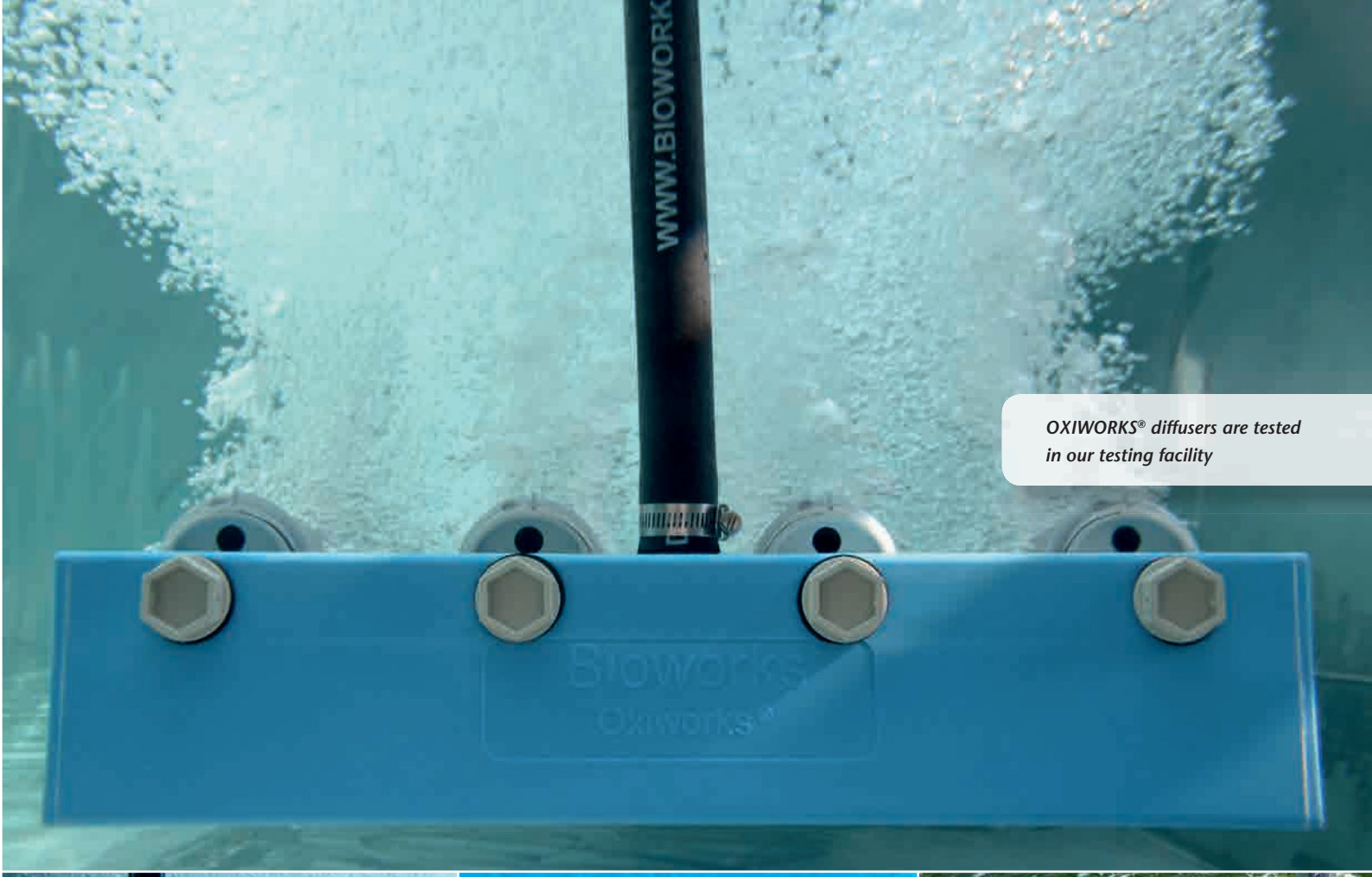
The OXIWORKS® diffuser with OXIRISE® is a quality product, made in Germany, developed in-house by our well experienced experts for aeration systems. For the OXIWORKS® diffuser, we use only durable and corrosion proof plastics or high quality stainless steel. The aeration membranes are made from temperature- and acid resistant silicone. OXIWORKS® diffusers are in full compliance with the latest state of technology.

... Efficiency

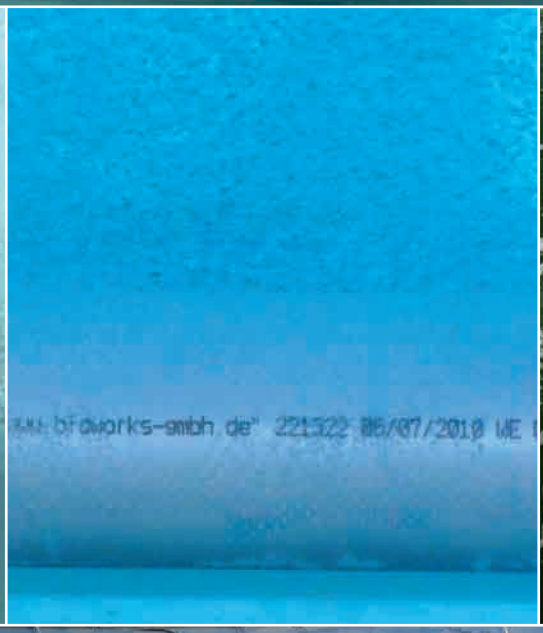
Each single OXIWORKS® diffuser can be installed with a unique, in-house developed and patented lifting

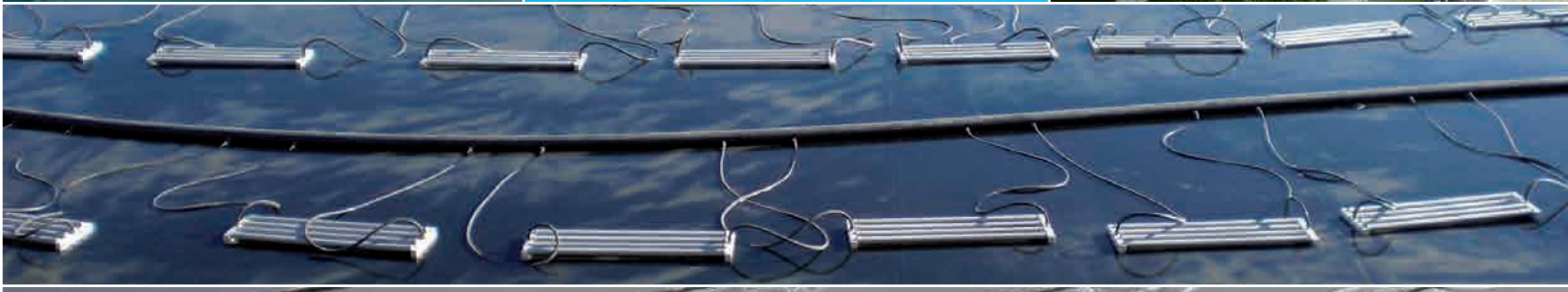


Activated sludge floc with higher organisms (ciliates). Magnification 1:400

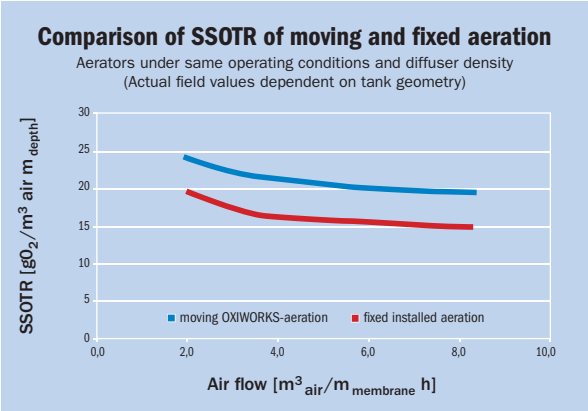


OXIWORKS® diffusers are tested in our testing facility





OXIWORKS® aeration chain with OXIRISE®: Simple maintenance of diffuser during full operation of plant.



device: the OXIRISE® system. OXIWORKS® with OXIRISE® had been designed with the main focus on simple maintenance and cost effective operation.

… easy operation

In the case of diffuser maintenance, former floating aerations systems required the manual lifting of the diffuser from the boat, a difficult work because of the weight of the diffuser and the slippery hoses. With the OXIRISE® system, each single diffuser can be moved automatically by pneumatically lifting it to the water surface, where it can be easily inspected and cleaned or removed from the hoses and put into the boat, should maintenance on land be necessary.

… simple membrane replacement

Simply 2 screws have to be loosened to detach a diffuser tube from the OXIWORKS® diffuser assembly and to change a membrane. The basin doesn´t need to be emptied and the operation can continue without interruption.

… as a result, low operation costs

The aeration system OXIWORKS® with OXIRISE® offers a technological solution that combines high and durable quality with superior efficiency.

- the floating and moving aeration installation makes it possible to use the cost-effective BIOWORKS® earth basin design with HDPE lining, resulting in dramatically reduced construction costs.
- all materials used for OXIWORKS® are chosen for longevity and durability.
- maintenance is as simple and effective as it can possibly be.
- energy efficiency is verifiably higher than those of comparable fixed installed aeration systems. O&M costs are reduced to a minimum.

Efficiency in operation and maintenance

» Because of the new OXIRISE® System, the cleaning of the diffusers has become much easier than before and we are consuming less chemicals. Furthermore we save 60 % of the former costs for electricity. «

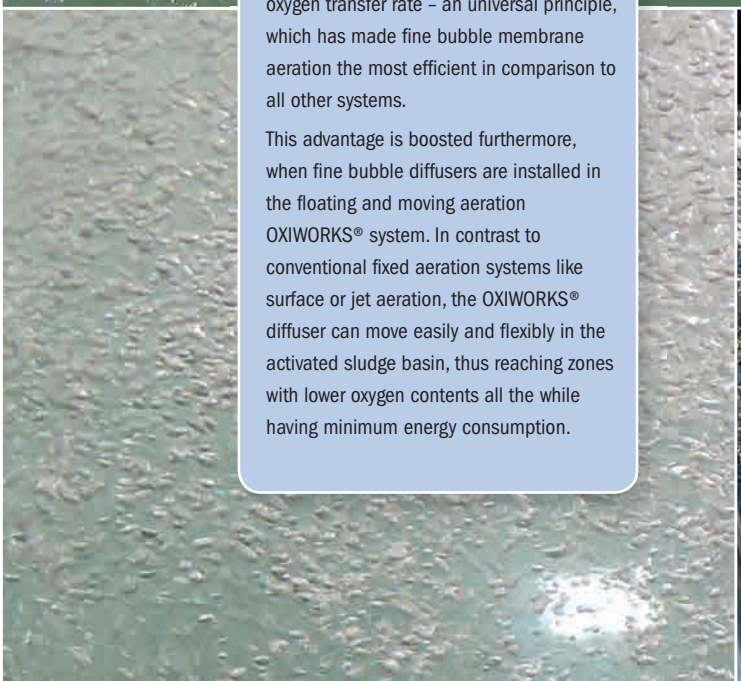
Wastewater treatment plant DDGF (Danmark)

Floating and moving OXIWORKS® aeration chain

Fine bubbles deliver more oxygen

Many small air bubbles have more oxygen transfer surface then lesser and bigger air bubbles, with the direct result of increased oxygen transfer rate – an universal principle, which has made fine bubble membrane aeration the most efficient in comparison to all other systems.

This advantage is boosted furthermore, when fine bubble diffusers are installed in the floating and moving aeration OXIWORKS® system. In contrast to conventional fixed aeration systems like surface or jet aeration, the OXIWORKS® diffuser can move easily and flexibly in the activated sludge basin, thus reaching zones with lower oxygen contents all the while having minimum energy consumption.



Production and logistics from one source

Quality and trust are not just slogans

Besides innovative and effective technology, quality and reliability play an inportant role in our company. The aeration, the key component of the biological stage, is produced in-house, from the joining of plastics parts to final assembly. With regard to materials we only rely on high quality products from reputable manufacturers. All supplied components are from German production.

Thourough quality control with meticulous recording and secure packaging ensures that our products arrive on site exactly as our customers can expect it.
Out-sourced equipment – almost exclusively manufactured in Germany – is custom designed by our engineers and incoming and outgoing equipment are subject to strict scrutiny and quality control. This approach guarantees that errors during installation and operation of our plants can be prevented in advance.
In addition, BIOWORKS® owns a highly capable logistics centre where sea containers up to 40 ft can be loaded. By this we accomplish swift, reliable and complete deliveries, even under pressure from tight shipment schedules. A highly professional document processing provides smooth export and customs procedures for our worldwide shipments.
We are proud to be able to fulfill even the most difficult foreign standards of quality control and documentation. Our customers have a direct benefit from that, as first-class shipping documents reduce demurrage time in the customs port, saving time and money.

Logistics centre with container handling capabilities

Diffuser pipe prior to quality control

Diffuser manufacturing

In-house aeration test tank

OXIWORKS® diffuser under testing

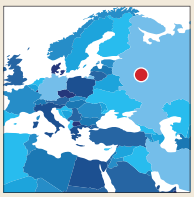
Product development and testing

Continuous development, improvement of our products and quality control is of highest priority for our company. Our products are undergoing rigorous testing and evaluation.

Our in-house test facility for aeration devices allows us to test our aeration system products in a large scale test tank.

The simulation of different operating scenarios helps us in the ongoing improvement of our products. Research and development is a cornerstone of the BIOWORKS® company policy.

BIOWORKS® and OXIWORKS® worldwide



Process:
Activated sludge plant with extended aeration, floating/ fine bubble aeration and full tertiary treatment according to BIOWORKS® design

Size:
30.000 PE(60) with 12.000 m3/day

Inlet values:

BOD(5)	150 mg/l
TSS	200 mg/l
Tot. N	25 mg/l
Tot. P	4 mg/l

Outlet values:

BOD(5)	< 3 mg/l
TSS	< 5 mg/l
NH4-N	< 0,4 mg/l
NO3-N	< 9 mg/l
Tot. P	< 0,2 mg/l

► Staraya Kupavna, Russia:

The wastewater treatment plant for Staraya Kupavna is located approximately 25 km east of Moscow, Russia and went into operation in November 2016. The treated wastewater is municipal wastewater with some industrial influence. The activated sludge basin is constructed as HDPE lined soil-basin.
This project was implemented by a private investor. After a detailed comparison the investor decided using the BIOWORKS® process to optimize both – investment and operating cost.
BIOWORKS® did the design works, supply and installation of the electromechanical equipment as well as the sealing of the basins with HDPE liner. In addition to the automation and control system with SCADA of the treatment plant. As the effluent requirements are very high the plant comprises full tertiary treatment with rapid gravity sand filters and UV-disinfection station.

Integrated clarifier and activated sludge basin

Process:
Activated sludge plant with extended aeration and floating/moving fine bubble aeration according to BIOWORKS®

Size:
666.667 PE(60)
with 100.000 m3/day

Inlet values:

BOD(5)	400 mg/l
TSS	500 mg/l
TKN	88 mg/l

Outlet values:

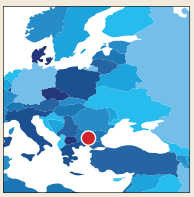
BOD(5)	< 2 mg/l
TSS	< 2 mg/l
NH4-N	< 1 mg/l

► 6th of October City, Egypt:

The wastewater treatment plant for 6th of October City is located approximately 25 km west of Cairo and treats the wastewater of the 6th of October city settlement. The project was realized under the consortium ORASCOM/BIOWORKS® and went into full operation in June 2014. It is separated in 3 parallel treatment lines, each treating 33.333 m^3/day wastewater.

The scope of BIOWORKS® included the complete design works and supply and installation of the electromechanical equipment as well as the sealing of the basins with HDPE liner. The plant comprises also full tertiary treatment with slow sand filters. These are one of the largest units ever built. The effluent quality is excellent, reaching outlet values of BOD/TSS < 12/15 mg/l after secondary and < 2/2 mg/l after tertiary treatment.

Sand removal facilities and activated sludge basins



Process:
Activated sludge plant with extended aeration and floating/moving fine bubble aeration according to BIOWORKS® design

Size:
80.000 PE(60)
with 29.000 m3/day

Inlet values:

BOD(5)	220 mg/l
TSS	200 mg/l
COD	596 mg/l
Tot. N	15,9 mg/l
Tot. P	3,8 mg/l

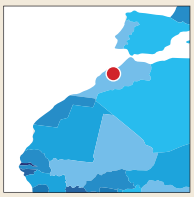
Outlet values:

BOD(5)	< 8 mg/l
TSS	< 10 mg/l
COD	50 mg/l
Tot. N	< 12 mg/l
Tot. P	< 1,6 mg/l

► Troyan, Bulgaria:

The wastewater treatment plant for the municipality of Troyan/Bulgaria had been build for the treatment of municipal wastewater with some industrial discharge (wood processing). The project was financed by cohesion fund of the European Union.
The plant is designed as activated sludge process with N- and P-removal. There are two parallel lines for the biological stage, each 14.500 m^3/d, including biological P-removal. Existing mechanical treatment steps had been considered and integrated in the design.
The plant was realized by an international consortium between BIOWORKS® and Bulgarian partners. Time for execution was comparatively short and especially installation was realized within only 10 weeks. The plant was commissioned in January 2011.

integrated clarifier and blower station



Process:
Activated sludge plant with extended aeration and floating/moving fine bubble aeration according to BIOWORKS® design

Size:
24.988 PE(60)
with 3.117 m³/day

Current inlet values:

BOD(5)	316 mg/l
TSS	549 mg/l
TKN	67,8 mg/l

Current outlet values:

BOD(5)	1,9 mg/l
COD	19 mg/l
TSS	< 6 mg/l

► Oued Laou, Morocco:

The wastewater treatment plant in Oued Laou is an activated sludge treatment with extended aeration, tertiary filtration and UV disinfection. The sludge from the WWTP is aerobically digested and odor free. The surplus sludge is dewatered mechanically using a centrifuge.
The total flow treated by the wastewater treatment plant is 3.117 m³/d. In order to be more flexible and be able to respond efficiently to the seasonal flow fluctuation the design of the biological lines was chosen as follows: two lines for a flow of approx. 500 m³/d and two lines for a flow of approx. 1.000 m³/d.
The plant has been commissioned in 2015.

Compact station for mechanical pre-treatment, blower station

Revival of a traditional technology: OXIWORKS® aeration is the advanced solution for lagoon systems

The collection in large ponds ("lagoons") is the oldest way to treat wastewater. The biological processes in lagoon systems (facultative unaerated) are actually quite complex: Wastewater is stored in large ponds with many days of hydraulic retention, sometimes up to 50 days or more. Solids will settle at the bottom and slowly decay under anaerobic conditions. On the water surface, oxygen is introduced by wind activity and supplies the bacteria in the water to digest pollutants. Usually several lagoons are arranged in series and the last lagoons will serve for polishing. After some years the lagoons will be filled with sludge and desludging is necessary. Unaerated lagoons are simple in design and non-energy consuming, however there are serious disadvantages:

- Strong odors are emitted.
- Enormous land area is required
- Cleaning performance is poor

Several disadvantages could be eliminated by introducing "artificial" aeration, mainly by mechanical surface aerators. This results in improved cleaning results, mitigation of odors and reduced land requirement. But the installation of surface aerators created some new problems, mainly very high electricity consumption.

Also the mixing of lagoons was still poor and aerosols by the aerators created new health and safety issues. Aerated lagoon systems had a recent revival by design improvements with the "complete mix" concept. This achieves better cleaning results while requiring less land. Fine bubble aeration systems with higher efficiency and better oxygen transfer replaced surface aerators. Nowadays such "high powered" aerated lagoons are often used as alternative to activated sludge systems, when there is no particular requirement on nutrient removal.

OXIWORKS® is the perfect solution for lagoons

The OXIWORKS® aeration system is exceptionally suitable for the use in any aerated lagoons system. The simple design of the OXIWORKS® aeration allows a "plug and play" approach. The movement of the diffusers will result in excellent mixing of the lagoon, dead zones are avoided. Compared to surface aerators, OXIWORKS® consumes 50 % less energy. In particular for complete mix lagoon systems, the OXIWORKS® aeration is the technology of choice.

Aerated lagoon with OXIWORKS® aeration

BIOWORKS® is also the ideal partner for retrofitting your aeration

The aeration system is the heart and soul of each aerobic treatment plant. Not only does the aeration system provide the oxygen necessary for the biological process, it´s also the largest contributor to the electrical bill. Dependent on type and process, the aeration system may consume up to 80 % of the total electrical energy.

Insufficient aeration can cause lack of oxygen, which will result in problems with process, smell and non-compliance with effluent regulations. So upgrading and replacing an old inefficient aeration system would seem like a very good idea. However many owners shy away from the investment.

The BIOWORKS® approach for retrofit

In the last couple of years, BIOWORKS® has upgraded numerous treatment plants with its modern and efficient aeration system OXIWORKS®. We have helped modernize conventional treatment plants, old activated sludge systems as well as aerated lagoons. The feedback from our customers is overwhelmingly positive.

In all cases, the treatment and process itself was improved and the cost for electrical energy significantly reduced. The investment proved to be worth the effort. The investment costs for such retrofit are usually much lower than one would expect. The return of investment by energy saving is usually 2-3 years. The upgrades can be implemented very fast, usually not more than 1-2 weeks are necessary. So far we managed to upgrade all plants under full operation, without shutting downs the treatment.

Before retrofit

After retrofit

BIOWORKS® retrofit at a glance

The upgrade of the aeration system will achieve significant cost savings for electrical consumption. It will furthermore improve the performance of the treatment plant, provide the owner with additional treatment contingency and safety for higher loadings. The return of investment is in most cases less than 3 years. The upgrade can be done in most cases during full operation of the treatment plant. BIOWORKS® has extensive experience in Aeration upgrades. If you are thinking about upgrading your aeration system, BIOWORKS® is the perfect partner for you!

BIOWORKS® – THE CLEAR SOLUTION

→ **Highly effective technology**
→ **Cost effective operation**
→ **Safety and reliability**

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