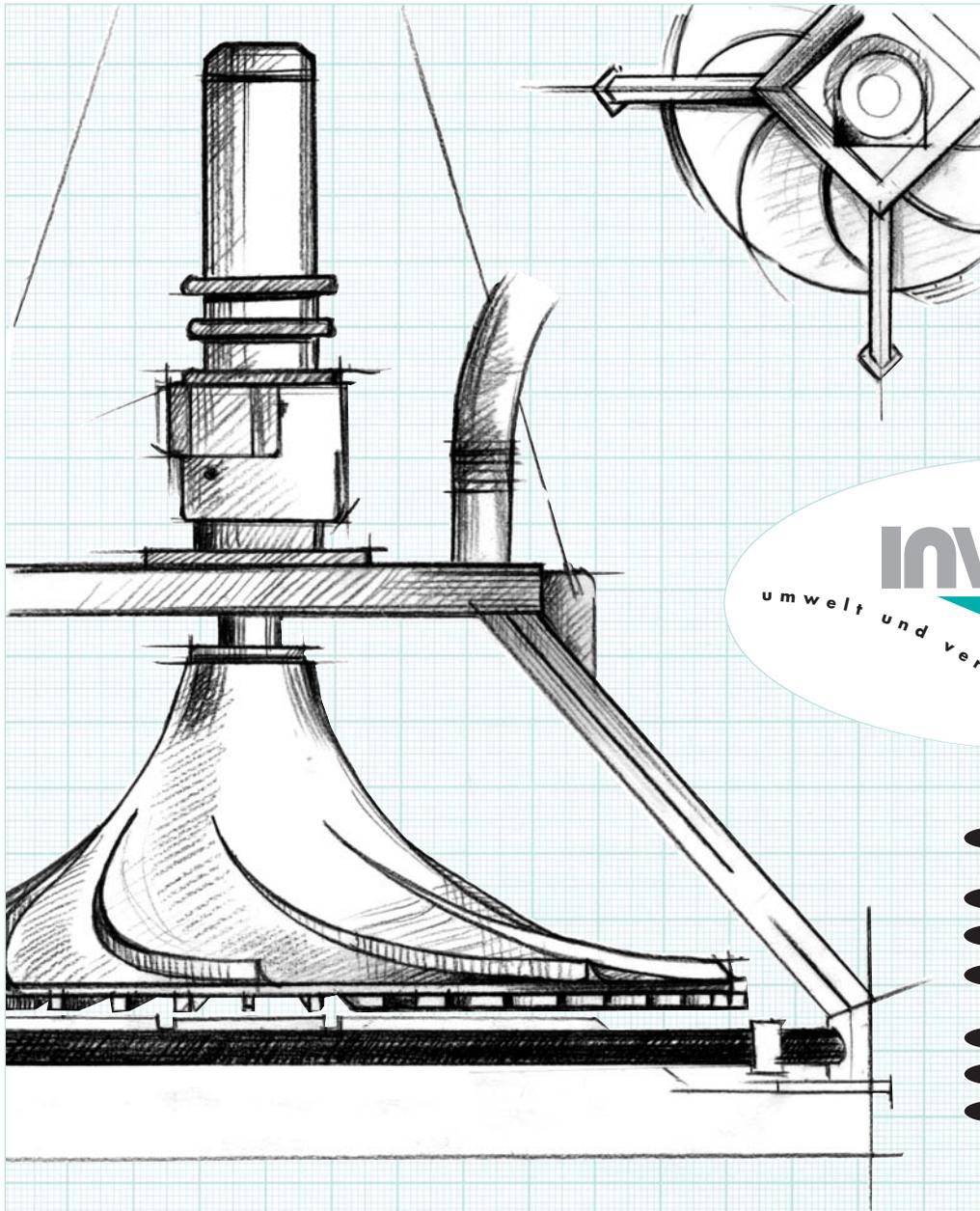


# ***HYPERDIVE***<sup>®</sup> - *Mixing- and Aeration System*

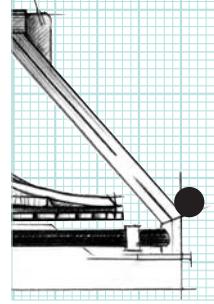
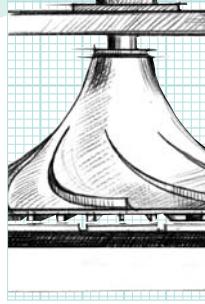
*mixing and aeration technology*



**invent**<sup>®</sup>

umwelt und verfahrenstechnik

- Fluid mechanically optimized
- High oxygen input
- Excellent mixing
- Low energy consumption
- Robust construction
- Low maintenance
- Easy to install



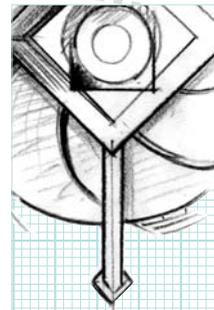
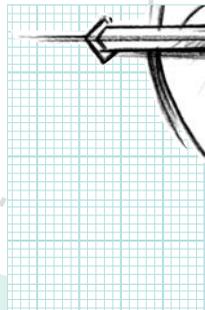
## *i n n o v a t i o n   f o r   n a t u r e*

*The growing pollution of our environment is a problem which concerns all of us. For years water pollution, in particular, has continued to grow in threatening proportions. Water is turning into a more and more limited resource. As a consequence, forward-looking technologies are desperately needed for water and wastewater treatment.*

*With great commitment **INVENT** is dedicated to the development and implementation of such technologies, thus creating powerful products which contribute greatly to the preservation of the water quality of our groundwater, rivers and lakes.*

*The protection, the preservation and, where necessary, the restoration of our environment will remain one of the most important tasks of our society in the future.*

***INVENT** takes on responsibility in this field, with innovative environmental and process engineering.*



## **HYPERDIVE®** Submersible Mixer/ Aerator

**INVENT** develops, produces and globally implements innovative components, systems and processes for the treatment of water and wastewater.

In water and wastewater treatment several process steps are applied. In combination they form a complete system.

It is important to distinguish between physical, physical/chemical and biological processes. The biological stage represents the heart of the plant. Here carbon and nitrogen compounds are biologically decomposed. The basis for this process is the effective mixing and efficient transfer of oxygen, so that the biologically active bacteria can work effectively.

**INVENT** specializes in exactly this field and, with its innovative products, is one of the world's leaders in the area of mixing and aeration technology for the water and wastewater treatment industry.

## Leaders in Mixing and Aeration



3 out of 4 **HYPERDIVE®** Mixing & Aeration Systems at an industrial wwtp in the Netherlands (Oil & Gas Industry)

The **HYPERDIVE®** Mixing and Aeration System was developed and optimized especially for demanding applications in municipal and industrial wastewater treatment plants. It provides efficient oxygen transfer and optimal mixing during the biological stage. Compared to conventional systems, it possesses the following advantages:

- In addition to the task of introducing oxygen, it also fulfils the important function of mixing and avoiding sedimentation.
- Due to the mechanical aeration method, the oxygen transfer performance is nearly as high in wastewater as it is in pure water.

# HYPERDIVE®

## An Overview

- Even after many years, the aeration performance is not diminished. The system's pressure loss remains constantly low.
- Aerosol development and noise emission are eliminated.
- The system can be installed simply and quickly, even in a filled tank.



1 out of 4 **HYPERDIVE®** Mixing & Aeration Systems at an industrial wwtp in the Netherlands (Oil & Gas Industry)

There are multiple areas of application for the **HYPERDIVE®** Mixing and Aeration System.

In principle, it can be used for all aeration tasks, especially in all variations of the activated sludge process, such as:

- For BOD/COD reduction and nitrification in conventional activated sludge plants
- In Membrane Bio Reactor plants (MBR)
- In Sequencing Batch Reactor plants (SBR)
- In swing zones with facultative denitrification/nitrification
- In pure oxygen plants
- For BOD/COD reduction as well as nitrification in carousel tanks, oxidation ditches or aerated ponds

The areas of application, the functionality, the construction and further technical details of the **HYPERDIVE®** Mixing and Aeration System are described in the following paragraphs.

### The Task

The task of mixing and aeration systems for biological wastewater treatment is to add large amounts of oxygen into the wastewater with the lowest possible energy consumption. At the same time, the wastewater should be intensively mixed so that the oxygen concentration and the activated sludge flocs are always uniformly distributed throughout the complete reactor, and sedimentation can be completely avoided.

For an efficient oxygen supply, air or gas bubbles of optimum size must be generated. Only in this way can the introduced oxygen amounts be used in the best possible way. This optimal bubble size is dependent on the depth at which the air is introduced. In order to achieve long retention times of the bubbles in the tank, the air should be introduced at the greatest possible depth. The generation of bubbles should therefore take place close to the tank bottom rather than at the water surface.

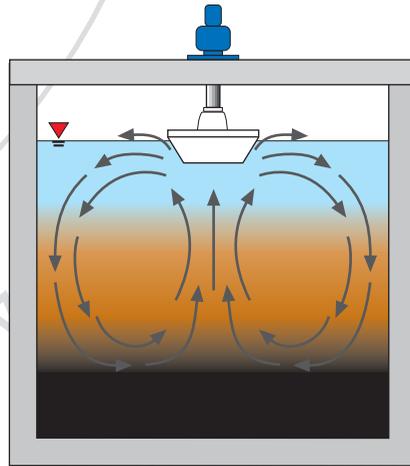
BOD: Biological oxygen demand  
COD: Chemical oxygen demand

**Efficient and reliable**

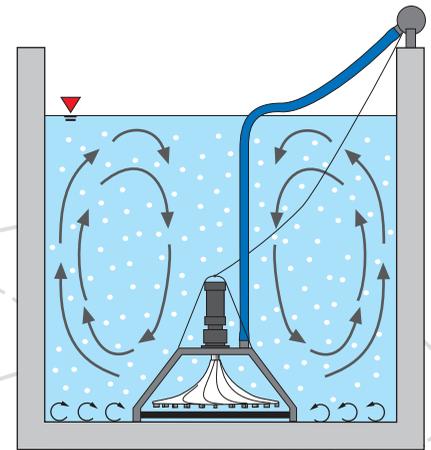
An intensive mixing is highly important for the optimal and safe operation of an activated sludge plant. The influence of mixing on the purification capacity of a plant is quite often underestimated. However, it is easily understandable that - for example - sedimentation on the tank's bottom, not only diminishes the available reactor volume, but also represents oxygen depression and a source of toxins due to the mostly anaerobic digestion. Besides reduced performance, this leads to poor sedimentation qualities of the sludge flocs in the secondary sedimentation tank.

Poor mixing, however, also leads to oxygen gradients in the activated sludge tank. This in turn reduces the oxygen supply performance, as the driving concentration gradient is reduced. Furthermore, such non-homogeneous occurrences create a problem for the usual single-point oxygen measurements which are usually located in the upper part of the basin, where the oxygen concentration tends to be higher than in the rest of the basin. All in all, the available basin volume is not used to the maximum.

To summarize, what is required is a system which fulfils the above demands with regard to optimal bubble sizes and homogenous mixing, which furthermore can be used in various applications, and is of sturdy construction and resistant to wear and tear.



*Oxygen distribution with insufficient mixing - poor purification performance*



*Oxygen distribution with good mixing & homogenization - excellent purification performance*

# HYPERDIVE®

## The Solution

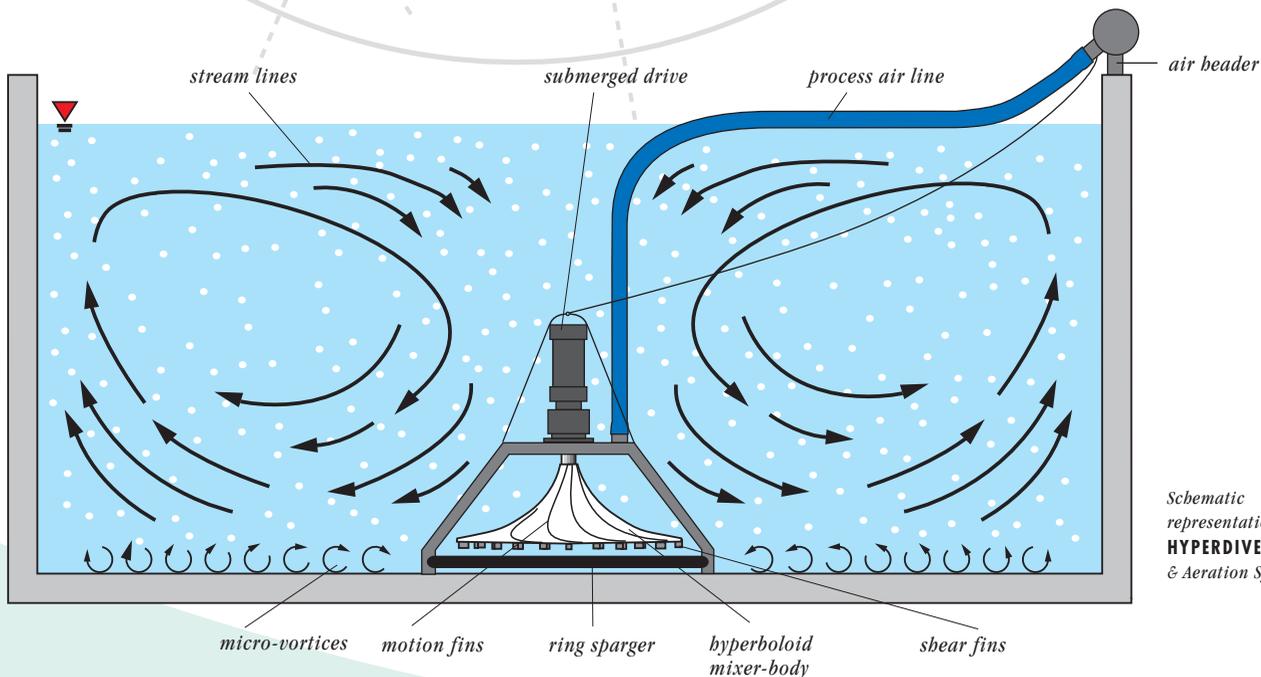
Highest efficiency  
through optimal design

### The Solution

The **INVENT HYPERDIVE®**-Mixing and Aeration System is a fluid-mechanically optimized mechanical aeration system with a hyperboloid-shaped mixer body which is installed close to the bottom, and a submerged drive. In contrast to other products, it was developed not only for the purpose of oxygen input but also for the purpose of mixing, and is tailor-made especially for carrying out this double task.

The way the hyperboloid mixer/aerator functions can be seen in the illustration below. The hyperboloid mixer/aerator is pictured with its three main components, the submerged drive, the hyperboloid mixer body and the cage/foot construction. It is shown in a typical activated sludge tank, which, depending on the type of treatment plant, can be rectangular or circular, naturally, other shapes of tank are also possible - for example, carousel tanks or aerated lagoons can be equipped with the **HYPERDIVE®** Mixing and Aeration System.

The hyperboloid mixer/aerator rotates close to the bottom and its eight integrated and specially optimized motion fins thus produce a bottom flow which is directed radially outwards. Particularly at the bottom, this flow is highly turbulent and thus effectively whirls up any deposits. Along the walls, the flow rises upwards and carries all particles until they are just below the water surface. The overall flow which forms in the activated sludge tank produces an intensive mixing of the activated sludge.



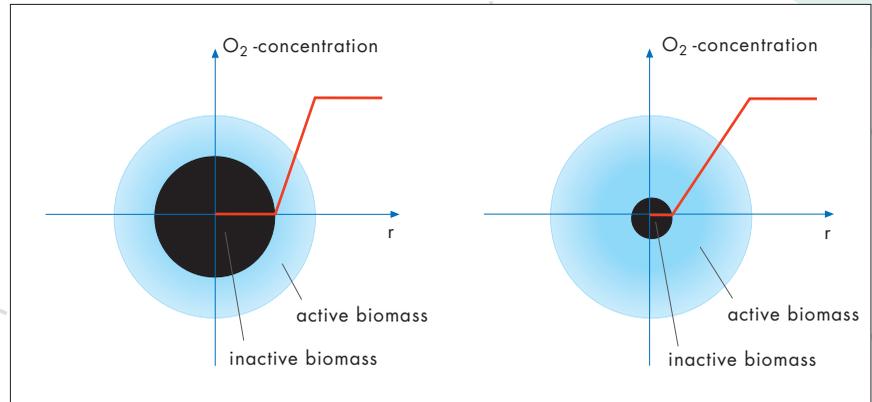
Schematic representation of the **HYPERDIVE®** Mixing & Aeration System

During the aeration mode, air or gas is blown under the hyperboloid mixer body. This is realized via a separate process air line which ends in a specially designed sparger system under the hyperboloid mixer body. There the air escapes and meets the specially shaped underside of the hyperboloid mixer body, which is equipped with so-called dispersing tunnels and special shear fins. As the hyperboloid mixer body rotates, the air in the dispersing tunnels is mixed intensively with the wastewater and is chopped into fine bubbles by the shear fins.

The main flow then transports these fine bubbles radially outwards and distributes them throughout the whole tank.

In summary, this optimized method of mechanical aeration with combined mixing possesses the following advantages:

- Optimally sized bubbles are produced and particularly high retention times are achieved, because of the air introduction at the tank bottom and radial distribution.
- High oxygen transfer and yield levels are therefore achieved.

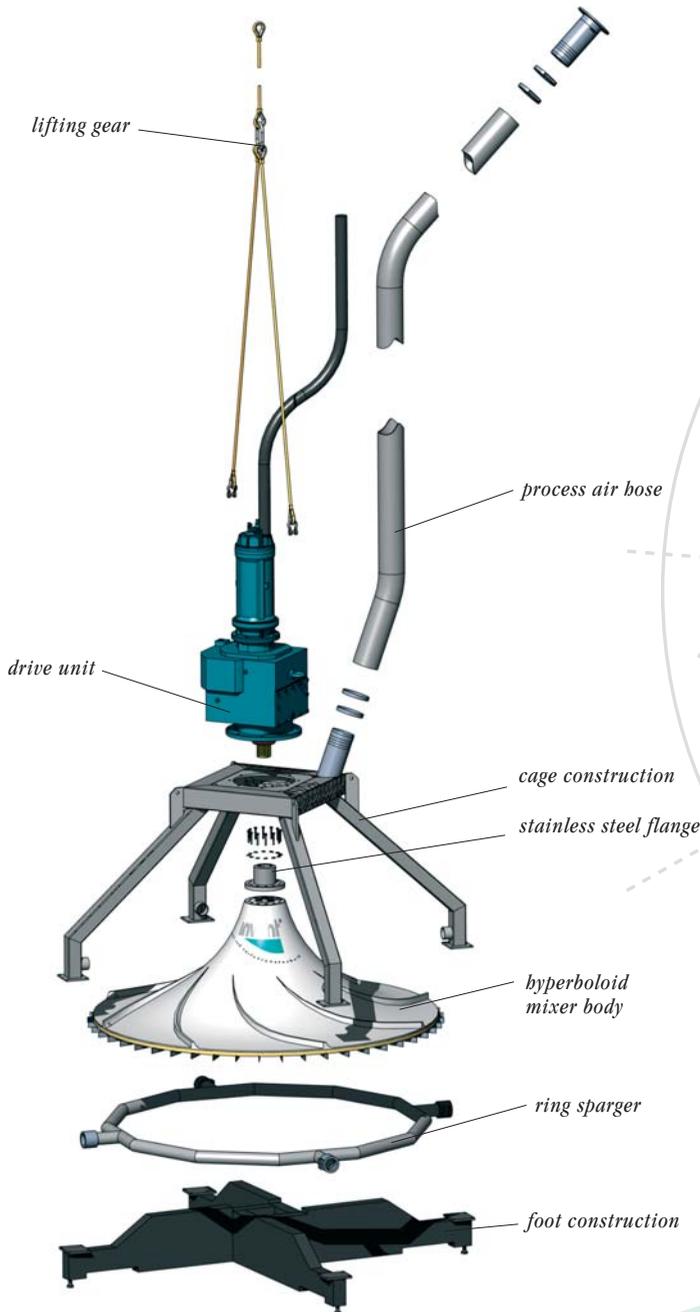


*Anaerobic sludge floc (small amount of active biomass and poor sludge settleability) / Aerobic sludge floc (large amount of active biomass and excellent sludge settleability)*

- The oxygen concentration is distributed homogeneously throughout the tank.
- The activated sludge flocs are optimally supplied with oxygen to their core. (cf. diagram) This improves the sludge quality immensely – especially the sedimentation qualities in the secondary sedimentation tanks.
- The activated sludge flocs are distributed throughout the tank, and sedimentation is eliminated.
- Production of aerosol and the associated hygienic and aesthetic problems no longer occur. Protective covers are unnecessary.
- There is no noise emission.
- The energy, installation and maintenance costs and thus the operating costs are reduced to a minimum.
- The system is absolutely non-clogging, there is no wear of membranes and no increase in loss of pressure.

# HYPERDIVE®

## Design and Material Selection



### Robust and proven

#### Design and Material Selection

As illustrated in the accompanying exploded drawing, the hyperboloid mixer/aerator is made up of three main components which are precisely fitted to each other: the submerged drive unit, the hyperboloid mixer body and the cage with foot construction.

#### Drive unit

The submerged drive sits on top of the cage construction and is directly connected to the hyperboloid mixer body via a stainless steel flange. The drive unit consists of a submersible electric motor, a gear-reducer and a mechanical seal.

Only energy-saving and robust motors, heavy-duty gear-reducers and reliable mechanical seals from leading manufacturers are used. High service factors are selected for the gear-reducers and the calculated bearing life expectancy is more than 100,000 hours.

### **Hyperboloid Mixer Body**

The hyperboloid mixer body, developed out of the **INVENT** laboratories in accordance with the most up-to-date knowledge of fluid mechanics, is manufactured using high-quality fibre-reinforced plastic. The use of the most modern fibre-reinforced composites makes possible the construction of a high-strength, corrosion-resistant and light component.

The complete hyperboloid mixer not only produces a favourable flow field but is also absolutely non-clogging because of the optimal shape and the motion fins, which are seamlessly integrated into the mixer body.

Fins are moulded not just on the upper side but also on the underside of the mixer body. The ones on top serve to transport the fluid, and therefore the mixing, and those below generate the bubbles. We call this **INVENT Double Fin Technology®**.

### **Cage Construction**

The cage construction consists of a heavy base construction with a stainless steel cage mounted upon it. The base construction is always made from a solid steel construction coated with epoxy resin. This gives the **HYPERDIVE®** Mixing and Aeration System the necessary weight to guarantee that it always remains in its position.

Furthermore the base, through its shape, also supports the development of a flow beneath the hyperboloid mixer body which is favourable to the aeration and mixing process. The stainless steel cage also includes the air collection and distribution into the sparger.

### **Process Air Hose/ Sparger System**

The process air hose provides the air from the air header outside the basin to the **HYPERDIVE®** Mixing and Aeration System. It is connected to the air manifold which is integrated into the cage construction. The manifold distributes it into the four legs, and from there the air is introduced into the special sparger system.



**HYPERDIVE®** Mixing & Aeration System ready for shipment

The sparger system is made so as to prevent clogging. It is responsible for the pre-distribution of the air under the mixer body. The pressurised air, or gas, that is used must be supplied from outside by means of a suitable blower system.

# HYPERDIVE®

## Installation and Operation

Low operational costs  
due to low energy consumption



1.



2.

1.-2.: Installation of a **HYPERDIVE®**  
Mixing & Aeration System

### Installation

The **HYPERDIVE®**-Mixing and Aeration System is constructed in such a way that it can be easily and quickly installed. It is normally delivered to the construction site in a preassembled state.

Depending on the means of transportation, the client might have to assemble a few parts before the whole unit can be installed. Once the **HYPERDIVE®** Mixing and Aeration System is fully assembled, a dry run is executed to carry out final checks. After that the **HYPERDIVE®** Mixing and Aeration System can be lifted up with a crane and be positioned in the basin without draining the basin.



3.

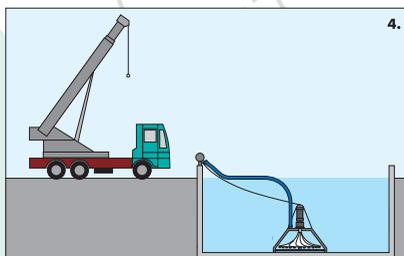
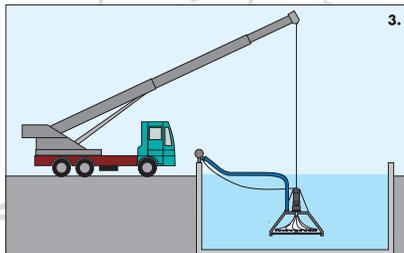
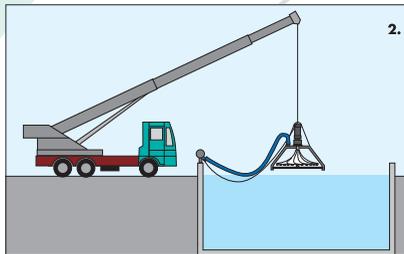
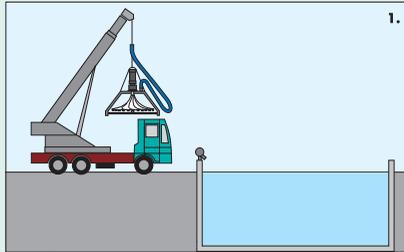


4.



5.

3.-5.: Installation of a **HYPERDIVE®**  
Mixing & Aeration System



Graphical representation of the 4 different installation steps

### Operation

After a short dry run and a check of the direction of rotation, the hyperboloid mixer/aerator can start operating without any further work. It is designed for permanent operation and does not require intense maintenance work, except for an occasional inspection of the gear reducer and the mechanical seal. For this procedure, which usually has to be executed every 2 years, the **HYPERDIVE®** Mixing and Aeration System is pulled out of the basin and serviced outside the basin in a dry position.



**HYPERDIVE®** Mixing & Aeration System during installation in a municipal wwtp in Middle East



**HYPERDIVE®** Mixing & Aeration System in operation in an industrial wwtp in Sweden (Pulp & Paper Industry)

Low maintenance costs

# HYPERDIVE®

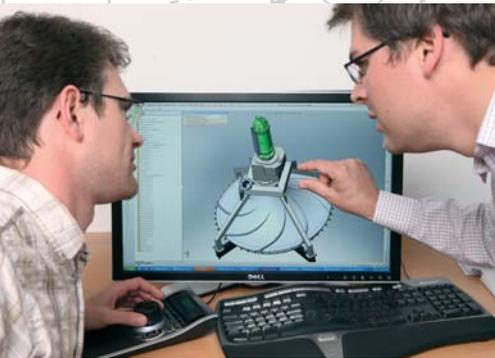
## Lay-out and Design

## Competent and experienced

In the case of industrial plants, for example in the paper and the petrochemical industries, it can also be important to understand the production process to a certain degree, because this significantly influences the wastewater composition.

**INVENT's** approach is to focus on the customer and to always try and offer objectively the best solution. When strictly put into practice this means not just offering one single system but instead selecting from the outset the most suitable one for the application at hand, from a range of mixing and aeration systems, membrane and further aeration systems. The selection of the suitable system is the first and most important step in the planning and designing of a plant. If the wrong system is chosen, it inevitably leads to a solution which is only partially suitable and thereby to a restricted performance of the plant and to increased costs.

Through many years of intensive research and development work in the field of mixing and aeration technology, **INVENT** has been able to develop a range of products, which optimally cover every application. Therefore you can always rely on getting the best solution from **INVENT** and not just the only one available.

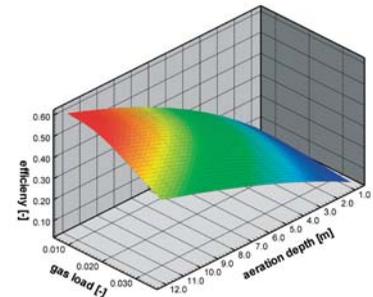


*INVENT design engineers*

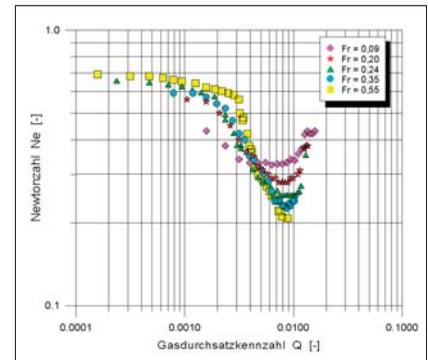
## Lay-out and Design

The lay-out and design of an optimum mixing and aeration system is a very complex task. It requires a large amount of competence, know-how and experience.

Above all, it is important to consider the entire system and to understand the complete process in addition to the standard parameters, to incorporate this information, and to integrate the aeration system optimally into the complete process.



*Typical characteristics of a **HYPERDIVE®** Mixing & Aeration System*



*Typical gassed power characteristics*

## The Laboratory

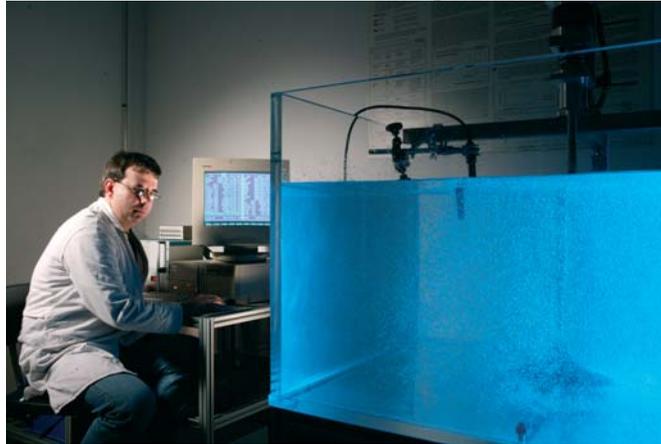
In the **INVENT** laboratories in Erlangen, all **INVENT** products are continuously developed and improved. The most modern equipment, measuring methods and analytical devices are available for this task. In order to determine fluid mechanical parameters, scale models are examined and optimized with the help of laser and ultrasound measuring methods. Chemical analyses help to examine mixed processes on micro and macro scale.

Standard methods, recommended by DWA<sup>1</sup> or ASCE<sup>2</sup> are used to measure the mass transfer.

Measuring instruments appropriate for taking measurements on large-scale plants are available. The „bubble size“ - an important parameter for the lay-out of aeration systems - is determined with optical measuring methods.



Quality control



Oxygen testing in the **INVENT** Laboratories

The use of a characterization method developed by **INVENT** allows us to characterize and lay out aeration systems with just a few measurements.

These high-level quality control procedures provide an assurance of quality that you should expect from superior products for water and wastewater treatment.

**Continuous improvement  
and quality control**

<sup>1</sup> DWA: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V.

<sup>2</sup> ASCE: American Society of Civil Engineers

# HYPERDIVE®

INVENT Products worldwide



INVENT team meeting

INVENT®, HYPERDIVE® and Double Fin Technology® are registered trademarks of INVENT Umwelt- und Verfahrenstechnik AG.

## Chosen references for Hyperboloid Mixer/Aerators

### Industrial:

- Dow Chemicals, Chemical Industry
- DSM, Chemical Industry
- Q8 Refinery, Petrochemical Industry
- Alpro Milk, Food Industry
- Arla Foods, Food Industry
- Södra Cell, Pulp and Paper Industry
- SAPPi, Pulp and Paper Industry
- Jass Papier, Pulp and Paper Industry
- Zucchi & Basetti, Textile Industry
- Mascioni, Textile Industry
- Dortmunder Union Brauerei, Beverage Industry
- Rottneros, Paper Industry

### Municipal:

- Presidente Prudente, Brazil
- Sao José dos Campos, Brazil
- Jabel Ali, U.A.E.
- Saida, Libanon
- Caleta Olivia, Argentina
- KA Riedlingen, Germany
- KA Isny, Germany
- Biomüllvergärung Mühlheim an der Ruhr, Germany

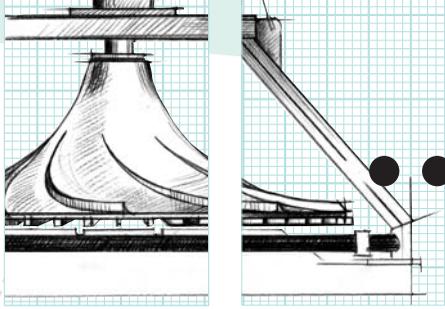
## Successful worldwide

### The Service

How can we support you with the planning, optimization or modernization of your plant, or just generally with the realization of your ideas? Please ask us about it!

In close co-operation with you, the **INVENT** team will draw up a first draft and will, if necessary, develop it further together with you via numerous iterative steps, until all requirements are met. After the order has been placed an experienced team of engineers will see to it that your project is carried out on schedule.

In accordance with the agreement, we will deliver and install the plant for you and will also carry out the commissioning. Our service team will reliably take care of all necessary maintenance work.



**H Y P E R D I V E**®  
Further INVENT Products

**Professional and innovative**

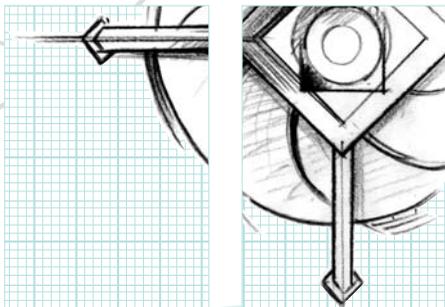
Beyond the delivery of components and plants, we also offer you general advisory and engineering services in the field of mixing technology. This can be, for example, the layout or optimization of a mixer, or the experimental examination of a stirring tank in a laboratory setting or through numeric simulation.

Furthermore, we carry out large-scale acceptance tests, whereby usually the velocity field, the solid matter concentration distribution, and the retention time distribution are examined.

### Other Products and Services

**INVENT** is the market leader for mixers, mixing and aeration systems, and membrane aeration systems for the water and wastewater treatment. Please do not hesitate to ask for information about our additional product lines. We would also be happy to offer you complete system solutions for your plants, such as a carefully laid-out and adapted equipment packages. We simulate and optimize your plant with the help of appropriate software packages, or else we optimize your plant or building with regard to fluid mechanics.

We are your specialist partner for all questions on water and wastewater treatment.



*aeration technology*



*system solutions*



*engineering & consulting*

*software-products*

*research & development*



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