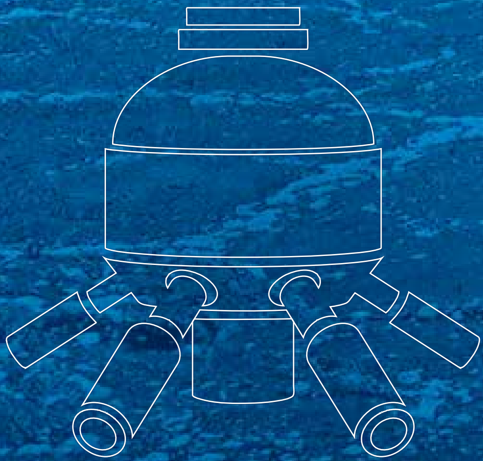


# Waste water aeration

## with increased efficiency

THE EJECTOR COMPANY

Water treatment with
Körting jet ejectors

**Energy-efficient solutions –
maintenance free and long service life**

# Waste water aeration with increased efficiency

## FIELDS OF APPLICATION

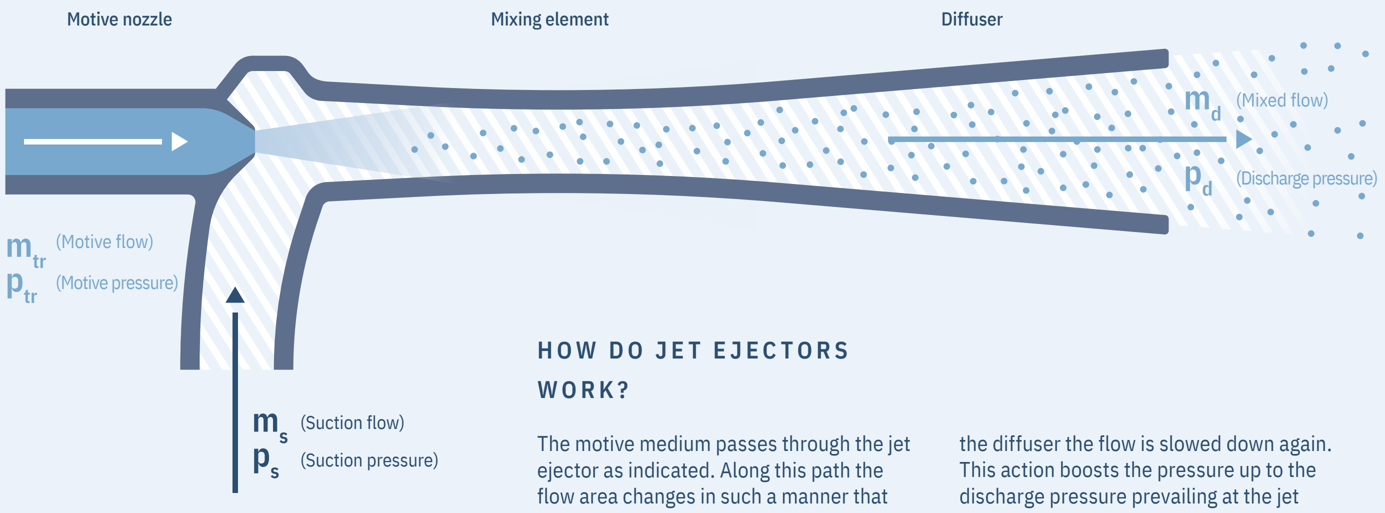
Körting jet ejectors are the heart of many gas transfer systems. They are used in numerous fields of water treatment. Their form and design are determined by the type of motive and conveying medium as well as by the pressures prevailing at all three ejector connections. Ejectors are self-priming and operate without any moving parts. Their method of operation is based solely on the laws of fluid dynamics.

Jet ejectors operated with water or another liquid are used to

- Mix liquids and gases
- Compress gases
- Mix liquids
- Convey liquids

You can find the practical questionnaire to quickly request a bid as well as additional information at **koerting.de/en/water-treatment.html**

## DESIGN OF A KÖRTING JET EJECTOR




## HOW DO JET EJECTORS WORK?

The motive medium passes through the jet ejector as indicated. Along this path the flow area changes in such a manner that pressure in the motive nozzle drops and velocity increases. The area with the lowest static pressure can be found just behind the motive nozzle. Here the suction medium can enter and be mixed with the motive medium whereby kinetic energy from the motive flow is transferred to the suction flow. Then in the diffuser the flow is slowed down again. This action boosts the pressure up to the discharge pressure prevailing at the jet ejector outlet.

Learn more about waste water aeration with Körting ejectors in this video.

**koerting.de/en/water-treatment.html**

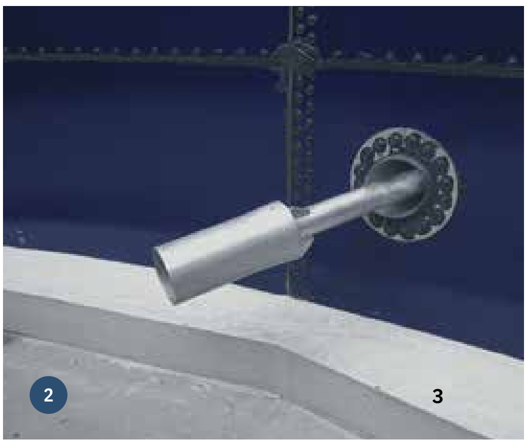
# Ideal for plants with highly polluted waste water

The design of the ejectors for the aeration process corresponds to that of a usual jet ejector. The air to be introduced is compressed in advance. Because of the high oxygen demand of organically polluted waste water and the increasing heights of modern biological waste water treatment plants it is energetically more efficient to pre-compress the air mechanically to the hydrostatic pressure prevailing at the installation point of the ejector and to supply it so to the suction connection. This waiving of a considerable pressure gain in the ejector reduces its necessary motive pressure. At the same time, more favourable mixing ratios (suction flow : motive flow) are achieved. Körting ejectors are equipped with a non-clogging spiral inside their motive nozzles. The motive jet thus disperses the air already at a low motive pressure in a myriad of fine bubbles which are then mixed vigorously together with the motive flow in the mixing element. This air/water mixture is injected into the aeration tank with a high turbulence. In this way the ejector guarantees optimum oxygen supply and a complete intermixing of the whole tank contents. Even with a high biomass concentration in the waste water it is still possible to attain flow velocities which prevent deposits on the bottom of the aeration tank.

## ADVANTAGES OF KÖRTING EJECTORS

- **Maintenance-free**
  No moving elements
- **High oxygen efficiency**
  Fine bubbles create large contact surfaces between air and water and high turbulence renews these contact surfaces
- **No deposits**
  The intensive jet flow directed towards the tank floor prevents deposits
- **Straightforward control of oxygen supply**
  by adjusting the air flow
- **Non-clogging construction**
  The motive nozzle diameter defines the narrowest flow area
- **No sealing problems**
  When the air supply stops, waste water can enter the air pipeline without negative effects and when re-started, the Venturi effect helps to expel any liquid in the pipe
- **Design according to requirements**
  Various sizes can be designed and adapted to customers' requirements

1) Multi-path ejectors inside aeration tanks
2) Installation from outside through the tank wall

# Multi-path ejectors inside aeration tanks

When equipping an aeration tank with Körting ejectors there will not be any moving parts inside the tank which would require maintenance. The ejector's wear and tear corresponds to that of a pipeline with a high flow velocity inside. Roots blowers, compressors and pumps can be installed outside the tank for easy maintenance.

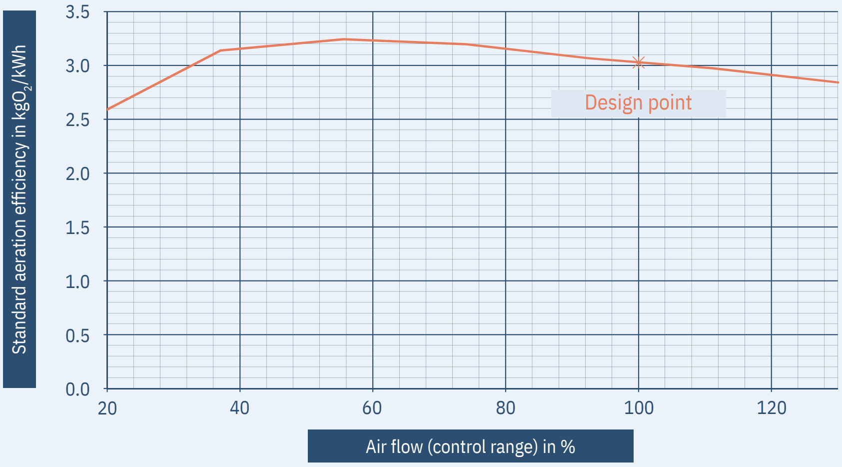
Twelve-path ejector made of PP

## OXYGEN TRANSFER EFFICIENCY

As oxygen transfer not only depends on bubble size (contact surface between gas and water) but to the same measure on the renewal of the gas bubble contact surfaces through turbulence of the waste water, ejectors – with their permanent circulation of the waste water – can so achieve a far higher oxygen efficiency than other aerators. With their inclined flow direction towards the floor Körting ejectors utilise the complete tank depth as entrance depth. Extensive oxygen supply tests in pure water (DWA-M 209) according to the oxygen adsorption method form the data basis for designing Körting aeration systems. All measurements were executed on full-scale plants and confirmed in numerous acceptance tests.

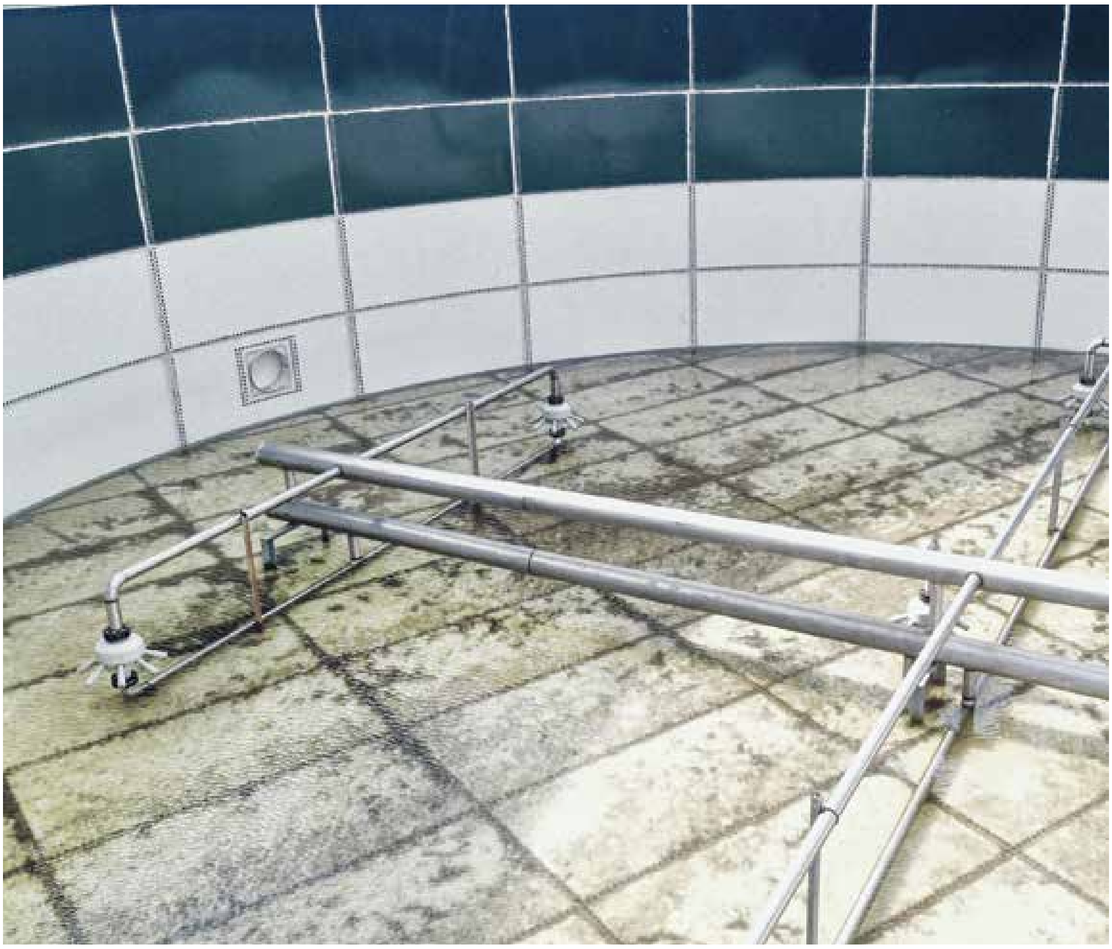
## CONTROL RANGE AND AERATION EFFICIENCY

Regulation of the oxygen supply is achieved solely by altering the air volume flow. A reduced air supply lowers the inlet pressure to the ejector, thereby additionally reducing the power consumption of the roots blower/compressor. At the same time the specific oxygen transfer efficiency is increased. The result is a nearly constant high aeration efficiency over the entire control range of the oxygen transfer system with its maximum value in partial load operation. Ejectors are designed – depending on the rheological properties of the activated sludge (temperature, dry solids content etc.) – for a suitable air/water ratio. The improved performance of the oxygen transfer system by simply increasing the air supply as well as its optimal optimal aeration efficiency in partial load operation are thus guaranteed at all times.




### STANDARD AERATION EFFICIENCY AS FACTORS OF THE CONTROL RANGE

For the calculation of the standard aeration efficiency practicable efficiency values have been considered for pumps and compressors (compressor: $\eta = 0.6$ centrifugal pump: $\eta = 0.75$)



Seven-path ejectors in a 2 200 m³ aeration tank in the cooking oil industry in Brazil

## DESIGN

The relatively short and detachable individual ejectors are connected to a common casing and supplied with motive flow from below and with compressed air from the top.

The jet flow is inclined towards the floor and the angle of exit is adapted individually to the installation conditions. As material we use polypropylene, which has excellent resistance to chemical impact.

For calcareous waste water, the motive nozzles or even the complete individual ejectors can be made of stainless steel. When there are high calcium carbonate concentrations in the aeration tank the choice of materials must always be adapted to the operating conditions.

## INSTALLATION INSIDE AERATION TANKS

Once the tank geometry, water depth and oxygen requirements have been determined then number, design form and arrangement of the multi-path ejectors can be adapted to the specific case. They are simple to install just between the two flanges in the pipelines for motive flow and compressed air.

Installation of compact units on the bottom of the guarantees comprehensive aeration and complete intermixing of the waste water.

# Installation from outside through the tank wall

The ejector shown here is made of stainless steel and is mounted from outside through the tank wall. Its connections for motive flow and compressed air are located outside the aeration tank.

These devices are equipped with a second downstream mixing element in which additional liquid is sucked in, thus to intensify the intermixing in the tank.

If required, the ejector can be equipped with a shut-off device downstream of the motive nozzle so that the motive nozzle can be checked at any time without emptying the tank.

This type of ejector allows a permanent availability of the oxygen transfer system, even with extreme concentrations of calcium carbonate in the waste water. Although the relatively large ejectors are inferior with regard to oxygen efficiency compared to our multi-path ejectors with finer air bubbles, their 100 % availability is often the decisive criterion for our customers. It is therefore not surprising that many plants have been realised in the paper industry and in dairy plants – sometimes also as a retrofitting action to replace inadequate aerators.

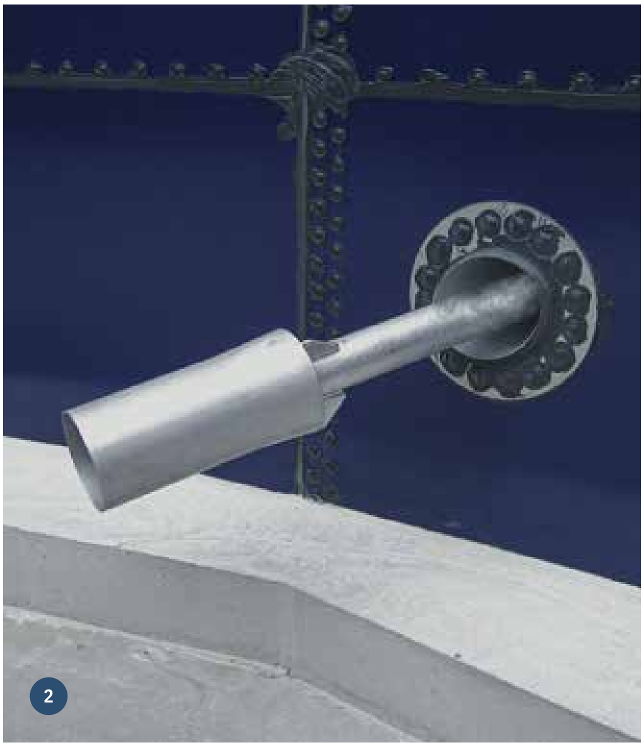
## OXYGEN EFFICIENCY

At the usual entrance depths of 5 – 8 m it is possible to achieve a specific standard oxygen transfer efficiency (SSOTE) of 11 g $O_2/m^3 \cdot m$. In partial load operation – at a reduced air flow – the specific standard oxygen transfer efficiency can be boosted above this value as far as 14 g $O_2/m^3 \cdot m$.

Depending on entrance depth and oxygen requirements, approx. 400 – 500 $Nm^3/h$ of compressed air can be injected by a single ejector.

**1)** Ejector from outside through the tank wall
**2)** Second downstream mixing element


1


2

**3/4)** 1 200 m³ aeration tank from a paper mill in Germany

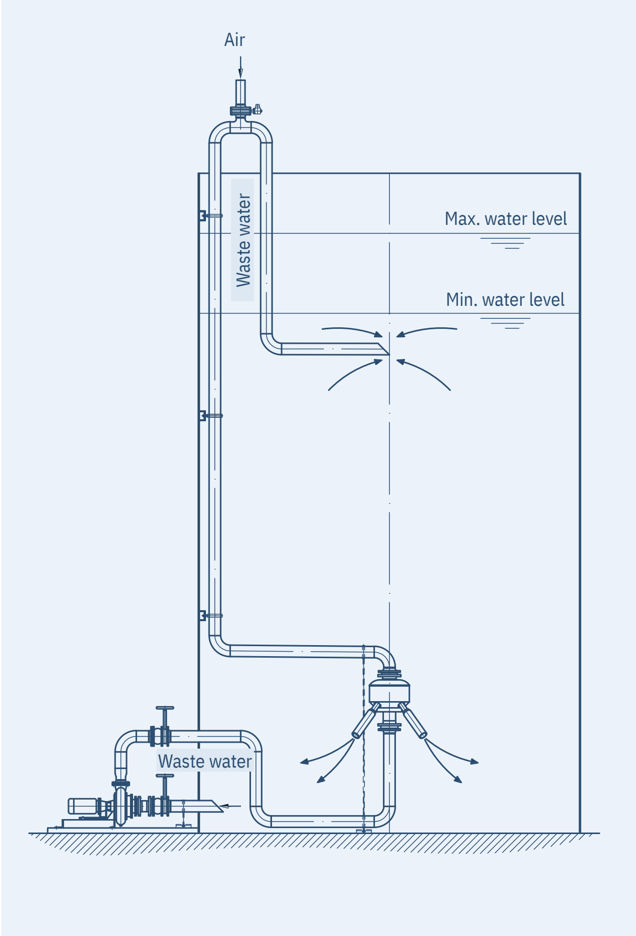
3

4

# Ejectors in SBR plants

Ejectors are ideally suited for the aeration and intermixing of so-called “SBR” plants (sequencing batch reactor). These aeration tanks in which, amongst others, the biological processes of nitrification and denitrification take place consecutively in the same tank, require a complete intermixing of the tank contents with and without air supply. Through the installation of special ejectors dedicated for this process, these can be utilised for the simultaneous aeration of waste water and intermixing during the aeration phase as well as for a an intensive circulation – without air supply – during the mixing phase.

Recirculation of the waste water through the ejectors takes place automatically at the end of the aeration phase. Both phases can be alternated as often as required, thereby supporting the independence of the waste water treatment process from the feed conditions.




SBR with atmospheric air intake

The ejectors, responsible for totally intermixing the tank contents during the mixing phase, are operated with the same circulation pumps used during the aeration phase. When the ejectors convey liquids, the power consumption of the circulation pumps is utilised to an optimum – even during the mixing phase.

From a certain reactor diameter, additional mixing nozzles are installed that are exclusively used during the mixing phase.

Ejectors and mixing nozzles for aeration and complete intermixing in an SBR reactor

## DESIGN ACCORDING TO REQUIREMENTS

The numerous design and arrangement possibilities of the ejectors and their differing operating methods with atmospheric air intake or compressed air provide ideal basic conditions for their application in large and small waste water treatment plants.

# Atmospheric intake

Through individual adaptation (motive nozzle, mixing element and diffuser) each water jet air compressor with atmospheric intake is customised for its operating conditions (filling height, oxygen transfer). The maximum oxygen supply at optimal energy utilisation is therefore always ensured.

The water jet air compressor can be installed in a tank as well as from outside through the tank wall. The motive side of the water jet air compressor is connected via a short pipeline to a circulation pump suited for the operation. The suction side is led out above the filling level by means of a pipeline or hose pipe.

Three water jet air compressors aerate and intermix the 4 000 m³ clear filtrate storage tank of the paper mill “Blue Paper SAS” in Strasbourg. Each water jet air compressor is operated by one circulation pump.

## COMPACT AERATOR

The so-called “compact aerator” is a combination of a water jet air compressor and a submersible pump mounted on a common base frame. The effort required for installation of this compact unit is extremely low.

Compact aerator / 11 kW

### COMPACT AERATORS ARE UTILISED PREDOMINANTLY FOR

- cost-efficient retrofitting of aeration tanks
- installation in mixing and equalisation tanks
- during conversion or for peak load coverage in aeration tanks

Mobile oxygen transfer system consisting of two ejectors and a submersible pump mounted on a common base frame; ready to be submerged in a waste water treatment plant.

Oxygen transfer system in the aeration tank of the Gebr. Lang GmbH paper mill in Ettringen, Germany. The six-path ejectors are supplied with gaseous oxygen from a stationary tank system.

# Ejectors for the introduction of gaseous oxygen

Ejectors for introducing gaseous oxygen are similar in design and function to apparatuses operated with compressed air.

They are installed principally within the aeration tanks and are operated by dry mounted or submerged centrifugal pumps. The difference to the ejectors operated with compressed air is that the gaseous oxygen is injected between the discharge side of the pump and the entrance to the ejector by a nozzle system installed in the connecting pipeline. Intermixing therefore takes place at the highest pressure level previous to entry into the ejector.

The intermixing is intensified while flowing through the ejector – whereby a considerable portion of the gas is dissolved already in the waste water. In the ejector, static pressure energy is converted to kinetic energy so that the two-phase mixture leaves the ejector into the aeration tank under high turbulence.

## DESIGN

In addition to multi-path ejectors, single-path ejectors are used as well. Installation can take place on the aeration tank floor as well as through the tank wall. All ejectors are manufactured from stainless steel, whereby the material quality depends on the respective waste water composition. Furthermore, their compact construction allows a later installation on a base frame as a mobile oxygen transfer system.

Mobile oxygen transfer system being submerged in the aeration tank of a company processing fruits and vegetables in Belgium. Installation was performed during plant operation by Westfalen AG. (Images © Westfalen AG, www.westfalen.com)

## FIELDS OF APPLICATION

In addition to oxygen transfer, ejectors can also be dimensioned for the complete intermixing of an aeration tank – without gas supply – so that their utilisation facilitates an intermittent nitrification/denitrification – without additional agitators. Deposits are prevented by the ejectors directing the flow over the tank floor. The oxygen transfer system is optimised by means of individual adaptation of the maintenance-free ejectors to the respective operating conditions while the power consumption and numbers of necessary pumps are reduced.

### EJECTORS ARE USED

- **for peak load coverage**
- **for basic load coverage**
- **for the introduction of gaseous oxygen generated as off-gas in ozone plants**

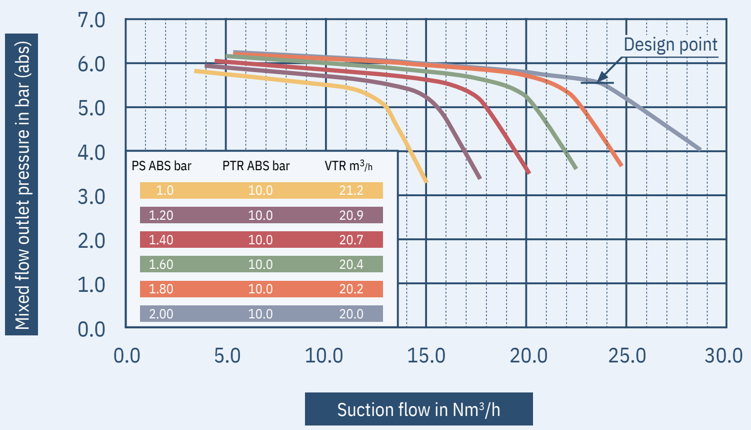
# Liquid jet gas compressors for introducing ozone

The introduction of ozone into liquids is an ideal field of application for liquid jet gas compressors. An ozone/air or ozone/oxygen mixture of approx. 10 % is taken from the ozone generator, vigorously intermixed with the liquid requiring treatment and then transferred under high pressure to the downstream system. The distinguishing features of our transfer technology include an excellent mass transfer and the absolutely leak-proof compression of the toxic gas mixture in the liquid jet gas compressor.

Since ozone is reduced to oxygen, it is ideally suited as an effective and environment friendly alternative to oxidation using chlorine or to other processes such as adsorption (e.g. activated charcoal) or separation (e.g. reverse osmosis).

In addition to the treatment of drinking water and waste water, ozone plants are also used in bleaching processes (e.g. paper pulp) and in other industrial oxidation processes.

**CHARACTERISTIC CURVE OF A LIQUID JET GAS COMPRESSOR**




Liquid jet gas compressor for ozone introduction in a municipal water treatment plant in Denmark

## TYPICAL FIELDS OF APPLICATION FOR OZONE WITH LIQUID JET GAS COMPRESSORS AS GAS TRANSFER SYSTEM

- **Cooling water disinfection with ozone**
  Ozone is used as an environment-friendly biocide instead of chlorine and organic biocides to prevent contamination of the cooling water and the formation of biofilms on heat exchangers.
- **Industrial waste water**
  Oxidation of persistent compounds that cannot be removed through other biological methods. For example, in waste water from the paper and chemical industry as well as refineries and from steel production.
- **Removal of trace substances**
  A number of pilot tests with ozone as an additional treatment stage have shown that ozone is a suitable measure for eliminating persistent substances. Ecologically and economically expedient ozone doses in the water can effectively remove existing trace substances.

Three liquid jet gas compressors for the ozone treatment of cooling water in a vertical transfer system on a common base frame (image © Xylem)

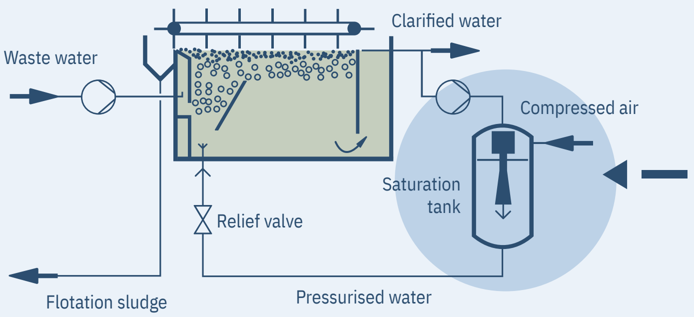
Liquid jet gas compressor for the ozone treatment of industrial waste water in a horizontal transfer system made of PVDF (image © Xylem)

# Liquid jet gas compressors for pressurised dissolved air flotation

Pressurised dissolved air flotation is a method of separating suspended solids. Microfine air bubbles adhering to the solid particles make them float to the surface where they can be removed. The air bubbles escape from the pressurised water being enriched with gas by lowering the pressure downstream of the relief valve.

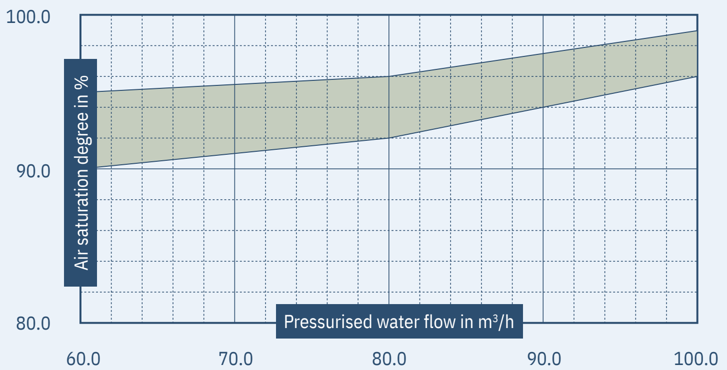
To saturate the pressurised water with air, a partial clarified water flow is utilised as motive flow for the liquid jet gas compressor. Compressed air is supplied to its suction side. The mixture comprising of motive and suction flow is fed – below liquid level – into the saturation tank.

A fine dispersion of air in the motive flow achieves an optimum air saturation degree of the pressurised water over the whole working range.




Pressurised dissolved air flotation as secondary sedimentation in a waste water treatment plant

**AIR SATURATION DEGREE IN A PRESSURISED WATER TANK GENERATED BY A KÖRTING LIQUID JET GAS COMPRESSOR**




Measurements acc. to H. Bennoit and C. Schuster, Steinbeis Transfer Center Meschede

# Liquid jet mixing nozzles

Körting liquid jet mixing nozzles create special mixing systems which can be applied for continuous as well as discontinuous mixing duties. They can be used as a complete replacement of mechanical agitators and in many cases surpass their mixing results.

Mixing nozzle in a denitrification

## HOW THEY WORK

A liquid flow is taken from the tank and supplied to the mixing nozzle via a centrifugal pump. Inside the motive nozzle, pressure energy is converted to kinetic energy. Underpressure is generated at the end of the motive nozzle, thereby sucking in liquid from the immediate vicinity. The suction flow is vigorously intermixed with the motive flow in the adjoining mixing element and accelerated by impulse exchange. The drag effect of the exiting mixed flow strengthens the mixing effect.

## YOUR BENEFITS

- **Low investment costs**
  Simple design
- **Maintenance-free operation**
  No moving elements
- **No sealing problems**
  No shaft passages through the tank wall
- **No dead zones**
  The individual arrangement of mixing nozzles permits installation in every tank geometry without influencing the mixing results

More information about the Körting liquid jet mixing nozzles and tank mixing systems can be found in the separate brochure and at **koerting.de/en**

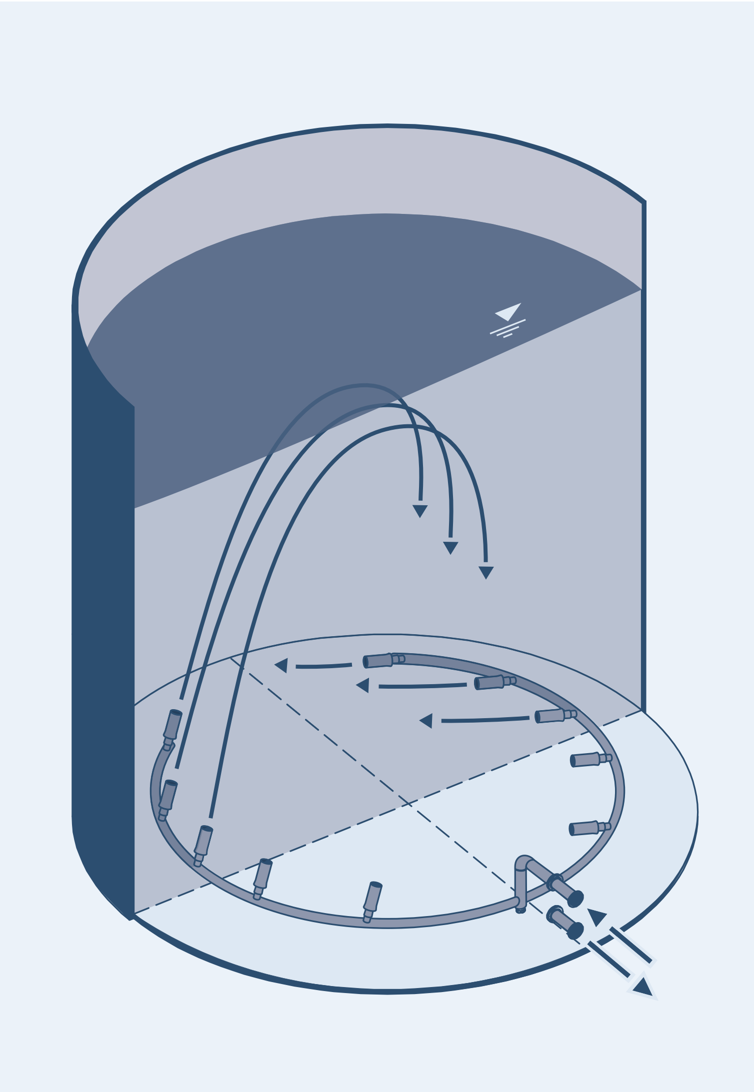
Liquid jet mixing nozzles for denitrification in an SBR plant

## INSTALLATION POSITION AND CFD SIMULATION

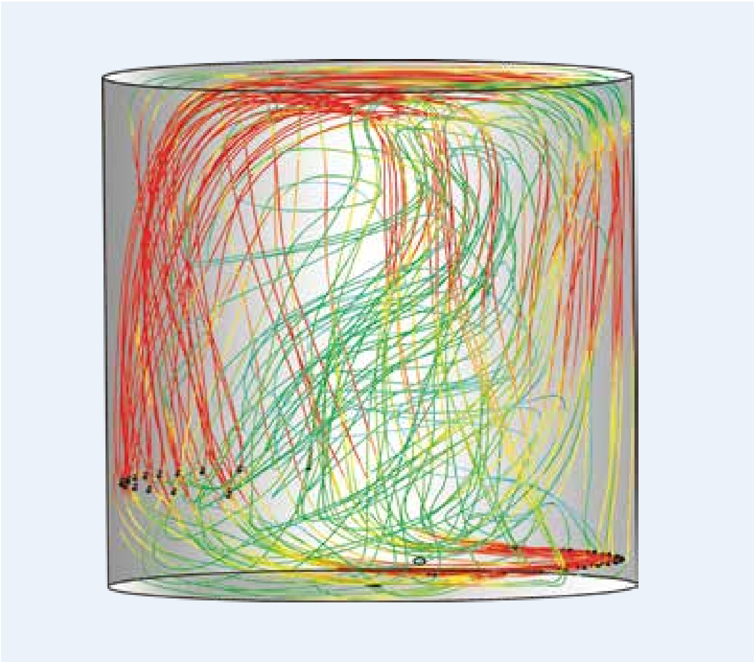
The installation of the mixing nozzles shall take place in accordance with our instructions. A corresponding installation sketch or drawing is included with the scope of supply. Recommendations for installations are available for nearly every tank geometry and ensure a complete intermixing of the tank contents. To optimise the mixing effects and minimise energy input a prior analysis of the installation situation and the performance data by means of computational fluid dynamics (CFD) simulation is available. First of all, the geometrical contours of the tank as well as the mixing nozzles arranged therein are reproduced. Subsequently a calculation grid is generated and the spatial flow profile determined by means of the CFD simulation is represented at different sectional planes.

The CFD simulation permits a very good evaluation of the overall system's mixing effect and can save energy.

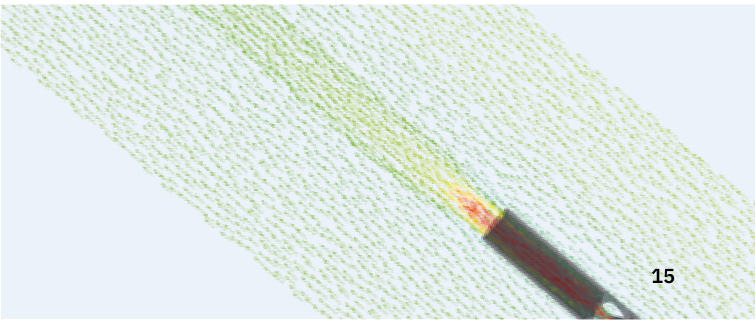
Liquid jet mixing nozzles with roller water flow for a 3 000 m³ buffer tank in the paper industry



Optimisation of the flow conditions in a cylindrical storage tank for edible oil through three dimensional computer simulation. Vertical section; spatial distribution of the flow velocity as a coloured halftone image



Numerically simulated flow conditions of a mixing nozzle



Körting Hannover GmbH
Badenstedter Str. 56
30453 Hannover | Germany

+49 511 2129 - 447
sales@koerting.de

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