**Aerated lagoons**
**for the treatment of municipal wastewater**

## General

Up to now several new methods of wastewater treatment in rural districts have been applied. The oldest and easiest type of wastewater treatment plants are sedimentation and oxidation lagoons, also referred to as “oxidation ponds”, “anaerobic ponds” or “naturally aerated ponds” respectively. However, to achieve satisfactory treatment results oxidation lagoons require a large amount of land area. For example 10 – 15 m² per population equivalent (p.e.) are needed in regions of temperate climate.

Particularly during the warm season anaerobic decomposition can generate odours. Therefore wastewater lagoons without mechanical aeration should only be built as temporary plants or in great distance from housing areas.

Small sewage treatment plants, which were frequently built in the past, often did not achieve the requested results. They proved to be very maintenance-intensive and susceptible to trouble.

Especially hydraulic overload or illegal feed of highly-concentrated wastewater (e.g. liquid manure or silo seepage) causes a long lasting breakdown of the treatment process.

Consequently, in the last few years preferably central treatment plants were built. Appropriate size, accurate design and correct maintenance result in high treatment standards. Furthermore central treatment plants are less sensitive to varying loads. However, large catchment areas are needed as well as wide-stretching sewers and high capital investment. The extended sewerage systems may considerably affect small rivers or other natural water bodies.

As financial means of communities are often limited, central treatment plants and large sewer systems become unaffordable.

Therefore, wastewater from less populated areas should be treated where it occurs. Aerated lagoons have proven very successful for this purpose. The most important advantages of this system are low maintenance and reliable treatment performance even at shock (peak) loads.
A properly designed aerated lagoon can easily meet with the effluent water quality standards applicable in Germany (COD $\leq$ 110 mg/l, $BOD_5 \leq$ 20 mg/l, SS $\leq$ 0.5 ml/l). Furthermore aerated lagoons can provide for stormwater treatment, if the design accounts for the additional storage capacity. Compared to oxidation lagoons, mechanical aeration reduces the area demand by app 90% to less than 2 $m^2$/p.e. Construction costs are much lower. Additionally, wastewater lagoons can be integrated into the surrounding landscape very well.

## Process description

A treatment plant for domestic wastewater should consist of a fine screen, two aerated lagoons in series and at least one polishing lagoon.

First, a fine screen removes coarse matter. A paved inlet zone in the first lagoon allows settlement of heavy sludge and grit. A scum baffle separates inlet zone and lagoon and prevents floating matter from entering the lagoon. Floating matter has to be removed manually once or twice a week with a rake.
According to our experience, sludge in the inlet zone of the first aerated wastewater lagoon has to be removed at regular intervals of several years. Liquid manure-vacuum-tankers are used to pump off the sludge.

Dissolved and suspended organic pollutants are distributed in the whole first lagoon.
Decomposable organic matter should mainly be stabilized aerobically to avoid odours or anaerobic sludge rising to the water surface.

The treatment process in aerated lagoons is similar to the natural process in flowing water bodies. Biological degradation of pollutants is based on attached growth. Unlike the “activated sludge process”, the active biomass builds a biofilm attached to the lagoon bottom and slope.

The biofilm needs continuous supply with oxygen and organic pollutants. In addition to sufficient oxygen transfer, circulating flow in the whole water body and effective mixing is required. The circulation of wastewater and dissolved oxygen ensures optimal conditions for aerobic growth at the lagoon bottom. Thus, organic pollution is highly reduced and dead zones can be avoided.

Polishing lagoons further improve the water quality. In particular, suspended light flocs of biomass settle down.

## Design Fundamentals

Aerated lagoons for municipal wastewater are designed according to the volume load and the retention time.

Volume load may not exceed 20 g $BOD_5/(m^3 \cdot d)$. This correlates to a specific volume greater than 3.0 $m^3$/p.e.

The retention time may not be less than 5 days even if a combined sewer system is used and infiltration rates are high.

According to our experience from more than 500 wastewater lagoons equipped with FUCHS OXY*STAR* Aerators, aerators for the first lagoon are chosen on the basis of organic load. 4 W/p.e. are required in the first lagoon.

Mixing requirements are the design basis for the second stage. According to the shape of the lagoons a power density between 1.3 - 2 $W/m^3$ is sufficient.

The aforementioned design criteria ensure sufficient oxygen transfer even at times of increased oxygen uptake, for example in early summer or at peak load. In times of low oxygen demand intermittent operation can save energy.

Two aerated stages in series are advantageous with regard to permanent high effluent quality. The first stage should have approx. 60%, the second stage approx. 40% of the total volume. A two-stage lagoon system performs much better than a one-stage design with reduced volume load.
Besides of hydraulic advantages, the process benefits from the biocenosis adapting to the specific conditions in each stage. Also, the two-stage design allows bypassing wastewater temporarily. Maintenance, for example desludging, is possible without causing a major deficit in treatment performance.

Polishing lagoons should provide 1 – 2 days retention time. This corresponds to a specific lagoon volume of 0.3 - 0.5 $m^3$/p.e.

## Stormwater treatment

Due to the long retention time and the low volume load aerated wastewater lagoons have a high capacity for peak load buffering.

Unlike activated sludge plants there is no danger for the active biomass to be carried out at hydraulic overload.

Accordingly, simultaneous rainwater treatment is easily possible. Often there are no special measures taken and the whole rainwater is led through the lagoons.

An improved solution includes additional storage capacity in the first lagoon. Stormwater is retained until, at maximum water level, an overflow or bypass structure goes into operation.

## Design of the lagoons

Aerated lagoons are often designed in rectangular shape. To enable a good circulation and mixing at low power demand, the corners should be rounded and the slope should not exceed a 2:1 (width to height) ratio.

It is also possible to adapt the shape of the lagoon to the surrounding ground. However, in this case more aerators of smaller size may be needed.

The depth of the lagoons should range between 2.00 - 3.00 m; mostly a water depth of 2.50 m is chosen. The angle of the slope corresponds to the local soil conditions. Normally it is 1:1.5 to 1:2.
Natural or clay lining should be used wherever possible. Plastic lining should be applied only in highly permeable soil in water protection areas.

The inlet zone of the first aerated lagoon should have a depressed floor level and it should be reinforced or paved, so that settled sludge and grit can easily be pumped off without risk of damage at normal waterlevel.

To prevent damages caused by muskrats, plants or erosion the slope should be reinforced at the height of normal water level.

The shape of the final clarification or polishing lagoon may vary in a wide range. However, short circuiting has to be avoided. The depth of the polishing lagoon should be approx. 1.20 m.

## Aeration of wastewater lagoons

FUCHS OXY*STAR* Aerators outstandingly meet the requirements of aerated lagoons.

If they are arranged appropriately in hydraulically well designed lagoons, they generate an even, circulating flow throughout the whole lagoon. OXYSTAR Aerators provide thorough mixing and oxygen supply in the entire water body at minimal power input.
For information concerning design and operation of these machines please see our brochure "Fuchs OXY*STAR* Aerator".

In large, round or square shaped lagoons a Fuchs CENTROX Aerator is placed in the centre. CENTROX Aerators generate a vertical flow pattern and complete the circular flow created by the OXYSTAR Aerators.

Both aerator types are very sturdy and virtually maintenance-free. Due to the low weight installation is easy and needs little time.

For use in lagoons, the aerators are preferably mounted on float assemblies.

The aerators have the following advantages:

- high circulation and mixing capacity
- virtually maintenance free
- no risk of clogging, even at intermittent operation or power failure
- no spray water → no aerosols or odours
  → low noise
  → trouble-free operation during frost

## Summary

Aerated lagoons are an efficient and cost-effective system for primary and secondary wastewater treatment in small communities. They can be integrated very well into the surrounding landscape.

If appropriate aerators are used the power input is similar to a comparable activated sludge plant. In addition to sufficient oxygen transfer the aerators have to provide for mixing and circulation.

Expenditures for maintenance and operation are restricted to a minimum

# Aerated Lagoons in Germany - Pictures

**Example 1**

- Inlet zone with scum baffle and walkway made of concrete
- 2 aerated lagoons
- 2 polishing lagoons

**Example 2**

- Inlet zone with scum baffle and walkway made of wood
- 2 aerated lagoons
- 1 polishing lagoons

**Example 3**

- Inlet zone with scum baffle and walkway made of concrete
- 1 aerated lagoon with reinforced slope
- 1 polishing lagoon

# Inlet zone

**Inlet zone with
scum baffle and walkway
made of concrete**

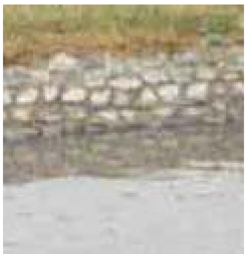
**Lagoon with plastic lining**

**Inlet zone with
scum baffle and walkway
made of wood**

**Paved inlet zone with
floating scum baffle**

**Inlet zone with
simple wooden scum baffle**

# Slope reinforcement



**Stone paving**

**Honeycomb paving**

**Gravel reinforcement**