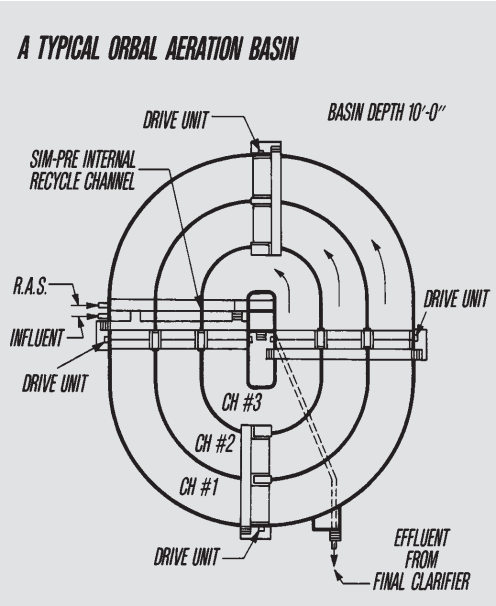
Water Technologies

# The Orbal® System For Biological Treatment

SIEMENS

*A typical Orbal Aeration Basin*




## FLEXIBLE, EFFICIENT, RELIABLE & SIMPLE

The Siemens Orbal® multichannel oxidation ditch is well-suited for conventional activated sludge, advanced secondary sludge treatment, simultaneous nitrification-denitrification, biological phosphorus removal and storm water treatment.

It is a complete mix, looped reactor system. Its principle benefits include:

## PROCESS ADAPTABILITY

The Orbal basin can easily be expanded to accommodate for future load conditions, either by adding on additional aerator assemblies to the existing channels, or by adding on an additional channel to the existing channels. State standards for multiplicity are met with single basin designs – since the Orbal process has dual basin capability in a single basin.

## DUAL BASIN CAPABILITY

The Orbal process can be easily modified to meet a wide assortment of influent conditions and effluent requirements, giving it exceptional process flexibility.

## OPERATOR CONVENIENCE

The Orbal basin, with its complete mix characteristics and its ability to operate at high MLSS concentrations, has a high buffer capacity for shock loads. The varying food to microorganism ratio (f:m) across its multi-channels promotes a MLSS with a low SVI and prevents sludge bulking.

## EASY MAINTENANCE

Only routine greasing of bearings is required. Aerator discs are non-fouling.

## ENERGY SAVINGS

The Orbal process requires less power to operate than any other oxidation ditch system.

# Benefits Of The Orbal Biological System

*This installation is typical of the more than 300 municipal and industrial Orbal biological systems in operation.*

## HOW THE ORBAL PROCESS WORKS

A typical orbal system uses the 0-1-2 punch for nitrification/denitrification. The Orbal basin has three concentric channels, with the outer channel having approximately 50% of the total volume. After screening and grit removal (optional), influent enters the outer channel which is operated under an oxygen deficit condition to promote simultaneous nitrification-denitrification. Though the actual oxygen demand of the first channel might be as high as 75% of the total, the aeration discs allotted to this channel supply only 30-60% of the system's overall oxygen requirements to ensure a constant oxygen deficit condition and an operating DO of zero throughout the channel. The simultaneous nitrification-denitrification environment of the first channel results in an overall denitrification performance rate of 80%, without internal recycle. The first channel, where the majority of the process "work" takes place, is classified as an aerated anoxic reactor. Despite the zero DO conditions, the majority of the system's nitrification takes place in this channel.

The DO of the second aeration channel operates in a "swing" mode. Although designed for 1 mg/1DO, the actual operating DO varies with the daily load conditions, being reduced to near zero during the peak loads of the day, and rising to 2 mg/1 during low load conditions.

## SIM-PRE® MODE FOR TOTAL NITROGEN REMOVAL

The DO of the last channel is designed for 2 mg/l, keeping this channel in a "polishing" mode to remove any remaining BOD and ammonia before the flow exits to final clarifiers. Since the oxygen demand of the last channel is only a fraction of the first, only a small amount of oxygen need be delivered to maintain a high DO.

Adding internal recycle to the Orbal process (from the third channel to the first) allows 95% or greater total nitrogen removal performance results. Design recycle rates vary from 1:1 to 4:1 (internal recycle flow to raw flow) depending upon application.

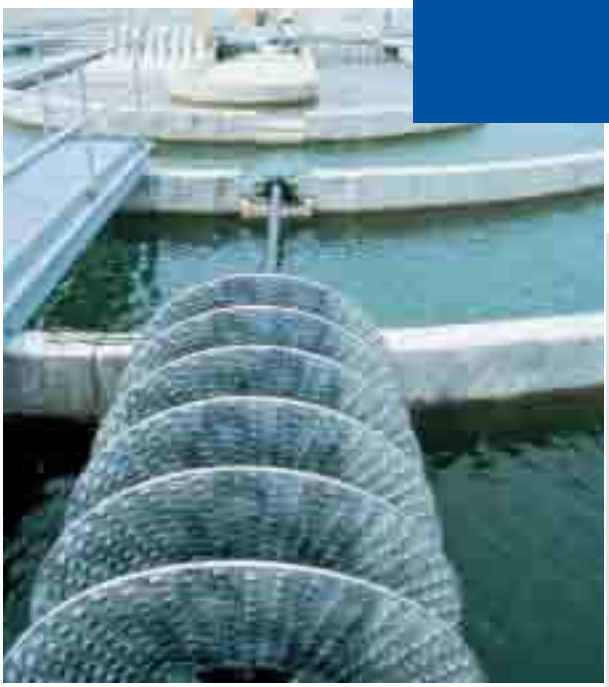
This arrangement offers a combination of simultaneous nitrification-denitrification (the conditions that prevail in the first channel) and predenitrification (where the majority of nitrates formed in the second and third channel are sent back to the first channel).

Orbal systems operated in the Sim-Pre® simultaneous pre-process mode have produced monthly average effluent TN levels lower than 1 mg/l and lower than 1 mg/l P (without chemicals). See Chart on the left for performance data.

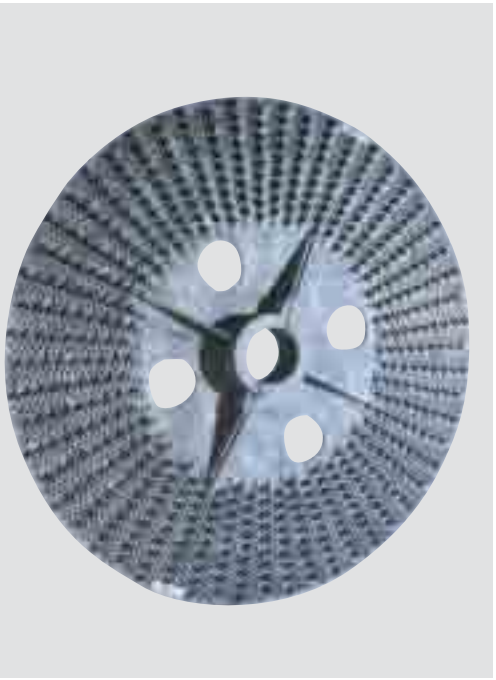
ORBAL SIM-PRE SYSTEM
Hammonton, NJ
Monthly Average – July, 1996

| | TKN | $NO_3$-N | TN |
|---|---|---|---|
| INF. | 38.0 | – | 38.0 |
| EFF. | 0.47 | 0.24 | 0.72 |

# The Aeration Disc Efficiently Aerates And Mixes



*Typical Orbal process basin arrangement*



*The Orbal process disc is manufactured of a molded thermoplastic compound immune to the effects of wastewater. The discs are 4 1/2 feet in diameter.*

## THE ORBAL PROCESS AERATION DISC IS ACCOMMODATING

The mechanical backbone of the Orbal system is its unique aeration disc with its high oxygen transfer efficiency and unmatched mixing efficiency.

The aeration and mixing is provided by triangular nodules on the face of the disc. The nodules have a base-face or an apex-face; changing the rotation direction of the disc will change the delivery and power characteristics. Delivery and power also vary with changes in immersion (from 9" to 21"), changes in speed (from 30 to 60 rpm) or with discs added on or removed from individual assemblies.

The disc is split into two half sections and can be directly attached to the aerator shaft at any location. This makes it easy to add on discs to existing shaft sections for future purposes.

Individual assemblies span one or more channels, the number of discs allotted per each channel being a function of the oxygen delivery requirements. In larger Orbal process designs multiple assemblies are provided.

Daily fluctuations in oxygen demand are handled by changes in the disc immersion. Long-term variations or sudden surges in demand are handled by turning on/off individual assemblies. Unexpected or emergency conditions are met by increasing the speed.

# The Orbal Process Has High Mixing Efficiency And Low Energy Requirements

*Orbal process discs in operation. An Orbal system needs only one horsepower per 100,000 to 200,000 gallons for efficient mixing.*

## ONE HORSEPOWER PER 100,000 TO 200,000 GALLONS

Mixing efficiency, defined as the number of gallons mixed per 1 hp to maintain a 1 fps channel velocity, is an extremely important feature of the Orbal system. It allows the Orbal basin to continue to keep a zero DO in the first channel during extreme underloaded conditions — while still keeping a velocity sufficient to keep solids in suspension. Independent mixing devices are not needed to maintain anoxic conditions in the first channel.

The mixing efficiency of the aeration discs in an Orbal basin is unmatched by any other aerator device. As an example, an outer channel with 1 million gallons of volume, requires only 5 hp of disc aerators to maintain a 1 fps channel velocity — or 20 hp to keep a 2 fps velocity (enough to keep grit in suspension). The high mixing efficiency of Siemens aeration discs in the Orbal system ensures the ultimate in biological process performance under almost all load conditions.

## LOW ENERGY REQUIREMENTS

The discs are designed to provide a low-level oxygen delivery intensity within the Orbal basin, the delivery rate typically being less than 2 lbs O2/hr per foot of shaft. This ensures maximum transfer efficiency under field conditions. In the first channel, where the operating DO is kept at zero and the oxygen demand is the highest, DO is zero entering the aerator and approximately zero leaving the aerator. However, due to the high circulation rate and multiple aeration locations, the average flow particle will pass through an aeration zone more than a thousand times, ensuring a high degree of oxygen transfer. Single channel ditches, with only one or two high delivery intensity aerators, saturate the liquid leaving the aerators with higher DO levels, resulting in lower oxygen transfer efficiencies.

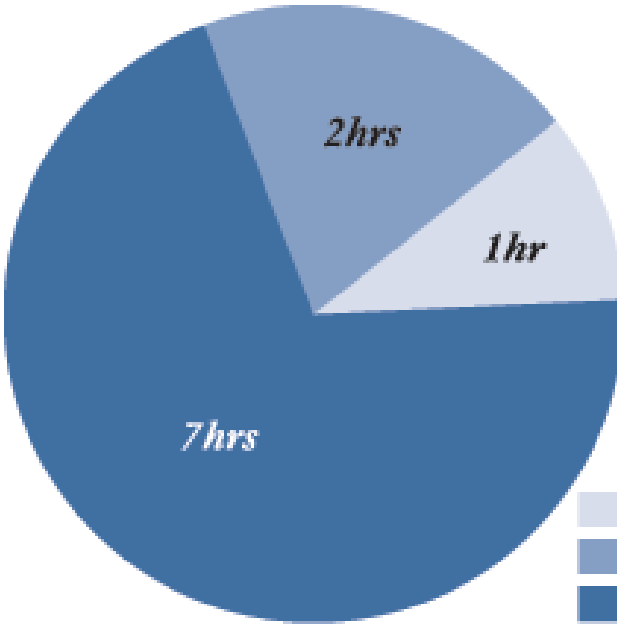
The Orbal process, with its natural high level of denitrification, its stratified DO levels across its three channels, and its low delivery intensity, will typically require 35% less oxygen delivery than a standard, single channel ditch.

# Other Orbal Process Applications

*Detention times in outer channels. From right to left*

*Orbal process design for biological phosphorus removal*

*Typical Orbal process design*




## STORM TREATMENT MODE

Excessively-high flows during storms are the bane of many treatment plants, causing clarifier solids washout and long-term loss of treatment performance. To prevent this type of problem, many plants design larger, more expensive clarifiers — or, operate at reduced MLSS levels (requiring larger aeration basins to maintain the same solids inventory) — or, add expensive equalization basins in front of the aeration tanks.

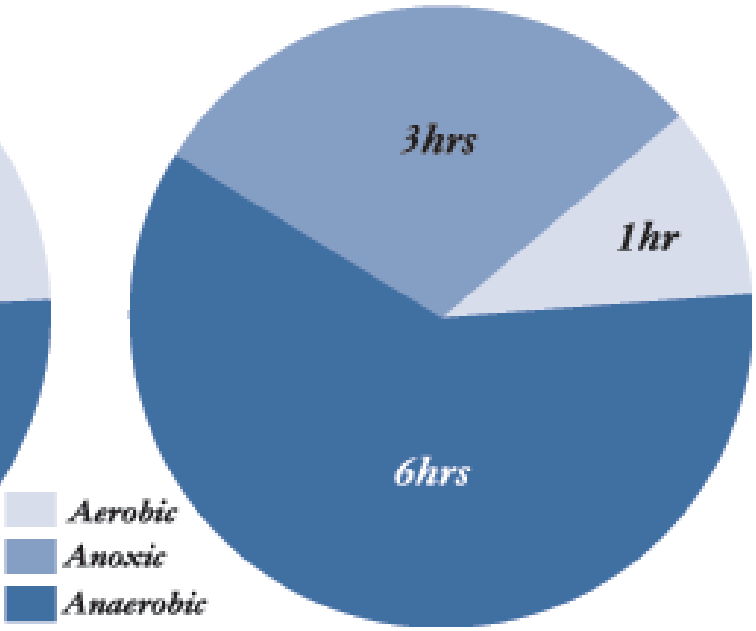
With the Orbal process, none of these remedies are needed. Stormflow rates five times the average flow can go through the Orbal basin without the danger of clarifier solids washout — or loss of process performance. This is accomplished by redirecting the influent flow (including stormflow) to an inner channel (typically the last) while keeping the return sludge flow in the first channel. The result is a quick increase in solids concentration in the first channel and a dramatic drop in MLSS in the last channel, which allows the solids loading on the clarifier to be dropped below design levels. When flows return to normal, the influent is returned to the first channel and the Orbal process shifts back into its conventional mode.

This treatment mode has been successfully used in hundreds of Orbal plants. These plants have experienced extremely low levels of BOD, SS and ammonia despite excessively high clarifier overflow rates when switching to this mode during storms.

## BIOLOGICAL PHOSPHORUS REMOVAL

To maximize biological phosphorus removal, the oxygen delivery in the first channel of the Orbal basin is reduced to levels lower than normal, allowing the oxygen deficit condition to become much stronger. This strong deficit condition in the first channel, coupled with an elevated sludge yield rate, will allow most plants to achieve effluent phosphorus levels of 1 mg/l or lower without chemical addition.

# Vertical Loop Reactor – An Orbal Process Variationn



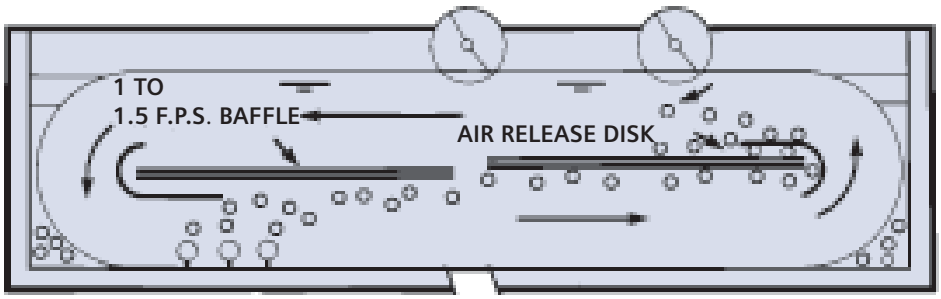

The Vertical Loop Reactor (VLR®) oxidation basin system has the process kinetics of the Orbal process with a much smaller foot-print. Essentially an oxidation ditch on its side, the VLR system can be designed for liquid depths greater than 20'. Each basin is divided into two compartments, an upper and a lower. Discs are located in the upper compartment for oxygen delivery and mixing; coarse bubble diffusers are located in the front part of the lower compartment for supplemental oxygen delivery. Air in the lower compartment is contained beneath the horizontal divider baffle (see diagram) for the full length of the tank, substantially increasing the retention time of the air in the liquid — the longer retention time doubling the OTE of the coarse bubble diffuser.

Besides increasing the efficiency of the coarse bubble air, the horizontal divider baffle acts as a structural beam to reduce the thickness of the side walls.

VLR systems, using multiple tanks in series, have the same process benefits of the Orbal system — including total nitrogen removal, biological phosphorus removal, stormflow treatment, and DO stratification across multiple reactors for energy savings. Because of the greater liquid depth and the common-wall rectangular tank configuration, the VLR system requires about half the land area of the Orbal system. Also, more aerator flexibility is provided with the VLR system — two sources of air being available to the operator. All reserve oxygen is provided by turning on more coarse bubble air; excessively-high peak delivery demands can be handled by including another air blower in the design.

*Orbal Aeration Disk*

*Section view Vertical Loop Reactor*




*Coarse Bubble Diffusers*

*Bubble Detention Time:*
*Lower Zone — 50 seconds*
*Upper Zone — 15 seconds*
*Total Detention — 65 seconds*

The mechanical components of the disc aerator assembly are simple to maintain or to replace. Shaft sections are solid steel with machined ends; no welded stub ends or welded collars are included. Each shaft end is supported by conventional split-housing pillow blocks. Multiple shaft sections include a non-lubricated flexible coupling.

The gentle, non-pulsating entry of the aeration disc into the liquid results in longer operating life for all component parts, including the drive and the disc itself.

Splash shields are included at every bearing location — pillow blocks, couplings and drives are kept in a completely dry environment. In cold weather applications, fiberglass weatherhoods cover the aeration discs to prevent ice build-up. Either shaft-mounted or based-mounted drives are available.


For further information please contact:

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*A bearing and coupling arrangement with splash shield.*

*Fiberglass weatherhoods in operating position.*




EN-ORBAL-BR-0706
Subject to change without prior notice.