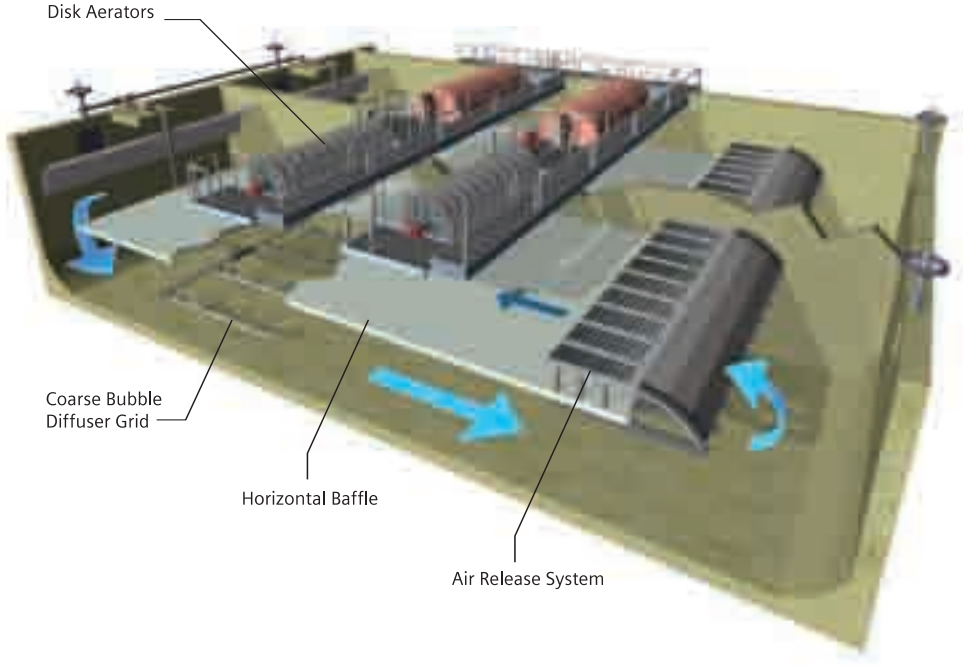
Water Technologies

Vertical Loop Reactor For Biological Treatment

SIEMENS

The Vertical Loop Reactor

The six basins of the Vertical Loop Reactor process share common walls, reducing construction costs.



The Vertical Loop Reactor (VLR®) process is a design based upon looped reactors in series that allows DO stratification. As such, it is suited for simultaneous nitrification/denitrification; biological phosphorus removal and storm water treatment.

The VLR process is installed in a rectangular tank, and is similar to an oxidation ditch that has been flipped on its side. There is an upper and lower compartment, separated by a horizontal baffle running the length of the tank. Commonly, three basins make up a VLR system. The VLR process is adapted from proven Orbal™ process technology and uses the same surface mounted discs to provide mixing and to deliver oxygen.

The construction cost of a VLR basin is less than that of a comparable conventional oxidation ditch. Because the horizontal baffle is a structural cross beam supporting the side walls, side walls can be designed 12 inches (305 mm) thick for 20 feet (6.10 m) deep tanks.

BENEFITS

- Common wall construction - lower construction cost.
- Small footprint - less land area required.
- Dual aerator design - operating flexibility.
- Lengthy aeration retention time - low power costs.
- Coarse bubble diffusers - easy to meet peak oxygen demands.
- DO stratification - process adaptability.

VLR OPERATIONS

The typical VLR system has two or more rectangular tanks placed side by side and operated in series. Like the Orbal process, the first tank is used as an aerated anoxic reactor in which an oxygen deficit is maintained and the DO level kept near zero.

In designs with three or more tanks in series, the aerated anoxic conditions may extend beyond the first tank. The last tank is operated with a DO level of 2 mg/l or higher.

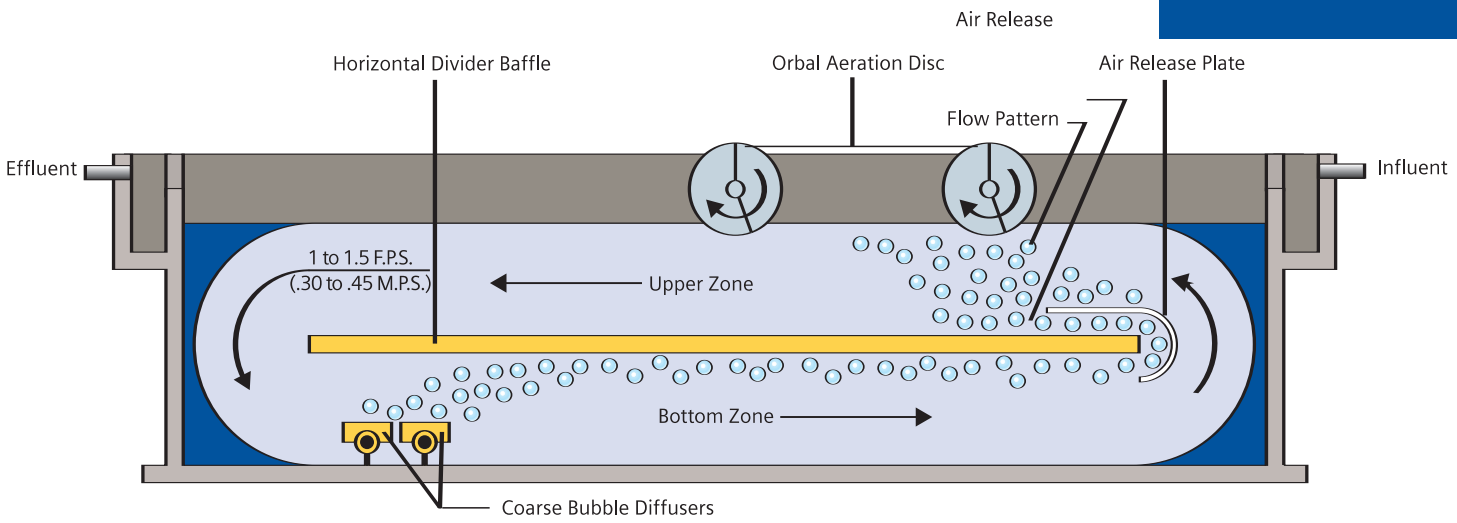
Most VLR systems are designed for liquid depths greater than 20 feet (6.10 m). The horizontal baffle is located about mid-depth so that both upper and lower compartments are about 10 feet deep (3.05 m). The surface aeration discs establish an “over and under” mixing pattern, with the flow direction on the surface opposite the flow direction on the bottom.

The surface discs are typically sufficient for mixing the entire tank. Coarse bubble diffusers in the first quadrant of the lower compartment supply any additional oxygen required by the process.

The horizontal baffle prevents the coarse bubbles from immediately rising to the surface. Instead of a retention time of only a few seconds, the air bubbles must travel the full length of the tank and then be re-released through a special perforated air release plate.

The Vertical Loop Reactor process has low power costs because of the inherent lengthy aeration retention time.

VLR Operations



The VLR process provides an overall retention time of from one to two minutes. This raises the SAE of the coarse bubble diffusers to 4 lb O_2/bhp.h (1.35 kg O_2/kW.h), more than twice their rating in a conventional aeration tank.

In effect, the one time cost for the baffle reduces the on-going power costs of the blowers. At the same time, it allows the process to deliver fine bubble efficiency with coarse bubble reliability.

First introduced in 1986, there are more than 30 VLR plants in operation ranging from 0.2 mgd (.7 MLD) to 41 mgd (155 MLD). Typically, however, the VLR process is recommended for flows of more than 1.0 mgd (3.8 MLD). To reduce aeration disc requirements, designs with BOD loadings above 16 lb BOD/1000 ft^3.d (0.26 kg/m^3/d) are suggested. The VLR process is most economically attractive in the loading range of 20 – 40 lb BOD/1000 ft^3.d (0.32 – 0.64 kg/m^3/d).

VLR PROCESS APPLICATIONS

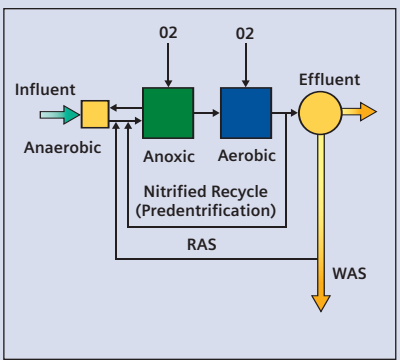
Plants utilizing the VLR process have been designed for stringent effluent ammonia requirements and phosphorus removal. A number of VLR plants have been designed for excessive storm water treatment, with peak flows five times the design flow.

The VLR system has also found industrial application, especially when flows and loadings vary. Peak oxygen delivery demands can easily be handled without designing in a major amount of additional mechanical aeration equipment. Peak demands are handled by turning on additional blowers and increasing the air flow rate through the coarse bubble diffusers.

The process should be considered when land area is limited, when biological nutrient removal requirements are present, when stormflow rates are high and BOD loadings fluctuate widely.

Existing rectangular tanks can be retrofitted to VLR tanks. Tanks should be at least 40 feet long (12.2 m) and 12 feet deep (3.6 m).

For purposes of total nitrogen removal or for biological phosphorus removal, VLR tanks can be added in front of existing aeration basins and used as aerated anoxic tanks. The VLR process is excellent for operating under anoxic conditions since it requires minimal power draw for obtaining channel velocities.



Aerated Anoxic with Anaerobic Selector Nitrogen and Phosphorus Removal

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