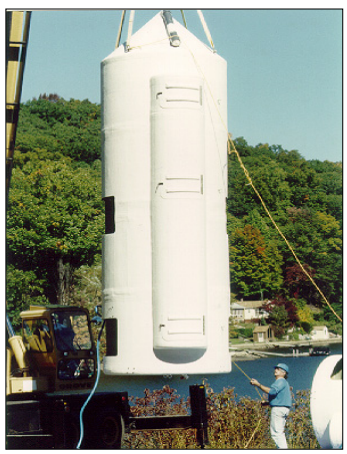
Aeration Techniques – *Ecosystem Consulting Service, Inc.*

Ecosystem Consulting Service, Inc. offers a full line of aerators for all of the available aeration approaches. All equipment designed, fabricated, and installed by ECS is constructed of the highest quality materials suitable for long-term service in water: fiberglass, stainless steel, etc. Each system is customized to the unique features of a specific application in order to optimize cost effectiveness. Factors such as depth, water level fluctuation, depth-discrete volumes, stratification dynamics, oxygen demand, resource uses, water supply intake locations, and habitat suitability requirements form the design criteria for selecting and optimizing an aerator design.

Artificial Circulation – "Destratification": Most applicable for shallow water bodies (generally <15 ft deep) which do not stratify strongly enough to perform hypolimnetic or layer aeration. Also useful as an "operating mode" in an aeration system to delay stratification, enhance Spring diatom dominance, controlled mixing in Fall, and for winter treatment for alewife control and to prevent winter kill. Artificial circulation is also useful in lakes and reservoirs in which phytoplanktonic productivity is not limited by nutrient availability (helps to promote dominance by non-nuisance green algae) and where control of anaerobic respiration product accumulation (Fe, Mn, H_2S) is the main objective.

Hypolimnetic Aeration: Most applicable in deep lakes where oxygen loss ascends to the top of the hypolimnion *but does not ascend above the thermocline*. Especially useful in lakes and reservoirs in which the iron cycle dominates anaerobic respiration and controls internal phosphorus dynamics. Applicable for coldwater fishery habitat restoration in lakes which still exhibit a highly aerobic metalimnion.



Layer Aeration: Most applicable in deep lakes where oxygen loss ascends above the thermocline and results in significant loss of cool water habitat (for cold water fish and zooplankton refuge), and internal nutrient loading that stimulates bluegreen algae blooms. Especially useful for coldwater fishery habitat restoration, water supply quality (when several vertical intake gates are available), and in lakes which exhibit very high areal oxygen demand. Layer aeration "adjusts how stratification develops", but does not destratify the water column.

Layer Aeration establishes a mixed aerated water layer in the middle of the water column, typically from the bottom of the epilimnion several meters down into the hypolimnion. The layer is bounded above and below by thermoclines. The thickness of the aerated layer and vertical positioning is designed specifically for a particular lake in order to utilize photosynthetic oxygen production above the compensation depth, maintain aerobic conditions over a large bottom area, maintain water quality at the depth of water supply withdrawal gates, and reduce the area and volume of the deepest hypolimnion. The smaller hypolimnion remains isolated, and can have some oxygen input to maintain a higher oxidation-reduction potential to prevent hydrogen sulfide accumulation and operate the deepest bottom area in the nitrogen and iron cycle very efficiently.

Oxygenation – Pneumatic DownFlow Technology: In lakes and reservoirs which exhibit extremely high oxygen demand, or where use of pure oxygen is desired, a downward water flow can be established in a chamber of a Hypolimnetic or Layer Aerator in order to serve as a gas-water contact reactor. The downward flow slightly exceeds the rise velocity of introduced oxygen bubbles, creating very long contact times to optimize gas-solute transfer efficiency. The approach uses air-lift pumping technology – no underwater electrical or mechanical components are required.

For additional technical information see:

Kortmann, R.W. and P.H. Rich, 1994. **Lake Ecosystem Energetics: The missing management link**. *Lake and Reservoir Management Journal*, 8(2):77-97.

Kortmann, R.W., G.W. Knoecklein, C.H. Bonnell, 1994. **Aeration of Stratified Lakes: Theory and Practice.** *Lake and Reservoir Management Journal*, 8(2):99-120.

US Patents: 4,669,914; 4,724,086; 5,755,976

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Aeration Systems: Materials and Methods

Ecosystem Consulting Service, Inc. offers a full line of aerators for all of the available aeration approaches. Each system is customized to the unique features of a specific application in order to optimize cost effectiveness. Factors such as depth, water level fluctuation, depth-discrete volumes, stratification dynamics, oxygen demand, resource uses, water supply intake locations, and habitat suitability requirements form the design criteria for selecting and optimizing an aerator design.

Air Lift Pumping

The buoyancy of a mixture of water and air bubbles provides the pumping action of the aerators. This is called “Air Lift Pumping” and has been used for many years for pumping water. Air Lift Pumping is very efficient for pumping large volumes of water in low head applications. In other words, air lift pumping is excellent for moving very large volumes of water when it doesn’t need to be pumped far above the surface. Compressed air from a land-based compressor system is carried through high density polyethylene pipes to diffusers which release it as small bubbles, creating the Air Lift Pump.

Full-Lift Aeration

In “Full-Lift Aeration” the bubble-water mixture jets all the way to the lake or reservoir surface where the gas bubbles are released. In Artificial Circulation (destratification) the diffusers are in the open water column. Air lift pumping causes a bottom-to-top circulation pattern. In Full-Lift Hypolimnetic or Full-Lift Layer Aerators the diffused bubble-water mix jets up through a vertical chamber to a surface structure where bubbles are released; water is returned to selected depth(s). Full-Lift aerators tend to be the most efficient for gas-solute transfer, and most easily observed and monitored. Full-lift aerators are most applicable in lakes and reservoirs where surface structures do not interfere with lake uses, and where wide fluctuations in surface elevation occur seasonally. In monomictic lakes (no winter ice cover) the aerator can remain permanently at the surface. In dimictic lakes a telescopic design is used with automatic buoyancy chambers which float the surface structure only when the system is on.

Partial-Lift Aeration

In “Partial-Lift Aeration” (Hypolimnetic or Layer Aeration) the bubbles are separated in a chamber below the surface and excess air is vented to the surface. Although slightly less efficient than full-lift, Ecosystem Consulting Service has developed apparatus features which maximize efficiency, including customizing aerator length to maximize gas-solute contact time, internal flow pattern, and down-flow chambers which serve as contact reactors for solute phase transfer. Partial-Lift Aerators have no surface structure to interfere with lake uses.

Construction Materials

All apparatus installed in a lake or reservoir is fabricated from high quality materials suitable for long-term in-water service, potable water grade, including reinforced unitized fiberglass, stainless steel hardware, EPDM rubber membrane diffusers, UV stabilized nylon, etc.

Although standardized design principals are used, each aeration system is customized to the specific features of a lake or reservoir (depths, vertical and longitudinal supply intake locations, trophic state and oxygen deficit rate, water level fluctuation, stratification intensity and dynamics, heat load and distribution, aerobic and anaerobic metabolic pathways (Fe vs S generating lakes), habitat suitability criteria for zooplankton refuge and secondary consumers, and lake-specific morphometry (areas and volumes of depth intervals), and other unique features).

A full range of aerator sizes are available for Artificial Circulation, Layer Aeration, Hypolimnetic Aeration and Special Treatments in water bodies ranging from less than an acre, to deep reservoirs covering thousands of acres.

Flow Routing Systems, Pneumatic DownFlow Oxygenation, and Innovative Techniques:

Ecosystem Consulting Service continues to invent and develop cost-effective management methods that work in concert with Nature. Depth-selective flow routing controls how water enters, flows through, and exits a lake in order to manage depth discrete flushing rates, vertical fluxes and the balance between trophogenic and tropholytic ecosystem processes. Pneumatic DownFlow Oxygenation (driven by air-lift pumping) was developed to eliminate the need for high cost maintenance associated with electrical/mechanical machinery under water. Alum surrogates (e.g. aluminum nitrate) were identified to advance the utility of nutrient inactivation approaches while reducing associated impacts (at the bottom of a lake nitrate is nearly as beneficial as oxygen). Water supply intake isolation (from poor quality raw water) and retro-fit intake attachments for depth-selective withdrawal help provide the highest quality raw water.

First understand Nature, then work in concert with Nature to accomplish management goals.

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