The Pond 1 by Lake Aid Systems is a wind- powered vertical aerator.

Dissolved Oxygen Key To Lake Health

The world is quickly accepting the fact that fresh water is a limited resource. Whether on the surface or hidden in subterranean aquifers, water is attracting the attention and concern of a growing number of people. Its protection is a national priority and is largely in the hands of managers of recreational areas.

Sports turf managers and golf course superintendents today are expected to guard closely the health and appearance of lakes, ponds, and reservoirs under their care. At the same time, they are being forced to utilize recycled water for turf and landscape irrigation. As a result, they must expand their knowledge of lake management and apply all available technology.

Algae blooms, odors, fish kills, and infestations of aquatic weeds are all symptoms of imbalanced biological activity in water. Sunlight, temperature, and the presence of organic nutrients from runoff, plants, or wildlife must all be balanced with an adequate supply of oxygen to prevent lakes from degrading. After all, the natural process of evolution for lakes is to fill in and disappear. People speed this process up with some of their actions. On the other hand, they can also slow or reverse lake degradation.

Leaves, clippings, animal wastes, and dead aquatic plants in water are broken down by bacteria rapidly when enough dissolved oxygen is present. If this vital gas is lacking, organic waste settles to the bottom where bacteria and other microorganisms slowly break it down without oxygen. Anaerobic (without oxygen) decomposition releases hydrogen sulfide and methane, the sources of odors often associated with stagnant lakes.

Undecomposed debris accumulates on the bottom and gradually decreases the depth of the lake. As Charles Barebo of Otterbine Barebo, Inc., points out, a two-acre irrigation reservoir can lose one third of its capacity to hold water within five years because of sludge buildup. As lakes become shallower, sunlight can reach the bottom, allowing aquatic weeds to get established. Without a management program, lakes have to undergo expensive dredging frequently.

The primary natural source of dissolved oxygen is wave action. Aquatic plants also release oxygen during respiration. Nature depends upon these to supply oxygen for bacterial decomposition. Anything which limits or disrupts air flow over a lake can result in a serious reduction in dissolved oxygen. Plant production of oxygen is dependent upon sunlight, stopping at night and slowing on cloudy days.

The other important aspect about dissolved oxygen is that it is often trapped near the surface unless mixed into the lower depths of a lake by wave action or current. As temperatures rise in the spring, warmer water near the surface becomes more buoyant than the water below. Without some form of mixing, layers of water form in a process called stratification. Warm water also holds less oxygen than cold. Not only does the warm surface layer hold less oxygen, it blocks this vital element from reaching lower levels. Fish and other organisms continue to withdraw oxygen from the water regardless of the season.

The only other natural source of oxygen is respiration by plants. Algae, floating plants, and emerged plants near the shoreline are of little benefit to stratified lakes. Yet submerged plants, such as bladderwort,

coontail, elodea, naiad, waterstargrass, and watermilfoil may produce enough oxygen on sunny days to prevent fish kills.

Lake managers should be on the alert for fish kills in the summer when clouds block the sun for extended periods. Cold summer rains or strong winds have also been known to kill fish by mixing oxygen-deficient bottom water with the other water in stagnant or stratified lakes. Fish kills can also take place in the winter. A long-lasting, thick cover of ice and snow blocks air exchange and sunlight.

Algae is perhaps the greatest problem of irrigation reservoirs and lakes. It thrives on nutrient-rich, warm water near the surface. These conditions cause a bloom of dense algae growth or mats. The mats restrict wave action and block light from penetrating the lake surface. Without light, plants below the surface die and bacteria utilize any existing oxygen to break them down. As a result, there is little to no oxygen left for fish or further decomposition. Lakes in this condition are known as eutrophic.

Avoiding eutrophication and degradation of lakes requires a combination of curative and preventative measures. It starts during construction and never ends. Lakes should be at least eight feet deep and have relatively steep banks to discourage establishment of bottom-rooted weeds. Liners can be installed for the same reason or to prevent leakage. Lake shape and location can influence natural wave action. Managers should realize that well water contains no oxygen if wells supply lakes and reservoirs.

Dyes can be used in problem lakes to block sunlight from algae and submerged aquatic weeds to prevent establishment and growth. They will not harm emerged or floating plants or trees with roots extending into lakes. Algaecides and aquatic herbicides can be used to eliminate weed infestations. Pay close attention to desirable shoreline vegetation and observe restrictions and delays required prior to irrigation. Be aware that aquatic vegetation killed by dyes or herbicides increases the oxygen demand on the lake for proper decomposition.

In certain states, plant-eating fish can be stocked to control aquatic vegetation. Sterile white amur can be carefully introduced in limited numbers, depending upon the amount of excess vegetation and habitat required by other fish. Tilapia is a fish recognized for its consumption of algae. However, they are not sterile, can overpopulate, and cannot survive water temperatures below 50 degrees F.

The Toro Aire O_2 is an electrically-powered horizontal aerator.

By eliminating stratification and increasing dissolved oxygen levels throughout lakes, aerators improve the biological balance.

Mechanical methods of aquatic weed control include dredging, harvesting, and aeration. Dredging removes bottom-rooted plants and built-up sediment. A lake's depth can be increased to prevent sunlight from reaching the bottom. The exception is sewage lagoons, which are generally six or less feet deep to prevent stratification.

Harvesting is simply cutting and removing bottom-rooted plants. Removal is essential to relieve a lake from an oxygen drain during decomposition. It does not prevent regrowth, and is generally followed by or used in combination with chemical treatment.

Aeration is the process of increasing the oxygen levels in lakes through injection, fountains, and mixing. The role of aerators in lake management has grown significantly during the past decade as parks and golf courses lean more toward prevention. By eliminating statification and increasing dissolved oxygen levels throughout lakes, aerators improve the biological balance. Aerobic decomposition is therefore able to keep up with nutrient loads and eutrophication is avoided.

Aeration is not a complete solution to aquatic weed control and lake health. But experience has shown it is a valuable tool when used in conjunction with other methods, in some instances reducing dependence on the other methods to a degree.

The value of aeration was established by water treatment facilities. By keeping organic solids suspended in oxygen-rich water, decomposition occurs at a faster rate. Aerobic breakdown also reduces odors. Fish farmers use aeration to improve productivity by increasing the holding capacity of ponds, contributing to the health of fish, and speeding up decomposition of wastes.

A variety of aeration devices are now available for lakes at recreational facilities.

continued on page 16

Lake Health

continued from page 15

Just as no two lakes are the same, neither is the right type of aeration for each. A combination of aerators may offer the best solution in some cases. Lake depth, shape, use, and budget must all be considered.

Lake aerators are generally classified in one of three groups: vertical, horizontal, or diffused air. Vertical aerators lift water from below to the surface, where it is exposed to air. They break through statified layers of water to the depth of the intake. The heavier, cold water brought to the surface

The Rain Jet Aquavator is a fountain-type vertical aerator by Hardie and offers eight different spray patterns and floodlighting for night display.

pushes warm surface layers down. This mixing alone is beneficial to lake health by cooling surface waters and improving decomposition of materials previously trapped beneath the surface. By turning water over within a vertical column, algae is deprived of both the warm water and exposure to sunlight it needs. In the winter, when water from beneath the surface is warmer, aerators prevent formation of ice.

Vertical aerators float on the surface. Since many models pump the water into the air so it can absorb additional oxygen, vertical aerators are often called fountain aerators. This characteristic can be used to make the aerators an attractive addition to lakes and to help point out water hazards to golfers. Light kits are also available to highlight the water spray at night. But as Barebo points out, aerators should not be confused with fountains. "Typically fountains do not move large volumes of water. Aerators move more than 500 gallons of water per horsepower minute."

These aerators are powered by electric motors, generally ranging from 1/3 to ten horsepower. Installation is a matter of anchoring or mooring the unit and having a qualified electrician connect it to a watertight power line from the shore. Manufacturers of electric vertical aerators include Otterbine/Barebo, RainJet Division of Hardie Irrigation, Lake Aid Systems, Airlake Aeration, Inc., and Air-O-Lator.

Lake Aid Systems also offers a wind-powered vertical aerator for locations without an available supply of power. A pump connected to a vertically mounted fan lifts water through an intake tube to the surface, where it is released horizontally. This device relies upon aeration from wave and wind action instead of spraying water into the air. It also requires a location with adequate winds at appropriate times of the year. However, since water does not have to be thrown above the surface and the intake tube can extend to the lake bottom, this unit can be used effectively on deeper lakes than can fountain-type aerators.

One limitation of vertical aerators is their area of influence. They improve water in a vertical column, though wave action and currents may help distribute the aerified water beyond the column to a certain degree.

Horizontal aerators were developed to overcome this limitation. Floating on the surface, they inject air at an angle beneath the surface. Like a boat, a propeller on the end of the aerator creates a powerful stream of water in the top few feet of the lake. Air from the surface is sucked into the stream and enters the water as fine bubbles. The current generated by the aerator can be aimed at problem areas or directed to improve circulation in the lake. Moving water helps keep debris suspended for aerobic decomposition.

Like their vertical cousins, horizontal aerators are electrically powered and installed fairly easily. They do not offer a dramatic display like a fountain, and are usually concealed with an artificial rock or lattice cover. The area of aeration they provide tends to be larger, but the depth of aeration may not be greater. The angle of injection can be adjusted to obtain the right combination of depth and horizontal flow.

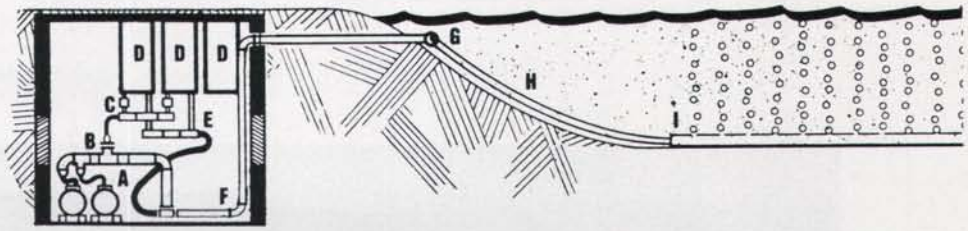
Toro is the prime supplier of horizontal aerators in the turf industry under a marketing agreement with Aeration Industries. Airlake Aeration also markets one.

Studies by the Louisiana Agricultural Experiment Service showed that the actual amount of oxygen transferred to water is

continued on page 18

ACTIVATED OXYGEN AND AERATION
Process Flow Diagram

A - Air Compressors
B - Air Supply Manifold
C - Activated Oxygen Feed Manifold
D - Activated Oxygen Generator
E - Activated Oxygen Collection Manifold
F - Activated Oxygen & Air Mixing Pipe To Shoreline
G - Lake Manifold
H - Lead Weighted Feeder Tubing
I - Lead Weighted Aeration Tubing



Flexalon's Restoration System mixes and aerates water with diffused air from the lake bottom.

Lake Health

continued from page 16

approximately the same per horsepower hour for vertical and horizontal aerators. Choosing between the two is often a matter of lake size and shape. As mentioned before, some lake managers are using a combination of the two for better results.

The third type of aerator, diffused air, injects air along the bottom of lakes through a network of weighted pipes. A land-based air pump blows air through pipes to emitters or perforated tubing placed on the lake bottom. Air bubbles rising to the surface exchange oxygen with water molecules and help mix colder bottom layers with warmer surface layers. The amount of oxygen transferred to the water increases with the depth of the lake.

Diffused air systems have several advantages: The pipe can be laid to fit any contour in the lake, they mix water from the bottom to the surface, there are no power connections within the lake, and the pump is easily accessible for maintenance. However, installation and repair of pipes or emitters may be entailed.

Flexalon and Airlake Aeration, Inc., offer diffused air systems. Flexalon believes it has simplified installation by using weighted plastic tubing in its Lake Restoration System. The flexible tubing can be installed from a boat if necessary. There are no emitters. Air is released through perforations in the tubing.

The company took an extra step by adding an ozone generator to the air injection system. Ozone is a short-lived gas consisting of three oxygen molecules instead of two. Like chlorine, ozone kills harmful bacteria and is used by an increasing number of water treatment facilities. Unlike chlorine, it breaks down quickly to become oxygen gas and leaves no residue. However, it is corrosive to some metals. The ozone generator increases the percentage of oxygen in the air injected into the lake. Air typically contains less than 20 percent oxygen.

Diffused air equipment is most practical to install during lake construction. Spacing should be determined by trained individuals, as the systems produce little water circulation. Since oxygen transfer improves with depth, diffused air systems are most effective on deeper portions of lakes.

No aerator provides an immediate cure for symptoms of poor lake water. They gradually raise levels of dissolved oxygen, and improve the biological balance in lakes over a period of weeks. Many users report odors when aerators are first installed, as gases and sediment trapped in oxygen-deficient lower layers are brought to the surface. However, this is a short-term problem and proves the aerator is correcting stratification.

Aeration should be considered more of a preventative tool than a cure. Do not wait for symptoms of poor lake health before running aerators. And, as just about every manufacturer will tell you, aerators do not constitute a complete aquatic weed control program. However, they are perhaps the most important tool a lake manager can utilize to renovate a sick lake outside of complete reconstruction.

A better understanding of lake management is imperative in today's environment. Each gallon of fresh water is climbing in value. Sports facilities are being judged on the condition of their lakes as well as the quality of their turf. Managers of these facilities today must respond with the best combination of chemicals and equipment available to get the job done.