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Use of Aeration and Water De-stratification Devices in Recreational Ponds

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Pond Stratification

During winter, reduced solar heat cools air temperatures which lower water temperatures in ponds. Except for periods of occasional ice cover, water in southern ponds are well mixed by wind and rain from the fall through the spring months. During that time, constant water mixing results in relatively uniform water temperatures throughout the water column.

Water stratification will occur in some ponds during the spring and summer. Sunlight begins the process by warming the waters near the pond's surface. With increasing depth, this warming is diminished from the loss of the sun's energy as light penetrates the water column and is absorbed. Cooler waters will accumulate throughout the summer months at depths where sunlight is absent. Depleted dissolved oxygen conditions may result in deep water where there is an absence of oxygen-producing algae or plants. Additionally, organic matter will accumulate and decompose near the pond bottom that will consume even more dissolved oxygen. These cooler waters will remain near the pond bottom until they are displaced by sinking surface waters made colder from lower air temperatures, wind or heavy rains.

Pond "Turnover"

Pond turnover is a term used to describe the sudden mixing of stratified water in a pond. The process will frequently occur during the summer or the first cool days and nights of fall. Water that has remained near the pond bottom throughout the warm summer months will be forced to the surface when surface waters become cooler than the deeper water. Dissolved oxygen concentrations may be depleted (below 3 mg/L) throughout the pond provided there is a large enough volume of oxygen-deficient water present to compromise the remaining volume. Sudden mixing of those waters may cause an algal bloom die off, a fish kill, or both.

To maintain good health, warm-water fish require a concentration of 5 mg/L dissolved oxygen. For several weeks, they may be able to withstand concentrations as low as 2-3 mg/L. Physical attributes of certain ponds may contribute to turn-over events related to low dissolved oxygen that result in fish kills. These may include: excessive plant and algae growth, protection from prevailing winds, pond depth, organic material load and pond age.

When to Use Water De-stratification or Aeration Systems?

In most cases, mechanically de-stratifying or aerating a pond during the warm season would increase the availability of dissolved oxygen to algae and fish. Other potential benefits may include the reduction of toxic chemical compounds building up near the pond bottom and reduced nutrient uptake by undesirable cyanobacteria (blue green algae). Increases in fish production may also result (Hargreaves 2003).

Brief descriptions of some basic pond and lake de-stratification and aeration systems are provided. The system best suited for a particular pond will depend on factors such as: average depth, wind exposure, and pond fertility.

In general, diffused air systems are used for water de-stratification in ponds and lakes deeper than 8 feet. De-stratification systems are run either continuously during the warm season, or year-round, to insure daily mixing of the water column. This helps prevent water stratification and low dissolved oxygen conditions from developing.

Aeration devices are best suited for shallow ponds (8 feet deep or less). They are designed to create a refuge of oxygenated water for fish to survive until environmental conditions improve. These devices provide some limited mixing of waters near the surface. Aerators may be operated on timers, or are activated manually when low dissolved oxygen concentrations are detected or anticipated. For instance, nighttime aeration may be practiced between 10:00 pm and 10:00 am during the warm summer months.

Importantly, a diffused air de-stratification system is not a substitute for pond aeration. If fish are to be heavily stocked and fed, the installation of an emergency aeration device should be considered. Alternatively, a diffused air system should provide better water column mixing in deeper ponds than would an aerator. Certain pond management scenarios may benefit from the use of both systems.

Most de-stratification and aeration devices are powered by electricity. In some instances, the cost of pond-side electrical installation may be prohibitive. Wind, solar and diesel-powered devices are available as alternatives. However, it is unlikely that wind or solar energy will provide enough energy to effectively or consistently provide improved water quality.

Diffused Air, Water De-Stratification Systems

Diffused air, de-stratification systems are typically powered by electric air compressors or blowers located near the pond bank. A submerged air hose connects the air source to a series of diffuser grids made of air stones or porous hose. Diffuser grids have a plate, tray or other device that allows placement near, but not directly on the pond bottom. Here they can release air bubbles that rise to the waters surface unobstructed by bottom mud, plants and organic debris

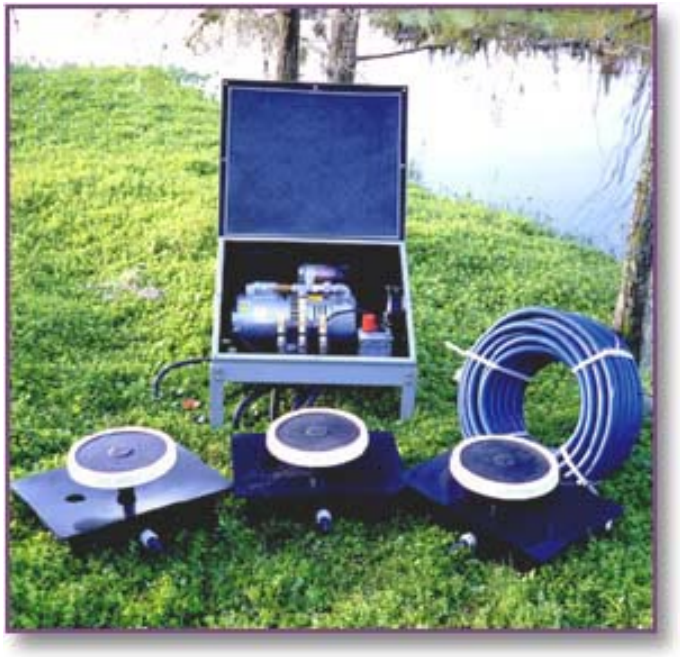
Pond diffuser systems work primarily by promoting movement of deeper water to the surface creating a constant mixing or de-stratifying effect approximately every 24 hours. Secondarily, some oxygen is transferred into the water column as the air bubbles rise to the surface. By keeping the pond waters constantly mixed, a diffused air system may prevent low dissolved oxygen emergencies from occurring, but will do little to correct such an event once it is in progress. These systems are generally run continuously during the warm weather months and may be operated during the winter months to prevent ponds from completely freezing. Diffused air systems may be removed and cleaned during late fall and re-installed in spring before pond stratification occurs.

Oxygen transfer efficiency increases with pond depth and the amount of contact time the air bubbles have with the water column. With the proper compressor, these systems tend to be more efficient in deeper water (greater than 8 feet) than in shallow ponds. Diffusers stones or hoses are made of fine-, medium-, and course-pore material. Fine-pore diffusers release smaller bubbles that have more surface area and transfer oxygen more efficiently to the surrounding water. However, smaller bubbles create less vertical mixing of water as they rise to the surface than larger bubbles. Fine pore devices must be injected with greater air pressure and will clog more frequently than those made of more course material. Course-pore diffusers may be used under lower air pressure and will allow more vertical water movement to the surface. However, the larger bubbles will transfer less oxygen into the water. A medium-pore air diffuser system should be adequate for most pond applications. A large, shallow pond would require more diffusers to be placed on the pond bottom to effectively mix the water column. Alternatively, a deeper pond of similar surface area could use a less powerful compressor to deliver bubbles with greater contact time from fewer diffusers. Diffused air system manufacturers should be consulted regarding the appropriate type and size system to install in a specific pond.

One advantage of a diffused air system is that there is no electrical device in the water which avoids a potential shock hazard. The compressor may be located away from the pond bank. A disadvantage of these devices is the power units tend to be noisy. They are best housed in an insulated enclosure with plenty of ventilation for the air intake. System diffusers and air lines will require periodic cleaning. Air filters will require cleaning or replacement.

Solar and wind powered diffuser systems are available for ponds without access to electricity. However, solar panels must provide enough energy to pump adequate amounts of air into the water to provide effective pond de-stratification during daylight. During nighttime

and cloudy weather conditions, these systems would need to rely on a backup power source, or not function. Unfortunately, these periods are when dissolved oxygen concentrations are typically lowest. Wind powered systems would not function during the hot, calm summer weather when the need for de-stratification is most critical (Hargreaves 2003). Cost and performance of solar and wind driven diffuser devices may limit their practical use.



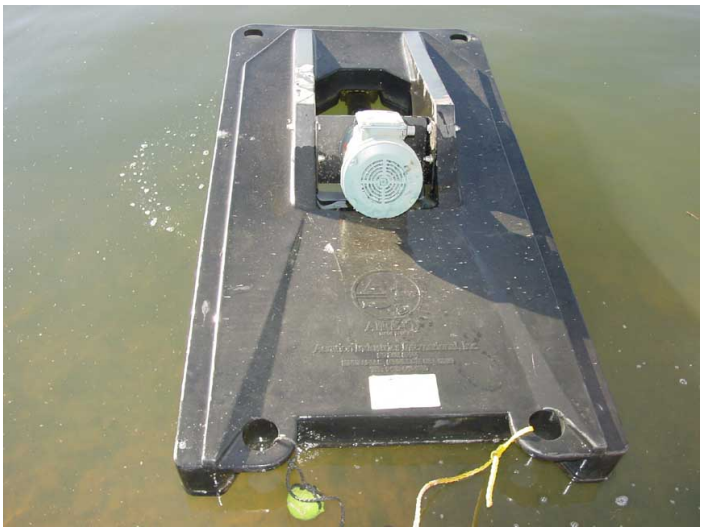
Diffused air system

Pond Aeration

There are a variety of pond aerators on the market. Aeration provides a zone of adequate dissolved oxygen where fish can seek refuge until dissolved oxygen concentrations are naturally restored. A few basic types of aeration devices are described.

Propeller-Aspirator Pump Aerators

A propeller-aspirator pump aerator consists of a surface mounted electric motor supported by a plastic pontoon. A hollow, rotating shaft is attached to the motor and may be adjusted to operate at an injection angle of 25 to 45 degrees in the water column. A propeller is attached to the lower end of the shaft and forces water past the end of the hollow shaft creating a vacuum which draws air from intake ports located above the water surface. Air is injected into the water and then diffused by the propeller below the surface. Air bubbles may be driven to a depth of 5 or 6 feet while moving water horizontally away from the aerator. These units are best suited to shallow ponds (less than 8 feet). Smaller ponds would use 1-3 hp. units, while large models are available up to 100 hp.

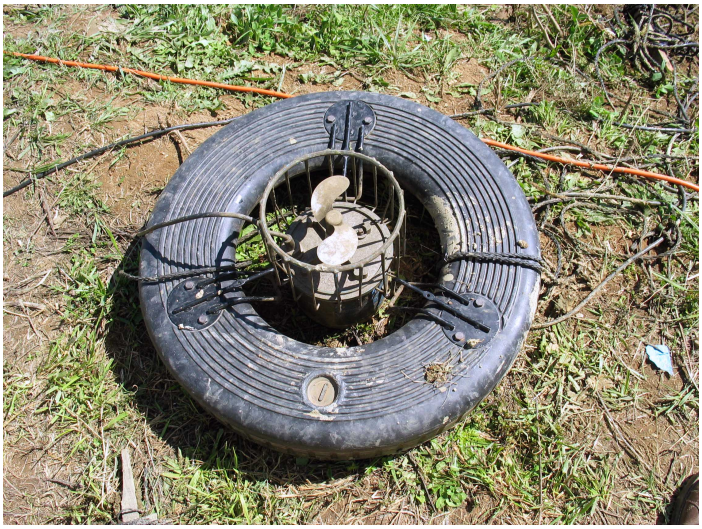


Propeller-Aspirator pump aerator

Vertical Pump Aerators

Vertical pump aerators are primarily used as emergency aeration devices in small, shallow ponds of less than 8 feet deep. Additionally, they may be used to prevent ice formation in small pond areas and in boat houses, when fitted with an appropriate propeller. A vertically submerged electric motor (1/2 to 2 hp) is suspended inside a float and drives a propeller located just below the surface of the water (Tucker 2005). These aerators provide high oxygen transfer efficiency to the nearby water. They will not de-stratify a deep pond since water is drawn to the surface from only a few feet in depth. Some units may be fitted with a pipe to draw water from greater depths of 5 to 7 feet, creating a better pond de-stratifying device. However, this will reduce its effectiveness as an aerator. Horizontal water circulation is minimal inasmuch as the propeller forces the water straight up in the air. Nevertheless, these aerators are well suited for small and particularly shallow ponds.

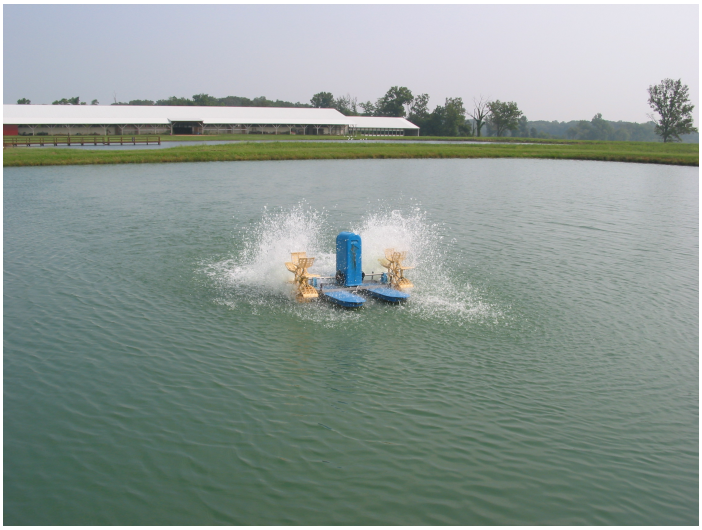
Vertical pump aerator



Vertical pump aerator with ring float

Plastic and Steel Paddlewheel Aerators

Plastic paddlewheel aerators are relatively inexpensive and are frequently used in the marine shrimp industry to aerate and circulate water in small, heavily stocked ponds. Plastic pontoons support a 1 to 2 hp electric motor which drives 2 or 4 plastic paddlewheels on a steel shaft. These devices do not transfer oxygen efficiently into the water. However, they do provide a reasonable amount of horizontal water circulation especially when used continuously in small, shallow (less than 8 feet deep) ponds. Paddlewheel aerators will not de-stratify ponds by mixing water vertically. Plastic paddlewheels are lightweight and relatively easy to assemble and install in ponds. In the past, the electric motors have not been reliable and have required replacement in some models.



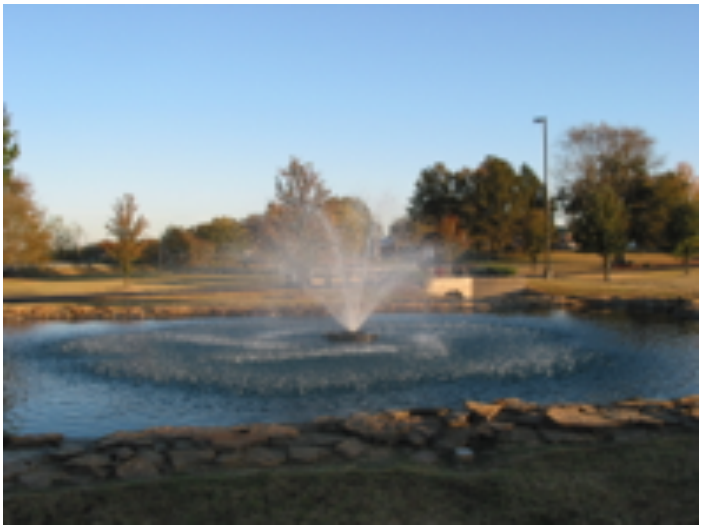
Plastic paddlewheel aerator

Steel paddlewheel aerators are primarily used on large, shallow aquaculture ponds. These aerators are rated from ½ to 20 hp and may be well suited for use in ponds where there is minimal need for vertical water de-stratification of depths greater than 10 feet. An electric motor drives a steel spindle with the attached blades arranged in a whorl pattern. The spindle and motor is housed in a metal frame. The aerators' frame rests on two aluminum pontoons and is anchored to the pond bank by steel arms. A high rate of oxygen transfer (Tucker 2005) and plenty of horizontal water movement is provided by these units. Water is pushed from only a few inches below the waters' surface providing little de-stratification of the water column. Although continuous operation is an option, typically these devices are timer or manually activated to run during the night, or as needed in emergency situations. Steel paddlewheels are durable and should provide years of service. They are more expensive than most other aerators.

Steel paddlewheel aerator

Fountains

Pond fountains consist of a series of nozzles that are supported by a float device and are fed water via a submerged electric pump. When compared to a vertical pump aerator, relatively small volumes of water are sprayed under high pressure into the air for aesthetic purposes. Some fountain pumps may be positioned near the pond bottom to provide some degree of water column de-stratification. Fountains will not typically provide an energy efficient or practical source or aeration/water de-stratification in most ponds.



Fountain

Conclusion

Diffused air systems should provide effective water de-stratification in deep ponds and lakes. However, air diffusers do not circulate water horizontally efficiency and their efficacy in shallow ponds (less than 8 feet deep) may be limited. Surface aerators are best suited to supply emergency aeration for shallow ponds. In some applications, both diffused air systems and aeration devices could be used simultaneously. Pond fountains emphasize visual aesthetics and should not be considered aerators or water circulation devices in all but the smallest and shallowest of ponds.

References

Hargreaves, J. A. 2003. Pond Mixing. Southern Regional Aquaculture Center Publication 4602, United States Department of Agriculture, Cooperative State Research, Education, and Extension Service. Mississippi State University, Mississippi State, Mississippi.

Tucker, C. 2005. Pond Aeration. Southern Regional Aquaculture Center Publication No. 3700, United States Department of Agriculture, Cooperative State Research, Education, and Extension Service. Mississippi State University, Mississippi State, Mississippi.

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