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

Forrest Wynne [1]

Pond Stratification

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

Water "stratification" will occur in some ponds during the warm weather months. This process begins when sunlight warms the waters near the pond's surface during spring and summer. With increasing depth, this warming influence is diminished due to the loss of the sun's energy as light penetrates into the water column and is absorbed. This allows cooler waters to accumulate throughout the summer months at depths where sunlight is not present. Depleted dissolved oxygen conditions may result in deep waters due to the absence of oxygen producing plants and algae that can not survive without sunlight. Organic matter will accumulate and decompose on the pond bottom which consumes even more 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 waters in a pond. This process will frequently occur during the summer or the first cool days of fall. Water that has sat 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 may be depleted throughout the entire pond provided there is a large enough volume of oxygen deficient water present. The sudden mixing of these waters may cause an algal bloom die off, a fish kill, or both.

To maintain good health, warmwater fish require a concentration of 5 mg/L dissolved oxygen. For short durations, they can withstand concentrations as low as 2 or 3 mg/L. Coldwater fish such as trout require 7 mg/L of dissolved oxygen to survive. The physical attributes of certain ponds may contribute to "turnover" and low dissolved oxygen events that result in fish kills. These would include: excessive plant and algae growth in extensive shallow areas, protection from prevailing winds, depths greater than 8 feet, and high inputs of nutrients or organic material.

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 the prevention of excessive nutrient uptake by plants or algae that may stimulate unwanted growth. 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 a number of factors including: physical pond characteristics, the density of the algae “bloom” or population, the amount of fish present and if any, the amount of fish food fed per surface acre/day.

In general, diffused air systems are used for water de-stratification in deeper ponds (8 feet or deeper) and lakes. These ponds would contain less than 1,000 lbs of fish per surface acre and should be fed less than 30 lbs per acre/day of feed in order to maintain light to moderate algae blooms. De-stratification systems are run continuously during the warm season to provide constant mixing of the water column. This helps prevent water stratification and low dissolved oxygen situations from developing.

Aeration systems may provide some limited mixing of the ponds’ water column. However, these devices are designed to create a refuge of oxygenated water for the fish to survive in until environmental conditions improve in the pond. Aeration systems are often run on a timer device, or are activated manually when low dissolved oxygen concentrations are detected or anticipated. Aeration devices are best suited for shallow ponds (8 feet deep or less) or are used in aquaculture ponds that contain dense algae blooms. These blooms typically occur in ponds where fish are grown at a rate of 1,000 lbs or more per acre and are fed more than 30 lbs of feed per surface acre/day. Recreational ponds would require aeration units rated at 1/2 to 1 hp per surface acre. Heavily stocked (and fed) fish production ponds may require units rated from 1 to 3 hp per acre.

A diffused air de-stratification system is not a substitute for an emergency aeration device. 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 ponds may benefit from using both systems.

Many de-stratification and aeration systems are powered by electricity. In some instances, the cost of pond side electrical installation may be prohibitive. In certain situations, wind, solar and diesel powered devices may be considered as alternatives.

Diffused Air, Water De-Stratification Systems

Diffused air, water de-stratification systems are typically powered by electric air compressors or blowers located on the pond bank. A submerged air hose connects the air source to a series of diffuser grids made of air stones, tubing 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. Some diffused air systems use secured, floating airlines that stretch into or across the ponds' surface. Air stones are suspended in the water column by plastic tubing or hoses connected to the floating air line.

Blower with floating airline

The diffuser system works primarily by moving deeper waters to the surface creating a constant mixing or "de-stratifying" effect. 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. In southern climates, air diffuser systems may be removed and cleaned during late fall and re-installed in spring before pond stratification occurs.

Diffused air system oxygen transfer efficiency increases with pond depth and the amount of contact time the air bubbles have with the water column. As a result, these systems would be more efficient in deeper water (8 feet or deeper) than shallow ponds. Diffusers 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 recreational pond applications. A large, shallower 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 blower 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.

Round diffuser stone

One advantage of a diffused air system is that there is no electrical device in the water. The electric blower or compressor may be located away from the pond. 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 also require cleaning or replacement.

Solar and wind powered diffuser systems are available for ponds without access to electricity. 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 have to rely on a backup power source, or not function at all. These are the times when dissolved oxygen concentrations are typically lowest. Wind powered systems would not function during the hot, calm days or nights of summer, another period when the need for de-stratification would be critical (Hargreaves 2003). Cost and performance considerations of solar and wind driven diffuser devices may render them of limited practical use for ponds in the southern United States. In 2005 the cost of an electric diffused air system started at approximately $700.00.

Diffused air system

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 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 waters' 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 deep) and are capable of providing emergency aeration in aquaculture ponds. Smaller ponds would use the 1-3 hp units starting at an approximate cost of $750.00. Larger models are available up to 100 hp.

Propeller-Aspirator pump aerator

Vertical pump aerator

Vertical pump aerator with ring float

Vertical Pump Aerators

Vertical pump aerators are typically used as emergency aeration devices in small, shallow (less than 8 feet deep) aquaculture ponds that are heavily stocked with fish. Additionally, they are used to prevent ice formation on small pond areas and in boat houses. A vertically submerged electric motor (1/2 to 2 hp) is suspended inside a float and drives a propeller located just below the waters' surface (Tucker 2005). These aerators provide high oxygen transfer efficiency to the water nearby. 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 tube to draw water from greater depths (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 since the propeller forces the water straight up into the air. Nevertheless, these aerators may be well suited for small and particularly shallow recreational ponds. Surface aerators start at a cost of $700.00.

Plastic and Steel Paddlewheel Aerators

Plastic paddlewheel aerators are relatively inexpensive ($700.00 and up) 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 (less than 8 feet deep) aquaculture ponds. These aerators are rated from ½ to 20 hp and may be well suited for use in shallow recreational ponds where there is minimal need for vertical water de-stratification. 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 if any de-stratification of the water column. Although continuous operation is an option, typically these devices are timer activated to run during nighttime hours, or as needed in emergency situations. Steel paddlewheels are durable and should provide years of service. They are more expensive than most other aerators with ½ hp units starting at about $1,200.00.

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 high into the air primarily for aesthetic purposes. Some fountain pumps may be positioned near the pond bottom to provide a 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. Without lights, a ½ hp pond fountain costs about $1,000, or more.

Fountain

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.

[1]State Extension Specialist for Aquaculture, Kentucky State University Aquaculture Program
Graves County Extension Office
251 Housman Street
Mayfield, KY 42066
(270)247-2334
E mail: fwynne@uky.edu