Y S I Environmental

Application Note

# Dissolved Oxygen Management and Related Costs in Pond Aquaculture

Dissolved oxygen control is critical in aquaculture. Dissolved oxygen, the volume of oxygen contained in water, is often the critical parameter in the health and well-being of your livestock. In general, most fish species will grow and thrive within a DO range of 5-12 mg/L (ppm). However, if levels drop below 4 mg/L they may stop feeding, become stressed and begin to die. This series of events can start a chain reaction in a pond aquaculture system that could prove detrimental.

Oxygen depletion usually occurs in the summer months because warmer water holds less oxygen than cooler water. For example, water with a temperature of 32°C can hold up to 7.3 mg/L of oxygen, while 7°C water can hold 12.1 mg/L. As water temperatures rise, oxygen levels decrease. Higher temperatures also increase the metabolic rate of fish resulting in the need for more oxygen.

*A typical pond at an aquaculture facility receiving oxygenation through a paddle wheel. As energy costs rise, make sure you can accurately determine when to aerate and when it's unnecessary.*

In summer months, ponds can undergo stratification because of differences in water densities with differing temperatures. Cooler water sinks, warmer water rises, and the water at the top of the pond is heated more rapidly through radiation by the sun. Although the pond's cooler bottom temperature holds more dissolved oxygen when the summer starts, as the summer progresses microbial decomposition of organic materials depletes oxygen at the pond's bottom.

*Manually checking a pond with the YSI Professional Plus.*

According to some studies, calculating with 1-m water depth, the 24 hour-long oxygen consumption of the pond bottom changes between 1 and 3 mg/L. In addition, the natural diurnal cycle in aquatic systems fluctuates greatly and can be exacerbated in aquaculture systems with high stocking densities. See Graph 1 for an average pond's DO diurnal cycle.

In order to accurately understand these differences and changes, most fish farmers use oxygen sensors to monitor dissolved oxygen and prevent oxygen depletion through monitoring and control. If levels drop too low, turning on an aeration system can quickly increase dissolved oxygen levels. Some farms operate more manually with workers checking ponds occasionally with a handheld instrument such as the YSI Professional Plus (www.ysi.com/proplus) then manually turning on an aerator or operating a tractor powered paddle wheel. Ponds can still be checked manually to validate the continuous monitor.

More efficient systems allow for an instrument such as the YSI 5400 MultiDO Monitor (www.ysi.com/5400) to continuously monitor the ponds and automatically control an aeration system based on preset levels. This allows farms to operate aerating systems more efficiently which significantly reduces energy costs and allows labor personnel to be used in other areas.

The 5400 instrument allows for multiple inputs so several ponds can be monitored continuously with remote alarming and control capabilities. There are various levels of control available allowing you to input more than one set point. The instrument could simply send an alarm such as a text message if the first set point is reached allowing you time to make good management decisions. Once the second point is reached, the 5400 can be set to control by turning on an aerating system to get the pond back into preset normal ranges.

As energy costs rise, reducing ongoing operating expenses becomes more and more important in an operation. Automatic monitoring with control can have a significant cost savings. Field testing shows, on average, an automatic system reduces aeration by 4 hours per night.

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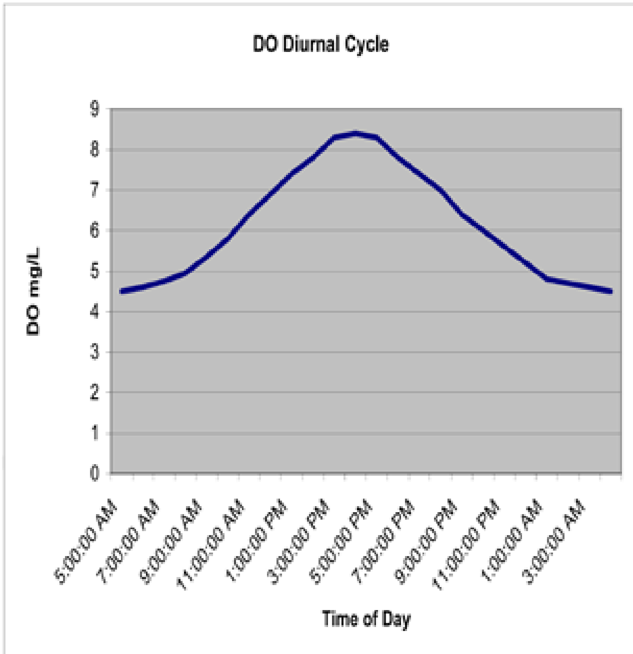


*Graph 1. Typical dissolved oxygen values of diurnal changes in a natural pond system. Heavily planted or stocked ponds can affect the values even more.*

If we assume two 10-hp paddle wheel aerators per pond on a farm with 8 large ponds we can determine a cost savings. Most energy costs are reported in cents per kilowatt hour ($/kWh). If we assume .1003/kWh for the energy cost and we use the following formula to calculate the cost, we could realize a significant savings through automation.

***Energy Cost Savings Example****

$ = hp x .746 x $/kWh x (4 hours saved per night)

hp is total horsepower and .746 is the conversion from hp to kW.

With two aerators per pond, running approximately 10 hours per night, the electricity costs saved would be:

(2 x 10 hp) x .746 x $0.1003/kWh x 4 hrs saved = $5.98 per night per pond

$5.98 per night per pond x 8 ponds = $47.84 per night total

$47.84 per night total x 30 days = **$1,435.20 per month**

* kWh cost average for March 2010 was 10.03 cents. Source www.eia.doe.gov

Not only can this system save on energy costs but it can also have definite added benefits. Personnel can be used in other areas of the operation more efficiently, potentially costly fish losses can be eliminated, and food costs can be reduced by feeding only when the conditions are optimal to feed. The Feed Smart™ software built into the 5400 allows you to also control your automatic feeders and account directly for feed conversion ratios (FCRs).

Ultimately, you have to make a decision for your operation on continual DO monitoring and control. Continuous, automatic DO monitoring can eliminate fish loss, reduce labor and energy costs, yield more productive ponds, make better pond management decisions, and provide valuable peace of mind.

*For additional aquaculture information including specifications on the YSI instruments, please visit:*
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*YSI 5400 multi-dissolved oxygen instrument with control and alarming capabilities.*