Aquaculture in the Classroom Newsletter
Volume 4, No.5, June 2016

Dear Aquaculture Enthusiasts:

In the last letter I introduced a pH management diagram. This will be reviewed and discussed as promised. Also reviewed from previous years is a simple way to spawn your tilapia over the summer. The last article is a review about on what to do and what not to do with your fish if you do not plan to keep them.

Alkalinity and pH control

(KH seen on this box is shorthand for alkalinity)

Summer Tilapia Spawning

Nature Friendly Fish Disposal

Alkalinity and pH Control

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \leftrightarrow 2H^+ + CO_3^{-2}$$

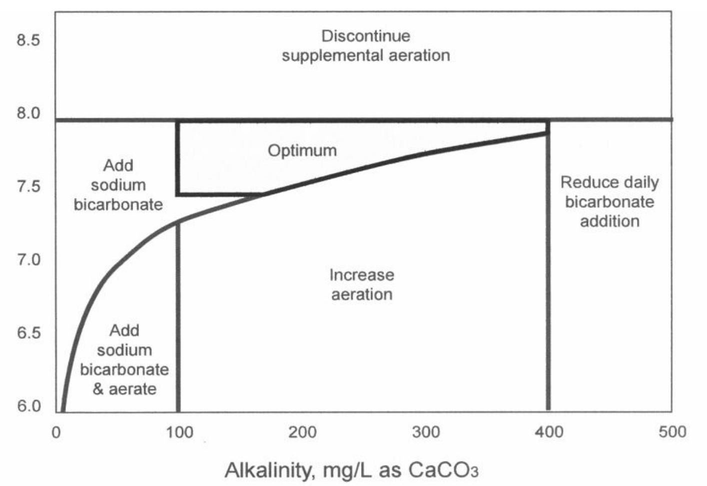

Figure 2. The pH management diagram, a graphical solution of the ionization constant equation for carbonic acid at 25oC.

Courtesy of Ronald F. Malone, Department of Civil Engineering, Louisiana State University, from Master's Thesis of Peter A. Allain, 1988, "Ion Shifts and pH Management in High Density Shedding Systems for Blue Crabs (Callinectes sapidus) and Red Swamp Crawfish (Procambarus clarkii)," Louisiana State University.

Alkalinity and the equation for carbon dioxide in water are very important in pH control. Depending upon the alkalinity of water, pH may need to be controlled by addition of baking soda, or simple aeration.

First, let us consider the chemical equation. This is three equations put together. It is important to note the arrows between sections of the equation are double arrows, meaning the equation can move to the left or to the right, depending upon what is present in the solution.

Fish respire and create CO_2. Algae do the same at night. Bacteria also create CO_2. So CO_2 is constantly created and dumped into the water. The first part of the equation shows us that when carbon dioxide and water are mixed, carbonic acid (H_2CO_3) results. The second part shows us that when carbonic acid is in water it ionizes into a hydrogen ion (H^+) and a bicarbonate ion (HCO_3^-). The last part shows us that the ionization can continue so 2 hydrogen ions form in addition to a carbonate ion (CO_3^{-2}).

Two things help the equation move in one direction or another. One is pH and the other is the quantity of chemical available. If we add lots of CO_2 to the solution, more and more hydrogen ions will be formed and the solution will become acidic. If we add sodium bicarbonate (baking soda) there will be more bicarbonate in the water and it will act like a sponge, combining with the hydrogen ions that have been formed. By neutralizing those hydrogen ions, pH does not continue to drop.

Alkalinity is the amount of bicarbonate or carbonate available to act as the sponge to soak up the hydrogen ions. Bicarbonate is most prevalent between pH 6 and 10. Carbonate is most prevalent from pH 10 and up. When alkalinity measures 30 – 100ppm, it is at an acceptable level. From 100 to 300ppm it is still reasonable, but it does present us will some difficulty in an RAS. Alkalinity at this level provides a huge sponge for hydrogen ion elimination, but it also means pH will not drop below 8 and that can mean problems if the total ammonia as nitrogen (TAN) gets too high.

Beyond 400ppm, alkalinity is considered a problem in a RAS. Between 100 and 400ppm, but below pH 7.5, no baking soda should have to be added to the system. So, if you are automatically adding sodium bicarbonate because you are feeding and anticipating a drop in pH, this would be wrong. Adding more baking soda could increase pH beyond the 6.8 – 7.2 range desired. Remember in the last newsletter, I said to check pH before adding baking soda.

Looking at the graph above, sometimes it instructs us to aerate only, add sodium bicarbonate only or do both. Why? Addition of sodium bicarbonate solves the problem of low pH and low alkalinity. The graph shows when alkalinity is between 5 and 100 and below 7.2, sodium bicarbonate and aeration should be added. But if pH is between 7.2 and 8 and alkalinity is between 100 and 400, only aeration should be used. A more complex portion of the graph advises to add only sodium bicarbonate.

In the first situation, bicarbonate addition will raise alkalinity. As more bicarbonate is added, the carbon dioxide equation equilibrium moves to the left and will add more carbon dioxide to the water. Aeration will force the carbon dioxide out of solution and into the air above. That carbon dioxide is no longer available to create carbonic acid and drop pH.

In the second situation, there is plenty of alkalinity in the water. It acts just as if sodium bicarbonate is being added. Therefore, no sodium bicarbonate addition is needed to raise pH, the alkalinity sponge is at work absorbing the hydrogen ions. However, the equation is still moving left and aeration will prudently remove carbon dioxide from the water.

Finally, the most interesting portion of the graph, based upon the shape it describes, calls for only adding sodium bicarbonate. This is the area where most of our systems abide. There is not quite enough bicarbonate, but there is not so much carbon dioxide that aeration is needed.

Summer Tilapia Spawning

If you are interested in spawning tilapia over the summer, now is the time to set up a tank, stock it, and let nature take its course. It is best to use a tank that does not have a biofilter so the young fish do not get scooped up by the pumps and run through the biofilter.

Rather a tank with a flat bottom and 18 – 24 inches of water will suffice for spawning. The water may be allowed to turn green. This provides food for newborn fish and reduces water clarity so the males do not constantly bother the females. Check the tank (a cattle watering trough is a good size) every two weeks to see if any fry are swimming around the edges of the tank. If so, net them out and put them in another tank to protect them from hungry adults.

Nature Friendly Fish Disposal

(Reprinted from V2N4, 2014)

What do you do with your fish at the end of the year? Do you:

1. Sell them
2. Harvest and eat them
3. Carry them over to the next school year in your tanks
4. Send them home with the students
5. Set them free in the wild

A couple of these options (5and6) are potentially problematic. A survey was published in 2012 that showed 25 percent of teachers who used organisms in the classroom then released them into the wild. But only 10 percent of those teachers participated in a planned release program. Consequently, those well-intentioned teachers might be introducing nuisance species into the wild. We use tilapia in many of our systems. Tilapia is an exotic fish that has been in the United States for many decades. However, it is closely regulated in many states. Here in Arkansas, the Game and Fish Commission has experimented with stocking tilapia into two lakes. The demonstrations showed that the tilapia perished as the lakes dropped in temperature and there were no signs of tilapia in those lakes after the winter. UAPB Aquaculture Extension personnel have generally advised that the tilapia not be put into bodies of water south of I-40. If a body of water has a warm source, such as a spring or heated water from a power plant (e.g. Lake Dardanelle) the tilapia could establish themselves under those conditions. Tilapia are aggressive and can greatly change the eco-balance in a body of water.

If you send tilapia home with students for their aquaria, make sure they understand they should not release them into the wild. You should not take a class out to a lake and "Free Willy." This is also true if you raise other species (perch, crayfish, etc.) you have ordered from outside of Arkansas. If the species are from Arkansas, you should still have them tested at one of our UAPB Fish Diagnostic Labs (Jonesboro, Lonoke, Pine Bluff, or Lake Village) before you send them out into the world to make sure they are not spreading some nasty disease to their brothers and sisters in the wild. The labs can also give you options for euthanizing the animals if needed. All services from these labs are free (your tax dollars at work).

Best Fishes,
Bauer